Annex 29

COUR INTERNATIONALE DE JUSTICE

RECUEIL DES ARRÊTS,
AVIS CONSULTATIFS ET ORDONNANCES

AFFAIRE RELATIVE AU MANDAT D'ARRÊT DU 11 AVRIL 2000

(RÉPUBLIQUE DÉMOCRATIQUE DU CONGO c. BELGIQUE)

ARRÊT DU 14 FÉVRIER 2002

2002

INTERNATIONAL COURT OF JUSTICE

REPORTS OF JUDGMENTS,
ADVISORY OPINIONS AND ORDERS

CASE CONCERNING THE ARREST WARRANT OF 11 APRIL 2000

(DEMOCRATIC REPUBLIC OF THE CONGO *v.* BELGIUM)

JUDGMENT OF 14 FEBRUARY 2002

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INTERNATIONAL COURT OF JUSTICE

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14 February 2002

CASE CONCERNING THE ARREST WARRANT OF 11 APRIL 2000

(DEMOCRATIC REPUBLIC OF THE CONGO *v.* BELGIUM)

Facts of the case — Issue by a Belgian investigating magistrate of "an international arrest warrant in absentia *" against the incumbent Minister for Foreign Affairs of the Congo, alleging grave breaches of the Geneva Conventions of 1949 and of the Additional Protocols thereto and crimes against humanity — International circulation of arrest warrant through Interpol — Person concerned subsequently ceasing to hold office as Minister for Foreign Affairs.*

* *

First objection of Belgium — Jurisdiction of the Court — Statute of the Court, Article 36, paragraph 2 — Existence of a "legal dispute" between the Parties at the time of filing of the Application instituting proceedings — Events subsequent to the filing of the Application do not deprive the Court of jurisdiction.

Second objection of Belgium — Mootness — Fact that the person concerned had ceased to hold office as Minister for Foreign Affairs does not put an end to the dispute between the Parties and does not deprive the Application of its object.

Third objection of Belgium — Admissibility — Facts underlying the Application instituting proceedings not changed in a way that transformed the dispute originally brought before the Court into another which is different in character.

Fourth objection of Belgium — Admissibility — Congo not acting in the context of protection of one of its nationals — Inapplicability of rules relating to exhaustion of local remedies.

Subsidiary argument of Belgium — Non ultra petita *rule — Claim in Application instituting proceedings that Belgium's claim to exercise a universal jurisdiction in issuing the arrest warrant is contrary to international law — Claim not made in final submissions of the Congo — Court unable to rule on that ques-*

tion in the operative part of its Judgment but not prevented from dealing with certain aspects of the question in the reasoning of its Judgment.

* *

Immunity from criminal jurisdiction in other States and also inviolability of an incumbent Minister for Foreign Affairs — Vienna Convention on Diplomatic Relations of 18 April 1961, preamble, Article 32 — Vienna Convention on Consular Relations of 24 April 1963 — New York Convention on Special Missions of 8 December 1969, Article 21, paragraph 2 — Customary international law rules — Nature of the functions exercised by a Minister for Foreign Affairs — Functions such that, throughout the duration of his or her office, a Minister for Foreign Affairs when abroad enjoys full immunity from criminal jurisdiction and inviolability — No distinction in this context between acts performed in an "official" capacity and those claimed to have been performed in a "private capacity".

No exception to immunity from criminal jurisdiction and inviolability where an incumbent Minister for Foreign Affairs suspected of having committed war crimes or crimes against humanity — Distinction between jurisdiction of national courts and jurisdictional immunities — Distinction between immunity from jurisdiction and impunity.

Issuing of arrest warrant intended to enable the arrest on Belgian territory of an incumbent Minister for Foreign Affairs — Mere issuing of warrant a failure to respect the immunity and inviolability of Minister for Foreign Affairs — Purpose of the international circulation of the arrest warrant to establish a legal basis for the arrest of Minister for Foreign Affairs abroad and his subsequent extradition to Belgium — International circulation of the warrant a failure to respect the immunity and inviolability of Minister for Foreign Affairs.

* *

Remedies sought by the Congo — Finding by the Court of international responsibility of Belgium making good the moral injury complained of by the Congo — Belgium required by means of its own choosing to cancel the warrant in question and so inform the authorities to whom it was circulated.

JUDGMENT

Present: *President* GUILLAUME; *Vice-President* SHI; *Judges* ODA, RANJEVA, HERCZEGH, FLEISCHHAUER, KOROMA, VERESHCHETIN, HIGGINS, PARRA-ARANGUREN, KOOIJMANS, REZEK, AL-KHASAWNEH, BUERGENTHAL; *Judges* ad hoc BULA-BULA, VAN DEN WYNGAERT; *Registrar* COUVREUR.

In the case concerning the arrest warrant of 11 April 2000,

between

the Democratic Republic of the Congo,

represented by

H.E. Mr. Jacques Masangu-a-Mwanza, Ambassador Extraordinary and Plenipotentiary of the Democratic Republic of the Congo to the Kingdom of the Netherlands,

as Agent;

H.E. Mr. Ngele Masudi, Minister of Justice and Keeper of the Seals,
Maître Kosisaka Kombe, Legal Adviser to the Presidency of the Republic,
Mr. François Rigaux, Professor Emeritus at the Catholic University of Louvain,
Ms Monique Chemillier-Gendreau, Professor at the University of Paris VII (Denis Diderot),
Mr. Pierre d'Argent, Chargé de cours, Catholic University of Louvain,
Mr. Moka N'Golo, Bâtonnier,
Mr. Djeina Wembou, Professor at the University of Abidjan,

as Counsel and Advocates;

Mr. Mazyambo Makengo, Legal Adviser to the Ministry of Justice,

as Counsellor,

and

the Kingdom of Belgium,

represented by

Mr. Jan Devadder, Director-General, Legal Matters, Ministry of Foreign Affairs,

as Agent;

Mr. Eric David, Professor of Public International Law, Université libre de Bruxelles,
Mr. Daniel Bethlehem, Barrister, Bar of England and Wales, Fellow of Clare Hall and Deputy Director of the Lauterpacht Research Centre for International Law, University of Cambridge,

as Counsel and Advocates;

H.E. Baron Olivier Gilles de Pélichy, Permanent Representative of the Kingdom of Belgium to the Organization for the Prohibition of Chemical Weapons, responsible for relations with the International Court of Justice,
Mr. Claude Debrulle, Director-General, Criminal Legislation and Human Rights, Ministry of Justice,
Mr. Pierre Morlet, Advocate-General, Brussels Cour d'Appel,
Mr. Wouter Detavernier, Deputy Counsellor, Directorate-General Legal Matters, Ministry of Foreign Affairs,
Mr. Rodney Neufeld, Research Associate, Lauterpacht Research Centre for International Law, University of Cambridge,
Mr. Tom Vanderhaeghe, Assistant at the Université libre de Bruxelles,

THE COURT,

composed as above,

after deliberation,

delivers the following Judgment:

1. On 17 October 2000 the Democratic Republic of the Congo (hereinafter referred to as "the Congo") filed in the Registry of the Court an Application instituting proceedings against the Kingdom of Belgium (hereinafter referred to as "Belgium") in respect of a dispute concerning an "international arrest warrant issued on 11 April 2000 by a Belgian investigating judge . . . against the Minister for Foreign Affairs in office of the Democratic Republic of the Congo, Mr. Abdulaye Yerodia Ndombasi".

In that Application the Congo contended that Belgium had violated the "principle that a State may not exercise its authority on the territory of another State", the "principle of sovereign equality among all Members of the United Nations, as laid down in Article 2, paragraph 1, of the Charter of the United Nations", as well as "the diplomatic immunity of the Minister for Foreign Affairs of a sovereign State, as recognized by the jurisprudence of the Court and following from Article 41, paragraph 2, of the Vienna Convention of 18 April 1961 on Diplomatic Relations".

In order to found the Court's jurisdiction the Congo invoked in the aforementioned Application the fact that "Belgium ha[d] accepted the jurisdiction of the Court and, in so far as may be required, the [aforementioned] Application signifie[d] acceptance of that jurisdiction by the Democratic Republic of the Congo".

2. Pursuant to Article 40, paragraph 2, of the Statute, the Application was forthwith communicated to the Government of Belgium by the Registrar; and, in accordance with paragraph 3 of that Article, all States entitled to appear before the Court were notified of the Application.

3. Since the Court included upon the Bench no judge of the nationality of either of the Parties, each Party proceeded to exercise the right conferred by Article 31, paragraph 3, of the Statute to choose a judge *ad hoc* to sit in the case; the Congo chose Mr. Sayeman Bula-Bula, and Belgium Ms Christine Van den Wyngaert.

4. On 17 October 2000, the day on which the Application was filed, the Government of the Congo also filed in the Registry of the Court a request for the indication of a provisional measure based on Article 41 of the Statute of the Court. At the hearings on that request, Belgium, for its part, asked that the case be removed from the List.

By Order of 8 December 2000 the Court, on the one hand, rejected Belgium's request that the case be removed from the List and, on the other, held that the circumstances, as they then presented themselves to the Court, were not such as to require the exercise of its power under Article 41 of the Statute to indicate provisional measures. In the same Order, the Court also held that "it [was] desirable that the issues before the Court should be determined as soon as possible" and that "it [was] therefore appropriate to ensure that a decision on the Congo's Application be reached with all expedition"

5. By Order of 13 December 2000, the President of the Court, taking account of the agreement of the Parties as expressed at a meeting held with their Agents on 8 December 2000, fixed time-limits for the filing of a Memorial by the Congo and of a Counter-Memorial by Belgium, addressing both issues of jurisdiction and admissibility and the merits. By Orders of 14 March 2001 and 12 April 2001, these time-limits, taking account of the reasons given by the Congo and the agreement of the Parties, were successively extended. The Memorial of the Congo was filed on 16 May 2001 within the time-limit thus finally prescribed.

6. By Order of 27 June 2001, the Court, on the one hand, rejected a request

by Belgium for authorization, in derogation from the previous Orders of the President of the Court, to submit preliminary objections involving suspension of the proceedings on the merits and, on the other, extended the time-limit prescribed in the Order of 12 April 2001 for the filing by Belgium of a Counter-Memorial addressing both questions of jurisdiction and admissibility and the merits. The Counter-Memorial of Belgium was filed on 28 September 2001 within the time-limit thus extended.

7. Pursuant to Article 53, paragraph 2, of the Rules, the Court, after ascertaining the views of the Parties, decided that copies of the pleadings and documents annexed would be made available to the public at the opening of the oral proceedings.

8. Public hearings were held from 15 to 19 October 2001, at which the Court heard the oral arguments and replies of:

For the Congo: H.E. Mr. Jacques Masangu-a-Mwanza,
H.E. Mr. Ngele Masudi,
Maître Kosisaka Kombe,
Mr. François Rigaux,
Ms Monique Chemillier-Gendreau,
Mr. Pierre d'Argent.

For Belgium: Mr. Jan Devadder,
Mr. Daniel Bethlehem,
Mr. Eric David.

9. At the hearings, Members of the Court put questions to Belgium, to which replies were given orally or in writing, in accordance with Article 61, paragraph 4, of the Rules of Court. The Congo provided its written comments on the reply that was given in writing to one of these questions, pursuant to Article 72 of the Rules of Court.

*

10. In its Application, the Congo formulated the decision requested in the following terms:

> "The Court is requested to declare that the Kingdom of Belgium shall annul the international arrest warrant issued on 11 April 2000 by a Belgian investigating judge, Mr. Vandermeersch, of the Brussels Tribunal de première instance against the Minister for Foreign Affairs in office of the Democratic Republic of the Congo, Mr. Abdulaye Yerodia Ndombasi, seeking his provisional detention pending a request for extradition to Belgium for alleged crimes constituting 'serious violations of international humanitarian law', that warrant having been circulated by the judge to all States, including the Democratic Republic of the Congo, which received it on 12 July 2000."

11. In the course of the written proceedings, the following submissions were presented by the Parties:

On behalf of the Government of the Congo,

in the Memorial:

> "In light of the facts and arguments set out above, the Government of the Democratic Republic of the Congo requests the Court to adjudge and declare that:

1. by issuing and internationally circulating the arrest warrant of 11 April 2000 against Mr. Abdulaye Yerodia Ndombasi, Belgium committed a violation in regard to the DRC of the rule of customary international law concerning the absolute inviolability and immunity from criminal process of incumbent foreign ministers;
2. a formal finding by the Court of the unlawfulness of that act constitutes an appropriate form of satisfaction, providing reparation for the consequent moral injury to the DRC;
3. the violation of international law underlying the issue and international circulation of the arrest warrant of 11 April 2000 precludes any State, including Belgium, from executing it;
4. Belgium shall be required to recall and cancel the arrest warrant of 11 April 2000 and to inform the foreign authorities to whom the warrant was circulated that, following the Court's Judgment, Belgium renounces its request for their co-operation in executing the unlawful warrant."

On behalf of the Government of Belgium,

in the Counter-Memorial:

"For the reasons stated in Part II of this Counter-Memorial, Belgium requests the Court, as a preliminary matter, to adjudge and declare that the Court lacks jurisdiction in this case and/or that the application by the Democratic Republic of the Congo against Belgium is inadmissible.

If, contrary to the preceding submission, the Court concludes that it does have jurisdiction in this case and that the application by the Democratic Republic of the Congo is admissible, Belgium requests the Court to reject the submissions of the Democratic Republic of the Congo on the merits of the case and to dismiss the application."

12. At the oral proceedings, the following submissions were presented by the Parties:

On behalf of the Government of the Congo,

"In light of the facts and arguments set out during the written and oral proceedings, the Government of the Democratic Republic of the Congo requests the Court to adjudge and declare that:

1. by issuing and internationally circulating the arrest warrant of 11 April 2000 against Mr. Abdulaye Yerodia Ndombasi, Belgium committed a violation in regard to the Democratic Republic of the Congo of the rule of customary international law concerning the absolute inviolability and immunity from criminal process of incumbent foreign ministers; in so doing, it violated the principle of sovereign equality among States;
2. a formal finding by the Court of the unlawfulness of that act constitutes an appropriate form of satisfaction, providing reparation for the consequent moral injury to the Democratic Republic of the Congo;
3. the violations of international law underlying the issue and international circulation of the arrest warrant of 11 April 2000 preclude any State, including Belgium, from executing it;
4. Belgium shall be required to recall and cancel the arrest warrant of 11 April 2000 and to inform the foreign authorities to whom the war-

rant was circulated that Belgium renounces its request for their co-operation in executing the unlawful warrant."

On behalf of the Government of Belgium,

"For the reasons stated in the Counter-Memorial of Belgium and in its oral submissions, Belgium requests the Court, as a preliminary matter, to adjudge and declare that the Court lacks jurisdiction in this case and/or that the Application by the Democratic Republic of the Congo against Belgium is inadmissible.

If, contrary to the submissions of Belgium with regard to the Court's jurisdiction and the admissibility of the Application, the Court concludes that it does have jurisdiction in this case and that the Application by the Democratic Republic of the Congo is admissible, Belgium requests the Court to reject the submissions of the Democratic Republic of the Congo on the merits of the case and to dismiss the Application."

* * *

13. On 11 April 2000 an investigating judge of the Brussels Tribunal de première instance issued "an international arrest warrant *in absentia*" against Mr. Abdulaye Yerodia Ndombasi, charging him, as perpetrator or co-perpetrator, with offences constituting grave breaches of the Geneva Conventions of 1949 and of the Additional Protocols thereto, and with crimes against humanity.

At the time when the arrest warrant was issued Mr. Yerodia was the Minister for Foreign Affairs of the Congo.

14. The arrest warrant was transmitted to the Congo on 7 June 2000, being received by the Congolese authorities on 12 July 2000. According to Belgium, the warrant was at the same time transmitted to the International Criminal Police Organization (Interpol), an organization whose function is to enhance and facilitate cross-border criminal police co-operation worldwide; through the latter, it was circulated internationally.

15. In the arrest warrant, Mr. Yerodia is accused of having made various speeches inciting racial hatred during the month of August 1998. The crimes with which Mr. Yerodia was charged were punishable in Belgium under the Law of 16 June 1993 "concerning the Punishment of Grave Breaches of the International Geneva Conventions of 12 August 1949 and of Protocols I and II of 8 June 1977 Additional Thereto", as amended by the Law of 10 February 1999 "concerning the Punishment of Serious Violations of International Humanitarian Law" (hereinafter referred to as the "Belgian Law").

Article 7 of the Belgian Law provides that "The Belgian courts shall have jurisdiction in respect of the offences provided for in the present Law, wheresoever they may have been committed". In the present case, according to Belgium, the complaints that initiated the proceedings as a result of which the arrest warrant was issued emanated from 12 individuals all resident in Belgium, five of whom were of Belgian nationality. It is not contested by Belgium, however, that the alleged acts to which

the arrest warrant relates were committed outside Belgian territory, that Mr. Yerodia was not a Belgian national at the time of those acts, and that Mr. Yerodia was not in Belgian territory at the time that the arrest warrant was issued and circulated. That no Belgian nationals were victims of the violence that was said to have resulted from Mr. Yerodia's alleged offences was also uncontested.

Article 5, paragraph 3, of the Belgian Law further provides that "[i]mmunity attaching to the official capacity of a person shall not prevent the application of the present Law".

16. At the hearings, Belgium further claimed that it offered "to entrust the case to the competent authorities [of the Congo] for enquiry and possible prosecution", and referred to a certain number of steps which it claimed to have taken in this regard from September 2000, that is, before the filing of the Application instituting proceedings. The Congo for its part stated the following: "We have scant information concerning the form [of these Belgian proposals]." It added that "these proposals . . . appear to have been made very belatedly, namely *after* an arrest warrant against Mr. Yerodia had been issued".

17. On 17 October 2000, the Congo filed in the Registry an Application instituting the present proceedings (see paragraph 1 above), in which the Court was requested "to declare that the Kingdom of Belgium shall annul the international arrest warrant issued on 11 April 2000". The Congo relied in its Application on two separate legal grounds. First, it claimed that "[t]he *universal jurisdiction* that the Belgian State attributes to itself under Article 7 of the Law in question" constituted a

> "[v]iolation of the principle that a State may not exercise its authority on the territory of another State and of the principle of sovereign equality among all Members of the United Nations, as laid down in Article 2, paragraph 1, of the Charter of the United Nations".

Secondly, it claimed that "[t]he non-recognition, on the basis of Article 5 . . . of the Belgian Law, of the immunity of a Minister for Foreign Affairs in office" constituted a "[v]iolation of the diplomatic immunity of the Minister for Foreign Affairs of a sovereign State, as recognized by the jurisprudence of the Court and following from Article 41, paragraph 2, of the Vienna Convention of 18 April 1961 on Diplomatic Relations".

18. On the same day that it filed its Application instituting proceedings, the Congo submitted a request to the Court for the indication of a provisional measure under Article 41 of the Statute of the Court. During the hearings devoted to consideration of that request, the Court was informed that in November 2000 a ministerial reshuffle had taken place in the Congo, following which Mr. Yerodia had ceased to hold office as Minister for Foreign Affairs and had been entrusted with the portfolio of Minister of Education. Belgium accordingly claimed that the Congo's Application had become moot and asked the Court, as has already been

recalled, to remove the case from the List. By Order of 8 December 2000, the Court rejected both Belgium's submissions to that effect and also the Congo's request for the indication of provisional measures (see paragraph 4 above).

19. From mid-April 2001, with the formation of a new Government in the Congo, Mr. Yerodia ceased to hold the post of Minister of Education. He no longer holds any ministerial office today.

20. On 12 September 2001, the Belgian National Central Bureau of Interpol requested the Interpol General Secretariat to issue a Red Notice in respect of Mr. Yerodia. Such notices concern individuals whose arrest is requested with a view to extradition. On 19 October 2001, at the public sittings held to hear the oral arguments of the Parties in the case, Belgium informed the Court that Interpol had responded on 27 September 2001 with a request for additional information, and that no Red Notice had yet been circulated.

21. Although the Application of the Congo originally advanced two separate legal grounds (see paragraph 17 above), the submissions of the Congo in its Memorial and the final submissions which it presented at the end of the oral proceedings refer only to a violation "in regard to the . . . Congo of the rule of customary international law concerning the absolute inviolability and immunity from criminal process of incumbent foreign ministers" (see paragraphs 11 and 12 above).

* * *

22. In their written pleadings, and in oral argument, the Parties addressed issues of jurisdiction and admissibility as well as the merits (see paragraphs 5 and 6 above). In this connection, Belgium raised certain objections which the Court will begin by addressing.

* *

23. The first objection presented by Belgium reads as follows:

> "That, in the light of the fact that Mr. Yerodia Ndombasi is no longer either Minister for Foreign Affairs of the [Congo] or a minister occupying any other position in the . . . Government [of the Congo], there is no longer a 'legal dispute' between the Parties within the meaning of this term in the Optional Clause Declarations of the Parties and that the Court accordingly lacks jurisdiction in this case."

24. Belgium does not deny that such a legal dispute existed between the Parties at the time when the Congo filed its Application instituting proceedings, and that the Court was properly seised by that Application. However, it contends that the question is not whether a legal dispute

existed at that time, but whether a legal dispute exists at the present time. Belgium refers in this respect *inter alia* to the *Northern Cameroons* case, in which the Court found that it "may pronounce judgment only in connection with concrete cases where there exists at the time of the adjudication an actual controversy involving a conflict of legal interests between the parties" (*I.C.J. Reports 1963*, pp. 33-34), as well as to the *Nuclear Tests* cases (*Australia* v. *France*) (*New Zealand* v. *France*), in which the Court stated the following: "The Court, as a court of law, is called upon to resolve existing disputes between States . . . The dispute brought before it must therefore continue to exist at the time when the Court makes its decision" (*I.C.J. Reports 1974*, pp. 270-271, para. 55; p. 476, para. 58). Belgium argues that the position of Mr. Yerodia as Minister for Foreign Affairs was central to the Congo's Application instituting proceedings, and emphasizes that there has now been a change of circumstances at the very heart of the case, in view of the fact that Mr. Yerodia was relieved of his position as Minister for Foreign Affairs in November 2000 and that, since 15 April 2001, he has occupied no position in the Government of the Congo (see paragraphs 18 and 19 above). According to Belgium, while there may still be a difference of opinion between the Parties on the scope and content of international law governing the immunities of a Minister for Foreign Affairs, that difference of opinion has now become a matter of abstract, rather than of practical, concern. The result, in Belgium's view, is that the case has become an attempt by the Congo to "[seek] an advisory opinion from the Court", and no longer a "concrete case" involving an "actual controversy" between the Parties, and that the Court accordingly lacks jurisdiction in the case.

25. The Congo rejects this objection of Belgium. It contends that there is indeed a legal dispute between the Parties, in that the Congo claims that the arrest warrant was issued in violation of the immunity of its Minister for Foreign Affairs, that that warrant was unlawful *ab initio*, and that this legal defect persists despite the subsequent changes in the position occupied by the individual concerned, while Belgium maintains that the issue and circulation of the arrest warrant were not contrary to international law. The Congo adds that the termination of Mr. Yerodia's official duties in no way operated to efface the wrongful act and the injury that flowed from it, for which the Congo continues to seek redress.

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26. The Court recalls that, according to its settled jurisprudence, its jurisdiction must be determined at the time that the act instituting proceedings was filed. Thus, if the Court has jurisdiction on the date the case is referred to it, it continues to do so regardless of subsequent events. Such events might lead to a finding that an application has subsequently

become moot and to a decision not to proceed to judgment on the merits, but they cannot deprive the Court of jurisdiction (see *Nottebohm, Preliminary Objection, Judgment, I.C.J. Reports 1953*, p. 122; *Right of Passage over Indian Territory, Preliminary Objections, Judgment, I.C.J. Reports 1957*, p. 142; *Questions of Interpretation and Application of the 1971 Montreal Convention arising from the Aerial Incident at Lockerbie (Libyan Arab Jamahiriya* v. *United Kingdom), Preliminary Objections, Judgment, I.C.J. Reports 1998*, pp. 23-24, para. 38; and *Questions of Interpretation and Application of the 1971 Montreal Convention arising from the Aerial Incident at Lockerbie (Libyan Arab Jamahiriya* v. *United States of America), Preliminary Objections, Judgment, I.C.J. Reports 1998*, p. 129, para. 37).

27. Article 36, paragraph 2, of the Statute of the Court provides:

> "The States parties to the present Statute may at any time declare that they recognize as compulsory *ipso facto* and without special agreement, in relation to any other State accepting the same obligation, the jurisdiction of the Court in all legal disputes concerning:
>
> *(a)* the interpretation of a treaty;
> *(b)* any question of international law;
> *(c)* the existence of any fact which, if established, would constitute a breach of an international obligation;
> *(d)* the nature or extent of the reparation to be made for the breach of an international obligation."

On 17 October 2000, the date that the Congo's Application instituting these proceedings was filed, each of the Parties was bound by a declaration of acceptance of compulsory jurisdiction, filed in accordance with the above provision: Belgium by a declaration of 17 June 1958 and the Congo by a declaration of 8 February 1989. Those declarations contained no reservation applicable to the present case.

Moreover, it is not contested by the Parties that at the material time there was a legal dispute between them concerning the international lawfulness of the arrest warrant of 11 April 2000 and the consequences to be drawn if the warrant was unlawful. Such a dispute was clearly a legal dispute within the meaning of the Court's jurisprudence, namely "a disagreement on a point of law or fact, a conflict of legal views or of interests between two persons" in which "the claim of one party is positively opposed by the other" (*Questions of Interpretation and Application of the 1971 Montreal Convention arising from the Aerial Incident at Lockerbie (Libyan Arab Jamahiriya* v. *United Kingdom), Preliminary Objections, Judgment, I.C.J. Reports 1998*, p. 17, para. 22; and *Questions of Interpretation and Application of the 1971 Montreal Convention arising from the Aerial Incident at Lockerbie (Libyan Arab Jamahiriya* v. *United States of America), Preliminary Objections, Juagment, I.C.J. Reports 1998*, pp. 122-123, para. 21).

28. The Court accordingly concludes that at the time that it was seised

of the case it had jurisdiction to deal with it, and that it still has such jurisdiction. Belgium's first objection must therefore be rejected.

* *

29. The second objection presented by Belgium is the following:

> "That in the light of the fact that Mr. Yerodia Ndombasi is no longer either Minister for Foreign Affairs of the [Congo] or a minister occupying any other position in the . . Government [of the Congo], the case is now without object and the Court should accordingly decline to proceed to judgment on the merits of the case."

30. Belgium also relies in support of this objection on the *Northern Cameroons* case, in which the Court considered that it would not be a proper discharge of its duties to proceed further in a case in which any judgment that the Court might pronounce would be "without object" (*I.C.J. Reports 1963*, p. 38), and on the *Nuclear Tests* cases, in which the Court saw "no reason to allow the continuance of proceedings which it knows are bound to be fruitless" (*I.C.J. Reports 1974*, p. 271, para. 58; p. 477, para. 61). Belgium maintains that the declarations requested by the Congo in its first and second submissions would clearly fall within the principles enunciated by the Court in those cases, since a judgment of the Court on the merits in this case could only be directed towards the clarification of the law in this area for the future, or be designed to reinforce the position of one or other Party. It relies in support of this argument on the fact that the Congo does not allege any material injury and is not seeking compensatory damages. It adds that the issue and transmission of the arrest warrant were not predicated on the ministerial status of the person concerned, that he is no longer a minister, and that the case is accordingly now devoid of object.

31. The Congo contests this argument of Belgium, and emphasizes that the aim of the Congo — to have the disputed arrest warrant annulled and to obtain redress for the moral injury suffered — remains unachieved at the point in time when the Court is called upon to decide the dispute. According to the Congo, in order for the case to have become devoid of object during the proceedings, the cause of the violation of the right would have had to disappear, and the redress sought would have to have been obtained.

*

32. The Court has already affirmed on a number of occasions that events occurring subsequent to the filing of an application may render the application without object such that the Court is not called upon to give a decision thereon (see *Questions of Interpretation and Application of the 1971 Mont-*

real Convention arising from the Aerial Incident at Lockerbie (Libyan Arab Jamahiriya v. *United Kingdom), Preliminary Objections, Judgment, I.C.J. Reports 1998*, p. 26, para. 46; and *Questions of Interpretation and Application of the 1971 Montreal Convention arising from the Aerial Incident at Lockerbie (Libyan Arab Jamahiriya* v. *United States of America), Preliminary Objections, Judgment, I.C.J. Reports 1998*, p. 131, para. 45).

However, it considers that this is not such a case. The change which has occurred in the situation of Mr. Yerodia has not in fact put an end to the dispute between the Parties and has not deprived the Application of its object. The Congo argues that the arrest warrant issued by the Belgian judicial authorities against Mr. Yerodia was and remains unlawful. It asks the Court to hold that the warrant is unlawful, thus providing redress for the moral injury which the warrant allegedly caused to it. The Congo also continues to seek the cancellation of the warrant. For its part, Belgium contends that it did not act in violation of international law and it disputes the Congo's submissions. In the view of the Court, it follows from the foregoing that the Application of the Congo is not now without object and that accordingly the case is not moot. Belgium's second objection must accordingly be rejected.

* *

33. The third Belgian objection is put as follows:

> "That the case as it now stands is materially different to that set out in the [Congo]'s Application instituting proceedings and that the Court accordingly lacks jurisdiction in the case and/or that the application is inadmissible."

34. According to Belgium, it would be contrary to legal security and the sound administration of justice for an applicant State to continue proceedings in circumstances in which the factual dimension on which the Application was based has changed fundamentally, since the respondent State would in those circumstances be uncertain, until the very last moment, of the substance of the claims against it. Belgium argues that the prejudice suffered by the respondent State in this situation is analogous to the situation in which an applicant State formulates new claims during the course of the proceedings. It refers to the jurisprudence of the Court holding inadmissible new claims formulated during the course of the proceedings which, had they been entertained, would have transformed the subject of the dispute originally brought before it under the terms of the Application (see *Fisheries Jurisdiction (Spain* v. *Canada), Jurisdiction of the Court, Judgment, I.C.J. Reports 1998*, pp. 447-448, para. 29). In the circumstances, Belgium contends that, if the Congo wishes to maintain its claims, it should be required to initiate proceedings afresh or, at the very least, apply to the Court for permission to amend its initial Application.

35. In response, the Congo denies that there has been a substantial amendment of the terms of its Application, and insists that it has presented no new claim, whether of substance or of form, that would have transformed the subject-matter of the dispute. The Congo maintains that it has done nothing through the various stages in the proceedings but "condense and refine" its claims, as do most States that appear before the Court, and that it is simply making use of the right of parties to amend their submissions until the end of the oral proceedings.

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36. The Court notes that, in accordance with settled jurisprudence, it "cannot, in principle, allow a dispute brought before it by application to be transformed by amendments in the submissions into another dispute which is different in character" (*Société commerciale de Belgique, Judgment, 1939, P.C.I.J., Series A/B, No. 78*, p. 173; cf. *Military and Paramilitary Activities in and against Nicaragua (Nicaragua* v. *United States of America), Jurisdiction and Admissibility, Judgment, I.C.J. Reports 1984*, p. 427, para. 80; see also *Certain Phosphate Lands in Nauru (Nauru* v. *Australia), Preliminary Objections, Judgment, I.C.J. Reports 1992*, pp. 264-267, in particular paras. 69 and 70). However, the Court considers that in the present case the facts underlying the Application have not changed in a way that produced such a transformation in the dispute brought before it. The question submitted to the Court for decision remains whether the issue and circulation of the arrest warrant by the Belgian judicial authorities against a person who was at that time the Minister for Foreign Affairs of the Congo were contrary to international law. The Congo's final submissions arise "directly out of the question which is the subject-matter of that Application" (*Fisheries Jurisdiction (Federal Republic of Germany* v. *Iceland), Merits, Judgment, I.C.J. Reports 1974*, p. 203, para. 72; see also *Temple of Preah Vihear, Merits, Judgment, I.C.J. Reports 1962*, p. 36).

In these circumstances, the Court considers that Belgium cannot validly maintain that the dispute brought before the Court was transformed in a way that affected its ability to prepare its defence, or that the requirements of the sound administration of justice were infringed. Belgium's third objection must accordingly be rejected.

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37. The fourth Belgian objection reads as follows:

> "That, in the light of the new circumstances concerning Mr. Yerodia Ndombasi, the case has assumed the character of an action of diplomatic protection but one in which the individual being pro-

tected has failed to exhaust local remedies, and that the Court accordingly lacks jurisdiction in the case and/or that the application is inadmissible."

38. In this respect, Belgium accepts that, when the case was first instituted, the Congo had a direct legal interest in the matter, and was asserting a claim in its own name in respect of the alleged violation by Belgium of the immunity of the Congo's Foreign Minister. However, according to Belgium, the case was radically transformed after the Application was filed, namely on 15 April 2001, when Mr. Yerodia ceased to be a member of the Congolese Government. Belgium maintains that two of the requests made of the Court in the Congo's final submissions in practice now concern the legal effect of an arrest warrant issued against a private citizen of the Congo, and that these issues fall within the realm of an action of diplomatic protection. It adds that the individual concerned has not exhausted all available remedies under Belgian law a necessary condition before the Congo can espouse the cause of one of its nationals in international proceedings.

39. The Congo, on the other hand, denies that this is an action for diplomatic protection. It maintains that it is bringing these proceedings in the name of the Congolese State, on account of the violation of the immunity of its Minister for Foreign Affairs. The Congo further denies the availability of remedies under Belgian law. It points out in this regard that it is only when the Crown Prosecutor has become seised of the case file and makes submissions to the Chambre du conseil that the accused can defend himself before the Chambre and seek to have the charge dismissed.

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40. The Court notes that the Congo has never sought to invoke before it Mr. Yerodia's personal rights. It considers that, despite the change in professional situation of Mr. Yerodia, the character of the dispute submitted to the Court by means of the Application has not changed: the dispute still concerns the lawfulness of the arrest warrant issued on 11 April 2000 against a person who was at the time Minister for Foreign Affairs of the Congo, and the question whether the rights of the Congo have or have not been violated by that warrant. As the Congo is not acting in the context of protection of one of its nationals, Belgium cannot rely upon the rules relating to the exhaustion of local remedies.

In any event, the Court recalls that an objection based on non-exhaustion of local remedies relates to the admissibility of the application (see *Interhandel, Preliminary Objections, Judgment, I.C.J. Reports 1959*, p. 26; *Elettronica Sicula S.p.A. (ELSI), Judgment, I.C.J. Reports 1989*, p. 42, para. 49). Under settled jurisprudence, the critical date for determining the admissibility of an application is the date on which it is filed

(see *Questions of Interpretation and Application of the 1971 Montreal Convention arising from the Aerial Incident at Lockerbie (Libyan Arab Jamahiriya* v. *United Kingdom), Preliminary Objections, Judgment, I.C.J. Reports 1998*, pp. 25-26, paras. 43-44; and *Questions of Interpretation and Application of the 1971 Montreal Convention arising from the Aerial Incident at Lockerbie (Libyan Arab Jamahiriya* v. *United States of America), Preliminary Objections, Judgment, I.C.J. Reports 1998*, pp. 130-131, paras. 42-43). Belgium accepts that, on the date on which the Congo filed the Application instituting proceedings, the Congo had a direct legal interest in the matter, and was asserting a claim in its own name. Belgium's fourth objection must accordingly be rejected.

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41. As a subsidiary argument, Belgium further contends that "[i]n the event that the Court decides that it does have jurisdiction in this case and that the application is admissible, . . . the *non ultra petita* rule operates to limit the jurisdiction of the Court to those issues that are the subject of the [Congo]'s final submissions". Belgium points out that, while the Congo initially advanced a twofold argument, based, on the one hand, on the Belgian judge's lack of jurisdiction, and, on the other, on the immunity from jurisdiction enjoyed by its Minister for Foreign Affairs, the Congo no longer claims in its final submissions that Belgium wrongly conferred upon itself universal jurisdiction *in absentia*. According to Belgium, the Congo now confines itself to arguing that the arrest warrant of 11 April 2000 was unlawful because it violated the immunity from jurisdiction of its Minister for Foreign Affairs, and that the Court consequently cannot rule on the issue of universal jurisdiction in any decision it renders on the merits of the case.

42. The Congo, for its part, states that its interest in bringing these proceedings is to obtain a finding by the Court that it has been the victim of an internationally wrongful act, the question whether this case involves the "exercise of an excessive universal jurisdiction" being in this connection only a secondary consideration. The Congo asserts that any consideration by the Court of the issues of international law raised by universal jurisdiction would be undertaken not at the request of the Congo but, rather, by virtue of the defence strategy adopted by Belgium, which appears to maintain that the exercise of such jurisdiction can "represent a valid counterweight to the observance of immunities".

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43. The Court would recall the well-established principle that "it is the duty of the Court not only to reply to the questions as stated in the final submissions of the parties, but also to abstain from deciding points not included in those submissions" (*Asylum, Judgment, I.C.J. Reports 1950*,

p. 402). While the Court is thus not entitled to decide upon questions not asked of it, the *non ultra petita* rule nonetheless cannot preclude the Court from addressing certain legal points in its reasoning. Thus in the present case the Court may not rule, in the operative part of its Judgment, on the question whether the disputed arrest warrant, issued by the Belgian investigating judge in exercise of his purported universal jurisdiction, complied in that regard with the rules and principles of international law governing the jurisdiction of national courts. This does not mean, however, that the Court may not deal with certain aspects of that question in the reasoning of its Judgment, should it deem this necessary or desirable.

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44. The Court concludes from the foregoing that it has jurisdiction to entertain the Congo's Application, that the Application is not without object and that accordingly the case is not moot and that the Application is admissible. Thus, the Court now turns to the merits of the case.

* * *

45. As indicated above (see paragraphs 41 to 43 above), in its Application instituting these proceedings, the Congo originally challenged the legality of the arrest warrant of 11 April 2000 on two separate grounds: on the one hand, Belgium's claim to exercise a universal jurisdiction and, on the other, the alleged violation of the immunities of the Minister for Foreign Affairs of the Congo then in office. However, in its submissions in its Memorial, and in its final submissions at the close of the oral proceedings, the Congo invokes only the latter ground.

46. As a matter of logic, the second ground should be addressed only once there has been a determination in respect of the first, since it is only where a State has jurisdiction under international law in relation to a particular matter that there can be any question of immunities in regard to the exercise of that jurisdiction. However, in the present case, and in view of the final form of the Congo's submissions, the Court will address first the question whether, assuming that it had jurisdiction under international law to issue and circulate the arrest warrant of 11 April 2000, Belgium in so doing violated the immunities of the then Minister for Foreign Affairs of the Congo.

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47. The Congo maintains that, during his or her term of office, a Minister for Foreign Affairs of a sovereign State is entitled to inviolability

and to immunity from criminal process being "absolute or complete", that is to say, they are subject to no exception. Accordingly, the Congo contends that no criminal prosecution may be brought against a Minister for Foreign Affairs in a foreign court as long as he or she remains in office, and that any finding of criminal responsibility by a domestic court in a foreign country, or any act of investigation undertaken with a view to bringing him or her to court, would contravene the principle of immunity from jurisdiction. According to the Congo, the basis of such criminal immunity is purely functional, and immunity is accorded under customary international law simply in order to enable the foreign State representative enjoying such immunity to perform his or her functions freely and without let or hindrance. The Congo adds that the immunity thus accorded to Ministers for Foreign Affairs when in office covers *all* their acts, including any committed before they took office, and that it is irrelevant whether the acts done whilst in office may be characterized or not as "official acts".

48. The Congo states further that it does not deny the existence of a principle of international criminal law, deriving from the decisions of the Nuremberg and Tokyo international military tribunals, that the accused's official capacity at the time of the acts cannot, before any court, whether domestic or international, constitute a "ground of exemption from his criminal responsibility or a ground for mitigation of sentence". The Congo then stresses that the fact that an immunity might bar prosecution before a specific court or over a specific period does not mean that the same prosecution cannot be brought, if appropriate, before another court which is not bound by that immunity, or at another time when the immunity need no longer be taken into account. It concludes that immunity does not mean impunity.

49. Belgium maintains for its part that, while Ministers for Foreign Affairs in office generally enjoy an immunity from jurisdiction before the courts of a foreign State, such immunity applies only to acts carried out in the course of their official functions, and cannot protect such persons in respect of private acts or when they are acting otherwise than in the performance of their official functions.

50. Belgium further states that, in the circumstances of the present case, Mr. Yerodia enjoyed no immunity at the time when he is alleged to have committed the acts of which he is accused, and that there is no evidence that he was then acting in any official capacity. It observes that the arrest warrant was issued against Mr. Yerodia personally.

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51. The Court would observe at the outset that in international law it is firmly established that, as also diplomatic and consular agents, certain

holders of high-ranking office in a State, such as the Head of State, Head of Government and Minister for Foreign Affairs, enjoy immunities from jurisdiction in other States, both civil and criminal. For the purposes of the present case, it is only the immunity from criminal jurisdiction and the inviolability of an incumbent Minister for Foreign Affairs that fall for the Court to consider.

52. A certain number of treaty instruments were cited by the Parties in this regard. These included, first, the Vienna Convention on Diplomatic Relations of 18 April 1961, which states in its preamble that the purpose of diplomatic privileges and immunities is "to ensure the efficient performance of the functions of diplomatic missions as representing States". It provides in Article 32 that only the sending State may waive such immunity. On these points, the Vienna Convention on Diplomatic Relations, to which both the Congo and Belgium are parties, reflects customary international law. The same applies to the corresponding provisions of the Vienna Convention on Consular Relations of 24 April 1963, to which the Congo and Belgium are also parties.

The Congo and Belgium further cite the New York Convention on Special Missions of 8 December 1969, to which they are not, however, parties. They recall that under Article 21, paragraph 2, of that Convention:

> "The Head of the Government, the Minister for Foreign Affairs and other persons of high rank, when they take part in a special mission of the sending State, shall enjoy in the receiving State or in a third State, in addition to what is granted by the present Convention, the facilities, privileges and immunities accorded by international law."

These conventions provide useful guidance on certain aspects of the question of immunities. They do not, however, contain any provision specifically defining the immunities enjoyed by Ministers for Foreign Affairs. It is consequently on the basis of customary international law that the Court must decide the questions relating to the immunities of such Ministers raised in the present case.

53. In customary international law, the immunities accorded to Ministers for Foreign Affairs are not granted for their personal benefit, but to ensure the effective performance of their functions on behalf of their respective States. In order to determine the extent of these immunities, the Court must therefore first consider the nature of the functions exercised by a Minister for Foreign Affairs. He or she is in charge of his or her Government's diplomatic activities and generally acts as its representative in international negotiations and intergovernmental meetings. Ambassadors and other diplomatic agents carry out their duties under his or her authority. His or her acts may bind the State represented, and there is a presumption that a Minister for Foreign Affairs, simply by virtue of that office, has full powers to act on behalf of the State (see, for

example, Article 7, paragraph 2 *(a)*, of the 1969 Vienna Convention on the Law of Treaties). In the performance of these functions, he or she is frequently required to travel internationally, and thus must be in a position freely to do so whenever the need should arise. He or she must also be in constant communication with the Government, and with its diplomatic missions around the world, and be capable at any time of communicating with representatives of other States. The Court further observes that a Minister for Foreign Affairs, responsible for the conduct of his or her State's relations with all other States, occupies a position such that, like the Head of State or the Head of Government, he or she is recognized under international law as representative of the State solely by virtue of his or her office. He or she does not have to present letters of credence: to the contrary, it is generally the Minister who determines the authority to be conferred upon diplomatic agents and countersigns their letters of credence. Finally, it is to the Minister for Foreign Affairs that chargés d'affaires are accredited.

54. The Court accordingly concludes that the functions of a Minister for Foreign Affairs are such that, throughout the duration of his or her office, he or she when abroad enjoys full immunity from criminal jurisdiction and inviolability. That immunity and that inviolability protect the individual concerned against any act of authority of another State which would hinder him or her in the performance of his or her duties.

55. In this respect, no distinction can be drawn between acts performed by a Minister for Foreign Affairs in an "official" capacity, and those claimed to have been performed in a "private capacity", or, for that matter, between acts performed before the person concerned assumed office as Minister for Foreign Affairs and acts committed during the period of office. Thus, if a Minister for Foreign Affairs is arrested in another State on a criminal charge, he or she is clearly thereby prevented from exercising the functions of his or her office. The consequences of such impediment to the exercise of those official functions are equally serious, regardless of whether the Minister for Foreign Affairs was, at the time of arrest, present in the territory of the arresting State on an "official" visit or a "private" visit, regardless of whether the arrest relates to acts allegedly performed before the person became the Minister for Foreign Affairs or to acts performed while in office, and regardless of whether the arrest relates to alleged acts performed in an "official" capacity or a "private" capacity. Furthermore, even the mere risk that, by travelling to or transiting another State a Minister for Foreign Affairs might be exposing himself or herself to legal proceedings could deter the Minister from travelling internationally when required to do so for the purposes of the performance of his or her official functions.

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56. The Court will now address Belgium's argument that immunities accorded to incumbent Ministers for Foreign Affairs can in no case protect them where they are suspected of having committed war crimes or crimes against humanity. In support of this position, Belgium refers in its Counter-Memorial to various legal instruments creating international criminal tribunals, to examples from national legislation, and to the jurisprudence of national and international courts.

Belgium begins by pointing out that certain provisions of the instruments creating international criminal tribunals state expressly that the official capacity of a person shall not be a bar to the exercise by such tribunals of their jurisdiction.

Belgium also places emphasis on certain decisions of national courts, and in particular on the judgments rendered on 24 March 1999 by the House of Lords in the United Kingdom and on 13 March 2001 by the Court of Cassation in France in the *Pinochet* and *Qaddafi* cases respectively, in which it contends that an exception to the immunity rule was accepted in the case of serious crimes under international law. Thus, according to Belgium, the *Pinochet* decision recognizes an exception to the immunity rule when Lord Millett stated that "[i]nternational law cannot be supposed to have established a crime having the character of a *jus cogens* and at the same time to have provided an immunity which is coextensive with the obligation it seeks to impose", or when Lord Phillips of Worth Matravers said that "no established rule of international law requires state immunity *ratione materiae* to be accorded in respect of prosecution for an international crime". As to the French Court of Cassation, Belgium contends that, in holding that, "under international law as it currently stands, the crime alleged [acts of terrorism], irrespective of its gravity, does not come within the exceptions to the principle of immunity from jurisdiction for incumbent foreign Heads of State", the Court explicitly recognized the existence of such exceptions.

57. The Congo, for its part, states that, under international law as it currently stands, there is no basis for asserting that there is any exception to the principle of absolute immunity from criminal process of an incumbent Minister for Foreign Affairs where he or she is accused of having committed crimes under international law.

In support of this contention, the Congo refers to State practice, giving particular consideration in this regard to the *Pinochet* and *Qaddafi* cases, and concluding that such practice does not correspond to that which Belgium claims but, on the contrary, confirms the absolute nature of the immunity from criminal process of Heads of State and Ministers for Foreign Affairs. Thus, in the *Pinochet* case, the Congo cites Lord Browne-Wilkinson's statement that "[t]his immunity enjoyed by a head of state in power and an ambassador in post is a complete immunity attached to the person of the head of state or ambassador and rendering him immune from all actions or prosecutions . . .". According to the Congo, the

French Court of Cassation adopted the same position in its *Qaddafi* judgment, in affirming that "international custom bars the prosecution of incumbent Heads of State, in the absence of any contrary international provision binding on the parties concerned, before the criminal courts of a foreign State".

As regards the instruments creating international criminal tribunals and the latter's jurisprudence, these, in the Congo's view, concern only those tribunals, and no inference can be drawn from them in regard to criminal proceedings before national courts against persons enjoying immunity under international law.

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58. The Court has carefully examined State practice, including national legislation and those few decisions of national higher courts, such as the House of Lords or the French Court of Cassation. It has been unable to deduce from this practice that there exists under customary international law any form of exception to the rule according immunity from criminal jurisdiction and inviolability to incumbent Ministers for Foreign Affairs, where they are suspected of having committed war crimes or crimes against humanity.

The Court has also examined the rules concerning the immunity or criminal responsibility of persons having an official capacity contained in the legal instruments creating international criminal tribunals, and which are specifically applicable to the latter (see Charter of the International Military Tribunal of Nuremberg, Art. 7; Charter of the International Military Tribunal of Tokyo, Art. 6; Statute of the International Criminal Tribunal for the former Yugoslavia, Art. 7, para. 2; Statute of the International Criminal Tribunal for Rwanda, Art. 6, para. 2; Statute of the International Criminal Court, Art. 27). It finds that these rules likewise do not enable it to conclude that any such an exception exists in customary international law in regard to national courts.

Finally, none of the decisions of the Nuremberg and Tokyo international military tribunals, or of the International Criminal Tribunal for the former Yugoslavia, cited by Belgium deal with the question of the immunities of incumbent Ministers for Foreign Affairs before national courts where they are accused of having committed war crimes or crimes against humanity. The Court accordingly notes that those decisions are in no way at variance with the findings it has reached above.

In view of the foregoing, the Court accordingly cannot accept Belgium's argument in this regard.

59. It should further be noted that the rules governing the jurisdiction of national courts must be carefully distinguished from those governing jurisdictional immunities: jurisdiction does not imply absence of immunity, while absence of immunity does not imply jurisdiction. Thus,

although various international conventions on the prevention and punishment of certain serious crimes impose on States obligations of prosecution or extradition, thereby requiring them to extend their criminal jurisdiction, such extension of jurisdiction in no way affects immunities under customary international law, including those of Ministers for Foreign Affairs. These remain opposable before the courts of a foreign State, even where those courts exercise such a jurisdiction under these conventions.

60. The Court emphasizes, however, that the *immunity* from jurisdiction enjoyed by incumbent Ministers for Foreign Affairs does not mean that they enjoy *impunity* in respect of any crimes they might have committed, irrespective of their gravity. Immunity from criminal jurisdiction and individual criminal responsibility are quite separate concepts. While jurisdictional immunity is procedural in nature, criminal responsibility is a question of substantive law. Jurisdictional immunity may well bar prosecution for a certain period or for certain offences; it cannot exonerate the person to whom it applies from all criminal responsibility.

61. Accordingly, the immunities enjoyed under international law by an incumbent or former Minister for Foreign Affairs do not represent a bar to criminal prosecution in certain circumstances.

First, such persons enjoy no criminal immunity under international law in their own countries, and may thus be tried by those countries' courts in accordance with the relevant rules of domestic law.

Secondly, they will cease to enjoy immunity from foreign jurisdiction if the State which they represent or have represented decides to waive that immunity.

Thirdly, after a person ceases to hold the office of Minister for Foreign Affairs, he or she will no longer enjoy all of the immunities accorded by international law in other States. Provided that it has jurisdiction under international law, a court of one State may try a former Minister for Foreign Affairs of another State in respect of acts committed prior or subsequent to his or her period of office, as well as in respect of acts committed during that period of office in a private capacity.

Fourthly, an incumbent or former Minister for Foreign Affairs may be subject to criminal proceedings before certain international criminal courts, where they have jurisdiction. Examples include the International Criminal Tribunal for the former Yugoslavia, and the International Criminal Tribunal for Rwanda, established pursuant to Security Council resolutions under Chapter VII of the United Nations Charter, and the future International Criminal Court created by the 1998 Rome Convention. The latter's Statute expressly provides, in Article 27, paragraph 2, that "[i]mmunities or special procedural rules which may attach to the

official capacity of a person, whether under national or international law, shall not bar the Court from exercising its jurisdiction over such a person".

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62. Given the conclusions it has reached above concerning the nature and scope of the rules governing the immunity from criminal jurisdiction enjoyed by incumbent Ministers for Foreign Affairs, the Court must now consider whether in the present case the issue of the arrest warrant of 11 April 2000 and its international circulation violated those rules. The Court recalls in this regard that the Congo requests it, in its first final submission, to adjudge and declare that:

> "[B]y issuing and internationally circulating the arrest warrant of 11 April 2000 against Mr. Abdulaye Yerodia Ndombasi, Belgium committed a violation in regard to the Democratic Republic of the Congo of the rule of customary international law concerning the absolute inviolability and immunity from criminal process of incumbent foreign ministers; in so doing, it violated the principle of sovereign equality among States."

63. In support of this submission, the Congo maintains that the arrest warrant of 11 April 2000 as such represents a "coercive legal act" which violates the Congo's immunity and sovereign rights, inasmuch as it seeks to "subject to an organ of domestic criminal jurisdiction a member of a foreign government who is in principle beyond its reach" and is fully enforceable without special formality in Belgium.

The Congo considers that the mere issuance of the warrant thus constituted a coercive measure taken against the person of Mr. Yerodia, even if it was not executed.

64. As regards the international circulation of the said arrest warrant, this, in the Congo's view, not only involved further violations of the rules referred to above, but also aggravated the moral injury which it suffered as a result of the opprobrium "thus cast upon one of the most prominent members of its Government". The Congo further argues that such circulation was a fundamental infringement of its sovereign rights in that it significantly restricted the full and free exercise, by its Minister for Foreign Affairs, of the international negotiation and representation functions entrusted to him by the Congo's former President. In the Congo's view, Belgium "[thus] manifests an intention to have the individual concerned arrested at the place where he is to be found, with a view to procuring his extradition". The Congo emphasizes moreover that it is necessary to avoid any confusion between the arguments concerning the legal effect of the arrest warrant abroad and the question of any responsibility of the foreign authorities giving effect to it. It points out in this regard that no State has acted on the arrest warrant, and that accordingly

"no further consideration need be given to the specific responsibility which a State executing it might incur, or to the way in which that responsibility should be related" to that of the Belgian State. The Congo observes that, in such circumstances, "there [would be] a direct causal relationship between the arrest warrant issued in Belgium and any act of enforcement carried out elsewhere".

65. Belgium rejects the Congo's argument on the ground that "the character of the arrest warrant of 11 April 2000 is such that it has neither infringed the sovereignty of, nor created any obligation for, the [Congo]".

With regard to the legal effects under Belgian law of the arrest warrant of 11 April 2000, Belgium contends that the clear purpose of the warrant was to procure that, if found in Belgium, Mr. Yerodia would be detained by the relevant Belgian authorities with a view to his prosecution for war crimes and crimes against humanity. According to Belgium, the Belgian investigating judge did, however, draw an explicit distinction in the warrant between, on the one hand, immunity from jurisdiction and, on the other hand, immunity from enforcement as regards representatives of foreign States who visit Belgium on the basis of an official invitation, making it clear that such persons would be immune from enforcement of an arrest warrant in Belgium. Belgium further contends that, in its effect, the disputed arrest warrant is national in character, since it requires the arrest of Mr. Yerodia if he is found in Belgium but it does not have this effect outside Belgium.

66. In respect of the legal effects of the arrest warrant outside Belgium, Belgium maintains that the warrant does not create any obligation for the authorities of any other State to arrest Mr. Yerodia in the absence of some further step by Belgium completing or validating the arrest warrant (such as a request for the provisional detention of Mr. Yerodia), or the issuing of an arrest warrant by the appropriate authorities in the State concerned following a request to do so, or the issuing of an Interpol Red Notice. Accordingly, outside Belgium, while the purpose of the warrant was admittedly "to establish a legal basis for the arrest of Mr. Yerodia . . . and his subsequent extradition to Belgium", the warrant had no legal effect unless it was validated or completed by some prior act "requiring the arrest of Mr. Yerodia by the relevant authorities in a third State". Belgium further argues that "[i]f a State had executed the arrest warrant, it might infringe Mr. [Yerodia's] criminal immunity", but that "the Party directly responsible for that infringement would have been that State and not Belgium".

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67. The Court will first recall that the "international arrest warrant *in absentia*", issued on 11 April 2000 by an investigating judge of the Brussels Tribunal de première instance, is directed against Mr. Yerodia,

stating that he is "currently Minister for Foreign Affairs of the Democratic Republic of the Congo, having his business address at the Ministry of Foreign Affairs in Kinshasa". The warrant states that Mr. Yerodia is charged with being "the perpetrator or co-perpetrator" of:

"— Crimes under international law constituting grave breaches causing harm by act or omission to persons and property protected by the Conventions signed at Geneva on 12 August 1949 and by Additional Protocols I and II to those Conventions (Article 1, paragraph 3, of the Law of 16 June 1993, as amended by the Law of 10 February 1999 concerning the punishment of serious violations of international humanitarian law)
— Crimes against humanity (Article 1, paragraph 2, of the Law of 16 June 1993, as amended by the Law of 10 February 1999 concerning the punishment of serious violations of international humanitarian law)."

The warrant refers to "various speeches inciting racial hatred" and to "particularly virulent remarks" allegedly made by Mr. Yerodia during "public addresses reported by the media" on 4 August and 27 August 1998. It adds:

> "These speeches allegedly had the effect of inciting the population to attack Tutsi residents of Kinshasa: there were dragnet searches, manhunts (the Tutsi enemy) and lynchings.
>
> The speeches inciting racial hatred thus are said to have resulted in several hundred deaths, the internment of Tutsis, summary executions, arbitrary arrests and unfair trials."

68. The warrant further states that "the position of Minister for Foreign Affairs currently held by the accused does not entail immunity from jurisdiction and enforcement". The investigating judge does, however, observe in the warrant that "the rule concerning the absence of immunity under humanitarian law would appear . . . to require some qualification in respect of immunity from enforcement" and explains as follows:

> "Pursuant to the general principle of fairness in judicial proceedings, immunity from enforcement must, in our view, be accorded to all State representatives welcomed as such onto the territory of Belgium (on 'official visits'). Welcoming such foreign dignitaries as official representatives of sovereign States involves not only relations between individuals but also relations between States. This implies that such welcome includes an undertaking by the host State and its various components to refrain from taking any coercive measures against its guest and the invitation cannot become a pretext for ensnaring the individual concerned in what would then have to be labelled a trap. In the contrary case, failure to respect this

undertaking could give rise to the host State's international responsibility."

69. The arrest warrant concludes with the following order:

"We instruct and order all bailiffs and agents of public authority who may be so required to execute this arrest warrant and to conduct the accused to the detention centre in Forest;

We order the warden of the prison to receive the accused and to keep him (her) in custody in the detention centre pursuant to this arrest warrant;

We require all those exercising public authority to whom this warrant shall be shown to lend all assistance in executing it."

70. The Court notes that the *issuance*, as such, of the disputed arrest warrant represents an act by the Belgian judicial authorities intended to enable the arrest on Belgian territory of an incumbent Minister for Foreign Affairs on charges of war crimes and crimes against humanity. The fact that the warrant is enforceable is clearly apparent from the order given to "all bailiffs and agents of public authority . . . to execute this arrest warrant" (see paragraph 69 above) and from the assertion in the warrant that "the position of Minister for Foreign Affairs currently held by the accused does not entail immunity from jurisdiction and enforcement". The Court notes that the warrant did admittedly make an exception for the case of an official visit by Mr. Yerodia to Belgium, and that Mr. Yerodia never suffered arrest in Belgium. The Court is bound, however, to find that, given the nature and purpose of the warrant, its mere issue violated the immunity which Mr. Yerodia enjoyed as the Congo's incumbent Minister for Foreign Affairs. The Court accordingly concludes that the issue of the warrant constituted a violation of an obligation of Belgium towards the Congo, in that it failed to respect the immunity of that Minister and, more particularly, infringed the immunity from criminal jurisdiction and the inviolability then enjoyed by him under international law.

71. The Court also notes that Belgium admits that the purpose of the international *circulation* of the disputed arrest warrant was "to establish a legal basis for the arrest of Mr. Yerodia . . . abroad and his subsequent extradition to Belgium". The Respondent maintains, however, that the enforcement of the warrant in third States was "dependent on some further preliminary steps having been taken" and that, given the "inchoate" quality of the warrant as regards third States, there was no "infringe[ment of] the sovereignty of the [Congo]". It further points out that no Interpol Red Notice was requested until 12 September 2001, when Mr. Yerodia no longer held ministerial office.

The Court cannot subscribe to this view. As in the case of the warrant's issue, its international circulation from June 2000 by the Belgian authorities, given its nature and purpose, effectively infringed Mr. Yero-

dia's immunity as the Congo's incumbent Minister for Foreign Affairs and was furthermore liable to affect the Congo's conduct of its international relations. Since Mr. Yerodia was called upon in that capacity to undertake travel in the performance of his duties, the mere international circulation of the warrant, even in the absence of "further steps" by Belgium, could have resulted, in particular, in his arrest while abroad. The Court observes in this respect that Belgium itself cites information to the effect that Mr. Yerodia, "on applying for a visa to go to two countries, [apparently] learned that he ran the risk of being arrested as a result of the arrest warrant issued against him by Belgium", adding that "[t]his, moreover, is what the [Congo] . . . hints when it writes that the arrest warrant 'sometimes forced Minister Yerodia to travel by roundabout routes'". Accordingly, the Court concludes that the circulation of the warrant, whether or not it significantly interfered with Mr. Yerodia's diplomatic activity, constituted a violation of an obligation of Belgium towards the Congo, in that it failed to respect the immunity of the incumbent Minister for Foreign Affairs of the Congo and, more particularly, infringed the immunity from criminal jurisdiction and the inviolability then enjoyed by him under international law.

* * *

72. The Court will now address the issue of the remedies sought by the Congo on account of Belgium's violation of the above-mentioned rules of international law. In its second, third and fourth submissions, the Congo requests the Court to adjudge and declare that:

> "A formal finding by the Court of the unlawfulness of [the issue and international circulation of the arrest warrant] constitutes an appropriate form of satisfaction, providing reparation for the consequent moral injury to the Democratic Republic of the Congo;
>
> The violations of international law underlying the issue and international circulation of the arrest warrant of 11 April 2000 preclude any State, including Belgium, from executing it;
>
> Belgium shall be required to recall and cancel the arrest warrant of 11 April 2000 and to inform the foreign authorities to whom the warrant was circulated that Belgium renounces its request for their co-operation in executing the unlawful warrant."

73. In support of those submissions, the Congo asserts that the termination of the official duties of Mr. Yerodia in no way operated to efface the wrongful act and the injury flowing from it, which continue to exist. It argues that the warrant is unlawful *ab initio*, that "[i]t is fundamentally flawed" and that it cannot therefore have any legal effect today. It points

out that the purpose of its request is reparation for the injury caused, requiring the restoration of the situation which would in all probability have existed if the said act had not been committed. It states that, inasmuch as the wrongful act consisted in an internal legal instrument, only the "withdrawal" and "cancellation" of the latter can provide appropriate reparation.

The Congo further emphasizes that in no way is it asking the Court itself to withdraw or cancel the warrant, nor to determine the means whereby Belgium is to comply with its decision. It explains that the withdrawal and cancellation of the warrant, by the means that Belgium deems most suitable, "are not means of enforcement of the judgment of the Court but the requested measure of legal reparation/restitution itself". The Congo maintains that the Court is consequently only being requested to declare that Belgium, by way of reparation for the injury to the rights of the Congo, be required to withdraw and cancel this warrant by the means of its choice.

74. Belgium for its part maintains that a finding by the Court that the immunity enjoyed by Mr. Yerodia as Minister for Foreign Affairs had been violated would in no way entail an obligation to cancel the arrest warrant. It points out that the arrest warrant is still operative and that "there is no suggestion that it presently infringes the immunity of the Congo's Minister for Foreign Affairs". Belgium considers that what the Congo is in reality asking of the Court in its third and fourth final submissions is that the Court should direct Belgium as to the method by which it should give effect to a judgment of the Court finding that the warrant had infringed the immunity of the Congo's Minister for Foreign Affairs.

*

75. The Court has already concluded (see paragraphs 70 and 71) that the issue and circulation of the arrest warrant of 11 April 2000 by the Belgian authorities failed to respect the immunity of the incumbent Minister for Foreign Affairs of the Congo and, more particularly, infringed the immunity from criminal jurisdiction and the inviolability then enjoyed by Mr. Yerodia under international law. Those acts engaged Belgium's international responsibility. The Court considers that the findings so reached by it constitute a form of satisfaction which will make good the moral injury complained of by the Congo.

76. However, as the Permanent Court of International Justice stated in its Judgment of 13 September 1928 in the case concerning the *Factory at Chorzów*:

> "[t]he essential principle contained in the actual notion of an illegal act — a principle which seems to be established by international practice and in particular by the decisions of arbitral tribunals — is that reparation must, as far as possible, wipe out all the conse-

quences of the illegal act and reestablish the situation which would, in all probability, have existed if that act had not been committed" (*P.C.I.J., Series A, No. 17*, p. 47).

In the present case, "the situation which would, in all probability, have existed if [the illegal act] had not been committed" cannot be re-established merely by a finding by the Court that the arrest warrant was unlawful under international law. The warrant is still extant, and remains unlawful, notwithstanding the fact that Mr. Yerodia has ceased to be Minister for Foreign Affairs. The Court accordingly considers that Belgium must, by means of its own choosing, cancel the warrant in question and so inform the authorities to whom it was circulated.

77. The Court sees no need for any further remedy: in particular, the Court cannot, in a judgment ruling on a dispute between the Congo and Belgium, indicate what that judgment's implications might be for third States, and the Court cannot therefore accept the Congo's submissions on this point.

* * *

78. For these reasons,

THE COURT,

(1) (A) By fifteen votes to one,

Rejects the objections of the Kingdom of Belgium relating to jurisdiction, mootness and admissibility;

IN FAVOUR: *President* Guillaume; *Vice-President* Shi; *Judges* Ranjeva, Herczegh, Fleischhauer, Koroma, Vereshchetin, Higgins, Parra-Aranguren, Kooijmans, Rezek, Al-Khasawneh, Buergenthal; *Judges* ad hoc Bula-Bula, Van den Wyngaert;

AGAINST: *Judge* Oda;

(B) By fifteen votes to one,

Finds that it has jurisdiction to entertain the Application filed by the Democratic Republic of the Congo on 17 October 2000;

IN FAVOUR: *President* Guillaume; *Vice-President* Shi *Judges* Ranjeva, Herczegh, Fleischhauer, Koroma, Vereshchetin, Higgins, Parra-Aranguren, Kooijmans, Rezek, Al-Khasawneh, Buergenthal *Judges* ad hoc Bula-Bula, Van den Wyngaert;

AGAINST: *Judge* Oda;

(C) By fifteen votes to one,

Finds that the Application of the Democratic Republic of the Congo is not without object and that accordingly the case is not moot;

IN FAVOUR: *President* Guillaume; *Vice-President* Shi; *Judges* Ranjeva, Herczegh, Fleischhauer, Koroma, Vereshchetin, Higgins, Parra-Aranguren,

Kooijmans, Rezek, Al-Khasawneh, Buergenthal; *Judges* ad hoc Bula-Bula, Van den Wyngaert;

AGAINST: *Judge* Oda;

(D) By fifteen votes to one,

Finds that the Application of the Democratic Republic of the Congo is admissible;

IN FAVOUR: *President* Guillaume; *Vice-President* Shi; *Judges* Ranjeva, Herczegh, Fleischhauer, Koroma, Vereshchetin, Higgins, Parra-Aranguren, Kooijmans, Rezek, Al-Khasawneh, Buergenthal; *Judges* ad hoc Bula-Bula, Van den Wyngaert;

AGAINST: *Judge* Oda;

(2) By thirteen votes to three,

Finds that the issue against Mr. Abdulaye Yerodia Ndombasi of the arrest warrant of 11 April 2000, and its international circulation, constituted violations of a legal obligation of the Kingdom of Belgium towards the Democratic Republic of the Congo, in that they failed to respect the immunity from criminal jurisdiction and the inviolability which the incumbent Minister for Foreign Affairs of the Democratic Republic of the Congo enjoyed under international law;

IN FAVOUR: *President* Guillaume; *Vice-President* Shi; *Judges* Ranjeva, Herczegh, Fleischhauer, Koroma, Vereshchetin, Higgins, Parra-Aranguren, Kooijmans, Rezek, Buergenthal; *Judge* ad hoc Bula-Bula;

AGAINST: *Judges* Oda, Al-Khasawneh; *Judge* ad hoc Van den Wyngaert;

(3) By ten votes to six,

Finds that the Kingdom of Belgium must, by means of its own choosing, cancel the arrest warrant of 11 April 2000 and so inform the authorities to whom that warrant was circulated.

IN FAVOUR: *President* Guillaume; *Vice-President* Shi *Judges* Ranjeva, Herczegh, Fleischhauer, Koroma, Vereshchetin, Parra-Aranguren, Rezek; *Judge* ad hoc Bula-Bula;

AGAINST: *Judges* Oda, Higgins, Kooijmans, Al-Khasawneh, Buergenthal; *Judge* ad hoc Van den Wyngaert.

Done in French and in English, the French text being authoritative, at the Peace Palace, The Hague, this fourteenth day of February, two thousand and two, in three copies, one of which will be placed in the archives of the Court and the others transmitted to the Government of the Demo-

cratic Republic of the Congo and the Government of the Kingdom of Belgium, respectively.

(Signed) Gilbert GUILLAUME,
President.

(Signed) Philippe COUVREUR,
Registrar.

President GUILLAUME appends a separate opinion to the Judgment of the Court; Judge ODA appends a dissenting opinion to the Judgment of the Court; Judge RANJEVA appends a declaration to the Judgment of the Court; Judge KOROMA appends a separate opinion to the Judgment of the Court; Judges HIGGINS, KOOIJMANS and BUERGENTHAL append a joint separate opinion to the Judgment of the Court; Judge REZEK appends a separate opinion to the Judgment of the Court; Judge AL-KHASAWNEH appends a dissenting opinion to the Judgment of the Court; Judge *ad hoc* BULA-BULA appends a separate opinion to the Judgment of the Court; Judge *ad hoc* VAN DEN WYNGAERT appends a dissenting opinion to the Judgment of the Court.

(Initialled) G.G.

(Initialled) Ph.C.

Annex 30

INTERNATIONAL COURT OF JUSTICE

REPORTS OF JUDGMENTS,
ADVISORY OPINIONS AND ORDERS

CASE CONCERNING AVENA AND OTHER MEXICAN NATIONALS

(MEXICO *v.* UNITED STATES OF AMERICA)

JUDGMENT OF 31 MARCH 2004

2004

COUR INTERNATIONALE DE JUSTICE

RECUEIL DES ARRÊTS,
AVIS CONSULTATIFS ET ORDONNANCES

AFFAIRE AVENA ET AUTRES RESSORTISSANTS MEXICAINS

(MEXIQUE c. ÉTATS-UNIS D'AMÉRIQUE)

ARRÊT DU 31 MARS 2004

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JUDGMENT

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ARRÊT

INTERNATIONAL COURT OF JUSTICE

2004
31 March
General List
No. 128

YEAR 2004

31 March 2004

CASE CONCERNING AVENA AND OTHER MEXICAN NATIONALS

(MEXICO *v.* UNITED STATES OF AMERICA)

Facts of the case — Article 36 of the Vienna Convention on Consular Relations of 24 April 1963.

* *

Mexico's objection to the United States objections to jurisdiction and admissibility — United States objections not presented as preliminary objections —Article 79 of Rules of Court not pertinent in present case.

* *

Jurisdiction of the Court.
First United States objection to jurisdiction — Contention that Mexico's submissions invite the Court to rule on the operation of the United States criminal justice system — Jurisdiction of Court to determine the nature and extent of obligations arising under Vienna Convention — Enquiry into the conduct of criminal proceedings in United States courts a matter belonging to the merits.

Second United States objection to jurisdiction — Contention that the first submission of Mexico's Memorial is excluded from the Court's jurisdiction — Mexico defending an interpretation of the Vienna Convention whereby not only the absence of consular notification but also the arrest, detention, trial and conviction of its nationals were unlawful, failing such notification — Interpretation of Vienna Convention a matter within the Court's jurisdiction.

Third United States objection to jurisdiction — Contention that Mexico's submissions on remedies go beyond the Court's jurisdiction — Jurisdiction of Court to consider the question of remedies — Question whether or how far the Court may order the requested remedies a matter belonging to the merits.

Fourth United States objection to jurisdiction — Contention that the Court lacks jurisdiction to determine whether or not consular notification is a human right — Question of interpretation of Vienna Convention.

* *

Admissibility of Mexico's claims.

First United States objection to admissibility — Contention that Mexico's submissions on remedies seek to have the Court function as a court of criminal appeal — Question belonging to the merits.

Second United States objection to admissibility — Contention that Mexico's claims to exercise its right of diplomatic protection are inadmissible on grounds that local remedies have not been exhausted — Interdependence in the present case of rights of the State and of individual rights — Mexico requesting the Court to rule on the violation of rights which it suffered both directly and through the violation of individual rights of its nationals — Duty to exhaust local remedies does not apply to such a request.

Third United States objection to admissibility — Contention that certain Mexican nationals also have United States nationality — Question belonging to the merits.

Fourth United States objection to admissibility — Contention that Mexico had actual knowledge of a breach but failed to bring such breach to the attention of the United States or did so only after considerable delay — No contention in the present case of any prejudice caused by such delay — No implied waiver by Mexico of its rights.

Fifth United States objection to admissibility — Contention that Mexico invokes standards that it does not follow in its own practice — Nature of Vienna Convention precludes such an argument.

* *

Article 36, paragraph 1 — Mexican nationality of 52 individuals concerned — United States has not proved its contention that some were also United States nationals.

Article 36, paragraph 1 (b) *— Consular information — Duty to provide consular information as soon as arresting authorities realize that arrested person is a foreign national, or have grounds for so believing — Provision of consular information in parallel with reading of "Miranda rights" — Contention that seven individuals stated at the time of arrest that they were United States nationals — Interpretation of phrase "without delay" — Violation by United States of the obligation to provide consular information in 51 cases.*

Consular notification — Violation by United States of the obligation of consular notification in 49 cases.

Article 36, paragraph 1 (a) *and* (c) *— Interrelated nature of the three subparagraphs of paragraph 1 — Violation by United States of the obligation to enable Mexican consular officers to communicate with, have access to and visit their nationals in 49 cases — Violation by United States of the obligation to*

enable Mexican consular officers to arrange for legal representation of their nationals in 34 cases.

Article 36, paragraph 2 — "Procedural default" rule — Possibility of judicial remedies still open in 49 cases — Violation by United States of its obligations under Article 36, paragraph 2, in three cases.

* *

Legal consequences of the breach.

Question of adequate reparation for violations of Article 36 — Review and reconsideration by United States courts of convictions and sentences of the Mexican nationals — Choice of means left to United States — Review and reconsideration to be carried out by taking account of violation of Vienna Convention rights — "Procedural default" rule.

Judicial process suited to the task of review and reconsideration — Clemency process, as currently practised within the United States criminal justice system, not sufficient in itself to serve as appropriate means of "review and reconsideration" — Appropriate clemency procedures can supplement judicial review and reconsideration.

Mexico requesting cessation of wrongful acts and guarantees and assurances of non-repetition — No evidence to establish "regular and continuing" pattern of breaches by United States of Article 36 of Vienna Convention — Measures taken by United States to comply with its obligations under Article 36, paragraph 1 — Commitment undertaken by United States to ensure implementation of its obligations under that provision.

* *

No a contrario *argument can be made in respect of the Court's findings in the present Judgment concerning Mexican nationals.*

* *

United States obligations declared in Judgment replace those arising from Provisional Measures Order of 5 February 2003 — In the three cases where the United States violated its obligations under Article 36, paragraph 2, it must find an appropriate remedy having the nature of review and reconsideration according to the criteria indicated in the Judgment.

JUDGMENT

Present: *President* SHI; *Vice-President* RANJEVA; *Judges* GUILLAUME, KOROMA, VERESHCHETIN, HIGGINS, PARRA-ARANGUREN, KOOIJMANS, REZEK, AL-KHASAWNEH, BUERGENTHAL, ELARABY, OWADA, TOMKA; *Judge* ad hoc SEPÚLVEDA; *Registrar* COUVREUR.

In the case concerning Avena and other Mexican nationals,

between

the United Mexican States,

represented by

H.E. Mr. Juan Manuel Gómez-Robledo, Ambassador, former Legal Adviser, Ministry of Foreign Affairs, Mexico City,

as Agent;

H.E. Mr. Santiago Oñate, Ambassador of Mexico to the Kingdom of the Netherlands,

as Agent (until 12 February 2004);

Mr. Arturo A. Dager, Legal Adviser, Ministry of Foreign Affairs, Mexico City,

Ms María del Refugio González Domínguez, Chief, Legal Co-ordination Unit, Ministry of Foreign Affairs, Mexico City,

as Agents (from 2 March 2004);

H.E. Ms Sandra Fuentes Berain, Ambassador-Designate of Mexico to the Kingdom of the Netherlands,

as Agent (from 17 March 2004);

Mr. Pierre-Marie Dupuy, Professor of Public International Law at the University of Paris II (Panthéon-Assas) and at the European University Institute, Florence,

Mr. Donald Francis Donovan, Attorney at Law, Debevoise & Plimpton, New York,

Ms Sandra L. Babcock, Attorney at Law, Director of the Mexican Capital Legal Assistance Programme,

Mr. Carlos Bernal, Attorney at Law, Noriega y Escobedo, and Chairman of the Commission on International Law at the Mexican Bar Association, Mexico City,

Ms Katherine Birmingham Wilmore, Attorney at Law, Debevoise & Plimpton, London,

Mr. Dietmar W. Prager, Attorney at Law, Debevoise & Plimpton, New York,

Ms Socorro Flores Liera, Chief of Staff, Under-Secretariat for Global Affairs and Human Rights, Ministry of Foreign Affairs, Mexico City,

Mr. Víctor Manuel Uribe Aviña, Head of the International Litigation Section, Legal Adviser's Office, Ministry of Foreign Affairs, Mexico City,

as Counsellors and Advocates;

Mr. Erasmo A. Lara Cabrera, Head of the International Law Section, Legal Adviser's Office, Ministry of Foreign Affairs, Mexico City,

Ms Natalie Klein, Attorney at Law, Debevoise & Plimpton, New York,

Ms Catherine Amirfar, Attorney at Law, Debevoise & Plimpton, New York,

Mr. Thomas Bollyky, Attorney at Law, Debevoise & Plimpton, New York,

Ms Cristina Hoss, Research Fellow at the Max Planck Institute for Comparative Public Law and International Law, Heidelberg,

Mr. Mark Warren, International Law Researcher, Ottawa,

as Advisers;

Mr. Michel L'Enfant, Debevoise & Plimpton, Paris,

as Assistant,

and

the United States of America,

represented by

The Honourable William H. Taft, IV, Legal Adviser, United States Department of State,

as Agent;

Mr. James H. Thessin, Principal Deputy Legal Adviser, United States Department of State,

as Co-Agent;

Ms Catherine W. Brown, Assistant Legal Adviser for Consular Affairs, United States Department of State,
Mr. D. Stephen Mathias, Assistant Legal Adviser for United Nations Affairs, United States Department of State,
Mr. Patrick F. Philbin, Associate Deputy Attorney General, United States Department of Justice,
Mr. John Byron Sandage, Attorney-Adviser for United Nations Affairs, United States Department of State,
Mr. Thomas Weigend, Professor of Law and Director of the Institute of Foreign and International Criminal Law, University of Cologne,
Ms Elisabeth Zoller, Professor of Public Law, University of Paris II (Panthéon-Assas),

as Counsel and Advocates;

Mr. Jacob Katz Cogan, Attorney-Adviser for United Nations Affairs, United States Department of State,
Ms Sara Criscitelli, Member of the Bar of the State of New York,
Mr. Robert J. Erickson, Principal Deputy Chief, Criminal Appellate Section, United States Department of Justice,
Mr. Noel J. Francisco, Deputy Assistant Attorney General, Office of Legal Counsel, United States Department of Justice,

Mr. Steven Hill, Attorney-Adviser for Economic and Business Affairs, United States Department of State,
Mr. Clifton M. Johnson, Legal Counsellor, United States Embassy, The Hague,
Mr. David A. Kaye, Deputy Legal Counsellor, United States Embassy, The Hague,
Mr. Peter W. Mason, Attorney-Adviser for Consular Affairs, United States Department of State,

as Counsel;

Ms Barbara Barrett-Spencer, United States Department of State,
Ms Marianne Hata, United States Department of State,
Ms Cecile Jouglet, United States Embassy, Paris,
Ms Joanne Nelligan, United States Department of State,
Ms Laura Romains, United States Embassy, The Hague,

as Administrative Staff,

THE COURT,

composed as above,

after deliberation,

delivers the following Judgment:

1. On 9 January 2003 the United Mexican States (hereinafter referred to as "Mexico") filed in the Registry of the Court an Application instituting proceedings against the United States of America (hereinafter referred to as the "United States") for "violations of the Vienna Convention on Consular Relations" of 24 April 1963 (hereinafter referred to as the "Vienna Convention") allegedly committed by the United States.

In its Application, Mexico based the jurisdiction of the Court on Article 36, paragraph 1, of the Statute of the Court and on Article I of the Optional Protocol concerning the Compulsory Settlement of Disputes, which accompanies the Vienna Convention (hereinafter referred to as the "Optional Protocol").

2. Pursuant to Article 40, paragraph 2, of the Statute, the Application was forthwith communicated to the Government of the United States; and, in accordance with paragraph 3 of that Article, all States entitled to appear before the Court were notified of the Application.

3. On 9 January 2003, the day on which the Application was filed, the Mexican Government also filed in the Registry of the Court a request for the indication of provisional measures based on Article 41 of the Statute and Articles 73, 74 and 75 of the Rules of Court.

By an Order of 5 February 2003, the Court indicated the following provisional measures:

"*(a)* The United States of America shall take all measures necessary to ensure that Mr. César Roberto Fierro Reyna, Mr. Roberto Moreno Ramos and Mr. Osvaldo Torres Aguilera are not executed pending final judgment in these proceedings;

(b) The Government of the United States of America shall inform the Court of all measures taken in implementation of this Order."

It further decided that, "until the Court has rendered its final judgment, it shall remain seised of the matters" which formed the subject of that Order.

In a letter of 2 November 2003, the Agent of the United States advised the Court that the United States had "informed the relevant state authorities of Mexico's application"; that, since the Order of 5 February 2003, the United States had "obtained from them information about the status of the fifty-four cases, including the three cases identified in paragraph 59 (I) *(a)* of that Order"; and that the United States could "confirm that none of the named individuals [had] been executed".

4. In accordance with Article 43 of the Rules of Court, the Registrar sent the notification referred to in Article 63, paragraph 1, of the Statute to all States parties to the Vienna Convention or to that Convention and the Optional Protocol.

5. By an Order of 5 February 2003, the Court, taking account of the views of the Parties, fixed 6 June 2003 and 6 October 2003, respectively, as the time-limits for the filing of a Memorial by Mexico and of a Counter-Memorial by the United States.

6. By an Order of 22 May 2003, the President of the Court, on the joint request of the Agents of the two Parties, extended to 20 June 2003 the time-limit for the filing of the Memorial; the time-limit for the filing of the Counter-Memorial was extended, by the same Order, to 3 November 2003.

By a letter dated 20 June 2003 and received in the Registry on the same day, the Agent of Mexico informed the Court that Mexico was unable for technical reasons to file the original of its Memorial on time and accordingly asked the Court to decide, under Article 44, paragraph 3, of the Rules of Court, that the filing of the Memorial after the expiration of the time-limit fixed therefor would be considered as valid; that letter was accompanied by two electronic copies of the Memorial and its annexes. Mexico having filed the original of the Memorial on 23 June 2003 and the United States having informed the Court, by a letter of 24 June 2003, that it had no comment to make on the matter, the Court decided on 25 June 2003 that the filing would be considered as valid.

7. In a letter of 14 October 2003, the Agent of Mexico expressed his Government's wish to amend its submissions in order to include therein the cases of two Mexican nationals, Mr. Víctor Miranda Guerrero and Mr. Tonatihu Aguilar Saucedo, who had been sentenced to death, after the filing of Mexico's Memorial, as a result of criminal proceedings in which, according to Mexico, the United States had failed to comply with its obligations under Article 36 of the Vienna Convention.

In a letter of 2 November 2003, under cover of which the United States filed its Counter-Memorial within the time-limit prescribed, the Agent of the United States informed the Court that his Government objected to the amendment of Mexico's submissions, on the grounds that the request was late, that Mexico had submitted no evidence concerning the alleged facts and that there was not enough time for the United States to investigate them.

In a letter received in the Registry on 28 November 2003, Mexico responded to the United States objection and at the same time amended its submissions so as to withdraw its request for relief in the cases of two Mexican nationals mentioned in the Memorial, Mr. Enrique Zambrano Garibi and Mr. Pedro Hernández Alberto, having come to the conclusion that the former had dual Mexican and United States nationality and that the latter had been informed of his right of consular notification prior to interrogation.

On 9 December 2003, the Registrar informed Mexico and the United States that, in order to ensure the procedural equality of the Parties, the Court had decided not to authorize the amendment of Mexico's submissions so as to include the two additional Mexican nationals mentioned above. He also informed the Parties that the Court had taken note that the United States had made no objection to the withdrawal by Mexico of its request for relief in the cases of Mr. Zambrano and Mr. Hernández.

8. On 28 November 2003 and 2 December 2003, Mexico filed various documents which it wished to produce in accordance with Article 56 of the Rules of Court. By letters dated 2 December 2003 and 5 December 2003, the Agent of the United States informed the Court that his Government did not object to the production of these new documents and that it intended to exercise its right to comment upon these documents and to submit documents in support of its comments, pursuant to paragraph 3 of that Article. By letters dated 9 December 2003, the Registrar informed the Parties that the Court had taken note that

the United States had no objection to the production of these documents and that accordingly counsel would be free to refer to them in the course of the hearings. On 10 December 2003, the Agent of the United States filed the comments of his Government on the new documents produced by Mexico, together with a number of documents in support of those comments.

9. Since the Court included upon the Bench no judge of Mexican nationality, Mexico availed itself of its right under Article 31, paragraph 2, of the Statute to choose a judge *ad hoc* to sit in the case: it chose Mr. Bernardo Sepúlveda.

10. Pursuant to Article 53, paragraph 2, of its Rules, the Court, having consulted the Parties, decided that copies of the pleadings and documents annexed would be made accessible to the public on the opening of the oral proceedings.

11. Public sittings were held between 15 and 19 December 2003, at which the Court heard the oral arguments and replies of:

For Mexico:	H.E. Mr. Juan Manuel Gómez-Robledo, Ms Sandra L. Babcock, Mr. Víctor Manuel Uribe Aviña, Mr. Donald Francis Donovan, Ms Katherine Birmingham Wilmore, H.E. Mr. Santiago Oñate, Ms Socorro Flores Liera, Mr. Carlos Bernal, Mr. Dietmar W. Prager, Mr. Pierre-Marie Dupuy.
For the United States:	The Honourable William H. Taft, IV, Ms Elisabeth Zoller, Mr. Patrick F. Philbin, Mr. John Byron Sandage, Ms Catherine W. Brown, Mr. D. Stephen Mathias, Mr. James H. Thessin, Mr. Thomas Weigend.

*

12. In its Application, Mexico formulated the decision requested in the following terms:

> "The Government of the United Mexican States therefore asks the Court to adjudge and declare:
>
> (1) that the United States, in arresting, detaining, trying, convicting, and sentencing the 54 Mexican nationals on death row described in this Application, violated its international legal obligations to Mexico, in its own right and in the exercise of its right of consular protection of its nationals, as provided by Articles 5 and 36, respectively of the Vienna Convention;
>
> (2) that Mexico is therefore entitled to *restitutio in integrum*;
>
> (3) that the United States is under an international legal obligation not to

apply the doctrine of procedural default, or any other doctrine of its municipal law, to preclude the exercise of the rights afforded by Article 36 of the Vienna Convention;

(4) that the United States is under an international legal obligation to carry out in conformity with the foregoing international legal obligations any future detention of or criminal proceedings against the 54 Mexican nationals on death row or any other Mexican national in its territory, whether by a constituent, legislative, executive, judicial or other power, whether that power holds a superior or a subordinate position in the organization of the United States, and whether that power's functions are international or internal in character;

(5) that the right to consular notification under the Vienna Convention is a human right;

and that, pursuant to the foregoing international legal obligations,

(1) the United States must restore the *status quo ante*, that is, re-establish the situation that existed before the detention of, proceedings against, and convictions and sentences of, Mexico's nationals in violation of the United States international legal obligations;

(2) the United States must take the steps necessary and sufficient to ensure that the provisions of its municipal law enable full effect to be given to the purposes for which the rights afforded by Article 36 are intended;

(3) the United States must take the steps necessary and sufficient to establish a meaningful remedy at law for violations of the rights afforded to Mexico and its nationals by Article 36 of the Vienna Convention, including by barring the imposition, as a matter of municipal law, of any procedural penalty for the failure timely to raise a claim or defence based on the Vienna Convention where competent authorities of the United States have breached their obligation to advise the national of his or her rights under the Convention; and

(4) the United States, in light of the pattern and practice of violations set forth in this Application, must provide Mexico a full guarantee of the non-repetition of the illegal acts."

13. In the course of the written proceedings, the following submissions were presented by the Parties:

On behalf of the Government of Mexico,

in the Memorial:

"For these reasons, . . . the Government of Mexico respectfully requests the Court to adjudge and declare

(1) that the United States, in arresting, detaining, trying, convicting, and sentencing the fifty-four Mexican nationals on death row described in

Mexico's Application and this Memorial, violated its international legal obligations to Mexico, in its own right and in the exercise of its right of diplomatic protection of its nationals, as provided by Article 36 of the Vienna Convention;

(2) that the obligation in Article 36 (1) of the Vienna Convention requires notification before the competent authorities of the receiving State interrogate the foreign national or take any other action potentially detrimental to his or her rights;

(3) that the United States, in applying the doctrine of procedural default, or any other doctrine of its municipal law, to preclude the exercise and review of the rights afforded by Article 36 of the Vienna Convention, violated its international legal obligations to Mexico, in its own right and in the exercise of its right of diplomatic protection of its nationals, as provided by Article 36 of the Vienna Convention; and

(4) that the United States is under an international legal obligation to carry out in conformity with the foregoing international legal obligations any future detention of or criminal proceedings against the fifty-four Mexican nationals on death row and any other Mexican national in its territory, whether by a constituent, legislative, executive, judicial or other power, whether that power holds a superior or a subordinate position in the organization of the United States, and whether that power's functions are international or internal in character;

and that, pursuant to the foregoing international legal obligations,

(1) Mexico is entitled to *restitutio in integrum* and the United States therefore is under an obligation to restore the *status quo ante*, that is, re-establish the situation that existed at the time of the detention and prior to the interrogation of, proceedings against, and convictions and sentences of, Mexico's nationals in violation of the United States' international legal obligations, specifically by, among other things,

(a) vacating the convictions of the fifty-four Mexican nationals;

(b) vacating the sentences of the fifty-four Mexican nationals;

(c) excluding any subsequent proceedings against the fifty-four Mexican nationals any statements and confessions obtained from them prior to notification of their rights to consular notification and access;

(d) preventing the application of any procedural penalty for a Mexican national's failure timely to raise a claim or defence based on the Vienna Convention where competent authorities of the United States have breached their obligation to advise the national of his rights under the Convention;

(e) preventing the application of any municipal law doctrine or judicial holding that prevents a court in the United States from providing a remedy, including the relief to which this Court holds that Mexico is entitled here, to a Mexican national whose Article 36 rights have been violated; and

(f) preventing the application of any municipal law doctrine or judicial holding that requires an individualized showing of prejudice as a prerequisite to relief for the violations of Article 36;

(2) the United States, in light of the regular and continuous violations set forth in Mexico's Application and Memorial, is under an obligation to take all legislative, executive, and judicial steps necessary to:

(a) ensure that the regular and continuing violations of the Article 36 consular notification, access, and assistance rights of Mexico and its nationals cease;

(b) guarantee that its competent authorities, of federal, state, and local jurisdiction, maintain regular and routine compliance with their Article 36 obligations;

(c) ensure that its judicial authorities cease applying, and guarantee that in the future they will not apply:

(i) any procedural penalty for a Mexican national's failure timely to raise a claim or defence based on the Vienna Convention where competent authorities of the United States have breached their obligation to advise the national of his or her rights under the Convention;

(ii) any municipal law doctrine or judicial holding that prevents a court in the United States from providing a remedy, including the relief to which this Court holds that Mexico is entitled here, to a Mexican national whose Article 36 rights have been violated; and

(iii) any municipal law doctrine or judicial holding that requires an individualized showing of prejudice as a prerequisite to relief for the Vienna Convention violations shown here."

On behalf of the Government of the United States,

in the Counter-Memorial:

"On the basis of the facts and arguments set out above, the Government of the United States of America requests that the Court adjudge and declare that the claims of the United Mexican States are dismissed."

14. At the oral proceedings, the following submissions were presented by the Parties:

On behalf of the Government of Mexico,

"The Government of Mexico respectfully requests the Court to adjudge and declare

(1) that the United States of America, in arresting, detaining, trying, convicting, and sentencing the 52 Mexican nationals on death row described in Mexico's Memorial, violated its international legal obligations to Mexico, in its own right and in the exercise of its right to diplomatic protection of its nationals, by failing to inform, without delay, the 52 Mexican nationals after their arrest of their right to consular notification and access under Article 36 (1) *(b)* of the Vienna Convention on Consular Relations, and by depriving Mexico of its right to provide consular protection and the 52 nationals' right to receive such protection as Mexico would provide under Article 36 (1) *(a)* and *(c)* of the Convention;

(2) that the obligation in Article 36 (1) of the Vienna Convention requires notification of consular rights and a reasonable opportunity for consular access before the competent authorities of the receiving State take any action potentially detrimental to the foreign national's rights;

(3) that the United States of America violated its obligations under Article 36 (2) of the Vienna Convention by failing to provide meaningful and effective review and reconsideration of convictions and sentences impaired by a violation of Article 36 (1); by substituting for such review and reconsideration clemency proceedings; and by applying the 'procedural default' doctrine and other municipal law doctrines that fail to attach legal significance to an Article 36 (1) violation on its own terms;

(4) that pursuant to the injuries suffered by Mexico in its own right and in the exercise of diplomatic protection of its nationals, Mexico is entitled to full reparation for those injuries in the form of *restitutio in integrum*;

(5) that this restitution consists of the obligation to restore the *status quo ante* by annulling or otherwise depriving of full force or effect the convictions and sentences of all 52 Mexican nationals;

(6) that this restitution also includes the obligation to take all measures necessary to ensure that a prior violation of Article 36 shall not affect the subsequent proceedings;

(7) that to the extent that any of the 52 convictions or sentences are not annulled, the United States shall provide, by means of its own choosing, meaningful and effective review and reconsideration of the convictions and sentences of the 52 nationals, and that this obligation cannot be satisfied by means of clemency proceedings or if any municipal law rule or doctrine inconsistent with paragraph (3) above is applied; and

(8) that the United States of America shall cease its violations of Article 36 of the Vienna Convention with regard to Mexico and its 52 nationals and shall provide appropriate guarantees and assurances that it shall take measures sufficient to achieve increased compliance with Article 36 (1) and to ensure compliance with Article 36 (2)."

On behalf of the Government of the United States,

"On the basis of the facts and arguments made by the United States in its Counter-Memorial and in these proceedings, the Government of the United States of America requests that the Court, taking into account that the United States has conformed its conduct to this Court's Judgment in the *LaGrand Case (Germany* v. *United States of America)*, not only with respect to German nationals but, consistent with the Declaration of the President of the Court in that case, to all detained foreign nationals, adjudge and declare that the claims of the United Mexican States are dismissed."

* * *

15. The present proceedings have been brought by Mexico against the United States on the basis of the Vienna Convention, and of the Optional Protocol providing for the jurisdiction of the Court over "disputes arising out of the interpretation or application" of the Convention. Mexico and the United States are, and were at all relevant times, parties to the Vienna Convention and to the Optional Protocol. Mexico claims that the United States has committed breaches of the Vienna Convention in relation to the treatment of a number of Mexican nationals who have been tried, convicted and sentenced to death in criminal proceedings in the United States. The original claim related to 54 such persons, but as a result of subsequent adjustments to its claim made by Mexico (see paragraph 7 above), only 52 individual cases are involved. These criminal proceedings have been taking place in nine different States of the United States, namely California (28 cases), Texas (15 cases), Illinois (three cases), Arizona (one case), Arkansas (one case), Nevada (one case), Ohio (one case), Oklahoma (one case) and Oregon (one case), between 1979 and the present.

16. For convenience, the names of the 52 individuals, and the numbers by which their cases will be referred to, are set out below:

1. Carlos Avena Guillen
2. Héctor Juan Ayala
3. Vicente Benavides Figueroa
4. Constantino Carrera Montenegro
5. Jorge Contreras López

6. Daniel Covarrubias Sánchez
7. Marcos Esquivel Barrera
8. Rubén Gómez Pérez
9. Jaime Armando Hoyos
10. Arturo Juárez Suárez
11. Juan Manuel López
12. José Lupercio Casares
13. Luis Alberto Maciel Hernández
14. Abelino Manriquez Jáquez
15. Omar Fuentes Martínez (a.k.a. Luis Aviles de la Cruz)
16. Miguel Angel Martínez Sánchez
17. Martín Mendoza García
18. Sergio Ochoa Tamayo
19. Enrique Parra Dueñas
20. Juan de Dios Ramírez Villa
21. Magdaleno Salazar
22. Ramón Salcido Bojórquez
23. Juan Ramón Sánchez Ramírez
24. Ignacio Tafoya Arriola
25. Alfredo Valdez Reyes
26. Eduardo David Vargas
27. Tomás Verano Cruz
28. [Case withdrawn]
29. Samuel Zamudio Jiménez
30. Juan Carlos Alvarez Banda
31. César Roberto Fierro Reyna
32. Héctor García Torres
33. Ignacio Gómez
34. Ramiro Hernández Llanas
35. Ramiro Rubí Ibarra
36. Humberto Leal García
37. Virgilio Maldonado
38. José Ernesto Medellín Rojas
39. Roberto Moreno Ramos
40. Daniel Angel Plata Estrada
41. Rubén Ramírez Cárdenas
42. Félix Rocha Díaz
43. Oswaldo Regalado Soriano
44. Edgar Arias Tamayo
45. Juan Caballero Hernández
46. Mario Flores Urbán
47. Gabriel Solache Romero
48. Martín Raúl Fong Soto
49. Rafael Camargo Ojeda
50. [Case withdrawn]
51. Carlos René Pérez Gutiérrez
52. José Trinidad Loza

53. Osvaldo Netzahualcóyotl Torres Aguilera
54. Horacio Alberto Reyes Camarena

17. The provisions of the Vienna Convention of which Mexico alleges violations are contained in Article 36. Paragraphs 1 and 2 of this Article are set out respectively in paragraphs 50 and 108 below. Article 36 relates, according to its title, to "Communication and contact with nationals of the sending State". Paragraph 1 *(b)* of that Article provides that if a national of that State "is arrested or committed to prison or to custody pending trial or is detained in any other manner", and he so requests, the local consular post of the sending State is to be notified. The Article goes on to provide that the "competent authorities of the receiving State" shall "inform the person concerned without delay of his rights" in this respect. Mexico claims that in the present case these provisions were not complied with by the United States authorities in respect of the 52 Mexican nationals the subject of its claims. As a result, the United States has according to Mexico committed breaches of paragraph 1 *(b)*; moreover, Mexico claims, for reasons to be explained below (see paragraphs 98 *et seq.*), that the United States is also in breach of paragraph 1 *(a)* and *(c)* and of paragraph 2 of Article 36, in view of the relationship of these provisions with paragraph 1 *(b)*.

18. As regards the terminology employed to designate the obligations incumbent upon the receiving State under Article 36, paragraph 1 *(b)*, the Court notes that the Parties have used the terms "inform" and "notify" in differing senses. For the sake of clarity, the Court, when speaking in its own name in the present Judgment, will use the word "inform" when referring to an individual being made aware of his rights under that subparagraph and the word "notify" when referring to the giving of notice to the consular post.

19. The underlying facts alleged by Mexico may be briefly described as follows: some are conceded by the United States, and some disputed. Mexico states that all the individuals the subject of its claims were Mexican nationals at the time of their arrest. It further contends that the United States authorities that arrested and interrogated these individuals had sufficient information at their disposal to be aware of the foreign nationality of those individuals. According to Mexico's account, in 50 of the specified cases, Mexican nationals were never informed by the competent United States authorities of their rights under Article 36, paragraph 1 *(b)*, of the Vienna Convention and, in the two remaining cases, such information was not provided "without delay", as required by that provision. Mexico has indicated that in 29 of the 52 cases its consular authorities learned of the detention of the Mexican nationals only after death sentences had been handed down. In the 23 remaining cases, Mexico contends that it learned of the cases through means other than notification to the consular post by the competent United States authorities under Article 36, paragraph 1 *(b)*. It explains that in five cases this

was too late to affect the trials, that in 15 cases the defendants had already made incriminating statements, and that it became aware of the other three cases only after considerable delay.

20. Of the 52 cases referred to in Mexico's final submissions, 49 are currently at different stages of the proceedings before United States judicial authorities at state or federal level, and in three cases, those of Mr. Fierro (case No. 31), Mr. Moreno (case No. 39) and Mr. Torres (case No. 53), judicial remedies within the United States have already been exhausted. The Court has been informed of the variety of types of proceedings and forms of relief available in the criminal justice systems of the United States, which can differ from state to state. In very general terms, and according to the description offered by both Parties in their pleadings, it appears that the 52 cases may be classified into three categories: 24 cases which are currently in direct appeal; 25 cases in which means of direct appeal have been exhausted, but post-conviction relief *(habeas corpus)*, either at state or at federal level, is still available; and three cases in which no judicial remedies remain. The Court also notes that, in at least 33 cases, the alleged breach of the Vienna Convention was raised by the defendant either during pre-trial, at trial, on appeal or in *habeas corpus* proceedings, and that some of these claims were dismissed on procedural or substantive grounds and others are still pending. To date, in none of the 52 cases have the defendants had recourse to the clemency process.

21. On 9 January 2003, the day on which Mexico filed its Application and a request for the indication of provisional measures, all 52 individuals the subject of the claims were on death row. However, two days later the Governor of the State of Illinois, exercising his power of clemency review, commuted the sentences of all convicted individuals awaiting execution in that State, including those of three individuals named in Mexico's Application (Mr. Caballero (case No. 45), Mr. Flores (case No. 46) and Mr. Solache (case No. 47)). By a letter dated 20 January 2003, Mexico informed the Court that, further to that decision, it withdrew its request for the indication of provisional measures on behalf of these three individuals, but that its Application remained unchanged. In the Order of 5 February 2003, mentioned in paragraph 3 above, on the request by Mexico for the indication of provisional measures, the Court considered that it was apparent from the information before it that the three Mexican nationals named in the Application who had exhausted all judicial remedies in the United States (see paragraph 20 above) were at risk of execution in the following months, or even weeks. Consequently, it ordered by way of provisional measure that the United States take all measures necessary to ensure that these individuals would not be executed

pending final judgment in these proceedings. The Court notes that, at the date of the present Judgment, these three individuals have not been executed, but further notes with great concern that, by an Order dated 1 March 2004, the Oklahoma Court of Criminal Appeals has set an execution date of 18 May 2004 for Mr. Torres.

* * *

THE MEXICAN OBJECTION TO THE UNITED STATES OBJECTIONS TO JURISDICTION AND ADMISSIBILITY

22. As noted above, the present dispute has been brought before the Court by Mexico on the basis of the Vienna Convention and the Optional Protocol to that Convention. Article I of the Optional Protocol provides:

> "Disputes arising out of the interpretation or application of the [Vienna] Convention shall lie within the compulsory jurisdiction of the International Court of Justice and may accordingly be brought before the Court by a written application made by any party to the dispute being a Party to the present Protocol."

23. The United States has presented a number of objections to the jurisdiction of the Court, as well as a number of objections to the admissibility of the claims advanced by Mexico. It is however the contention of Mexico that all the objections raised by the United States are inadmissible as having been raised after the expiration of the time-limit laid down by the Rules of Court. Mexico draws attention to the text of Article 79, paragraph 1, of the Rules of Court as amended in 2000, which provides that

> "Any objection by the respondent to the jurisdiction of the Court or to the admissibility of the application, or other objection the decision upon which is requested before any further proceedings on the merits, shall be made in writing as soon as possible, and not later than three months after the delivery of the Memorial."

The previous text of this paragraph required objections to be made "within the time-limit fixed for delivery of the Counter-Memorial". In the present case the Memorial of Mexico was filed on 23 June 2003; the objections of the United States to jurisdiction and admissibility were presented in its Counter-Memorial, filed on 3 November 2003, more than four months later.

24. The United States has observed that, during the proceedings on the request made by Mexico for the indication of provisional measures in this case, it specifically reserved its right to make jurisdictional arguments at the appropriate stage, and that subsequently the Parties agreed that there should be a single round of pleadings. The Court would however emphasize that parties to cases before it cannot, by purporting to "reserve their rights" to take some procedural action, exempt themselves from the application to such action of the provisions of the Statute and Rules of

Court (cf. *Application of the Convention on the Prevention and Punishment of the Crime of Genocide (Bosnia and Herzegovina* v. *Yugoslavia), Order of 13 September 1993, I.C.J. Reports 1993*, p. 338, para. 28).

The Court notes, however, that Article 79 of the Rules applies only to preliminary objections, as is indicated by the title of the subsection of the Rules which it constitutes. As the Court observed in the *Lockerbie* cases, "if it is to be covered by Article 79, an objection must . . . possess a 'preliminary' character", and "Paragraph 1 of Article 79 of the Rules of Court characterizes as 'preliminary' an objection 'the decision upon which is requested before any further proceedings'" (*Questions of Interpretation and Application of the 1971 Montreal Convention arising from the Aerial Incident at Lockerbie (Libyan Arab Jamahiriya* v. *United Kingdom) (Libyan Arab Jamahiriya v. United States of America), Preliminary Objections, I.C.J. Reports 1998*, p. 26, para. 47; p. 131, para. 46); and the effect of the timely presentation of such an objection is that the proceedings on the merits are suspended (paragraph 5 of Article 79). An objection that is not presented as a preliminary objection in accordance with paragraph 1 of Article 79 does not thereby become inadmissible. There are of course circumstances in which the party failing to put forward an objection to jurisdiction might be held to have acquiesced in jurisdiction (*Appeal Relating to the Jurisdiction of the ICAO Council, Judgment, I.C.J. Reports 1972*, p. 52, para. 13). However, apart from such circumstances, a party failing to avail itself of the Article 79 procedure may forfeit the right to bring about a suspension of the proceedings on the merits, but can still argue the objection along with the merits. That is indeed what the United States has done in this case; and, for reasons to be indicated below, many of its objections are of such a nature that they would in any event probably have had to be heard along with the merits. The Court concludes that it should not exclude from consideration the objections of the United States to jurisdiction and admissibility by reason of the fact that they were not presented within three months from the date of filing of the Memorial.

25. The United States has submitted four objections to the jurisdiction of the Court, and five to the admissibility of the claims of Mexico. As noted above, these have not been submitted as preliminary objections under Article 79 of the Rules of Court; and they are not of such a nature that the Court would be required to examine and dispose of all of them *in limine*, before dealing with any aspect of the merits of the case. Some are expressed to be only addressed to certain claims; some are addressed to questions of the remedies to be indicated if the Court finds that breaches of the Vienna Convention have been committed; and some are of such a nature that they would have to be dealt with along with the merits. The Court will however now examine each of them in turn.

* *

UNITED STATES OBJECTIONS TO JURISDICTION

26. The United States contends that the Court lacks jurisdiction to decide many of Mexico's claims, inasmuch as Mexico's submissions in the Memorial asked the Court to decide questions which do not arise out of the interpretation or application of the Vienna Convention, and which the United States has never agreed to submit to the Court.

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27. By its first jurisdictional objection, the United States suggested that the Memorial is fundamentally addressed to the treatment of Mexican nationals in the federal and state criminal justice systems of the United States, and the operation of the United States criminal justice system as a whole. It suggested that Mexico's invitation to the Court to make what the United States regards as "far-reaching and unsustainable findings concerning the United States criminal justice systems" would be an abuse of the Court's jurisdiction. At the hearings, the United States contended that Mexico is asking the Court to interpret and apply the treaty as if it were intended principally to govern the operation of a State's criminal justice system as it affects foreign nationals.

28. The Court would recall that its jurisdiction in the present case has been invoked under the Vienna Convention and Optional Protocol to determine the nature and extent of the obligations undertaken by the United States towards Mexico by becoming party to that Convention. If and so far as the Court may find that the obligations accepted by the parties to the Vienna Convention included commitments as to the conduct of their municipal courts in relation to the nationals of other parties, then in order to ascertain whether there have been breaches of the Convention, the Court must be able to examine the actions of those courts in the light of international law. The Court is unable to uphold the contention of the United States that, as a matter of jurisdiction, it is debarred from enquiring into the conduct of criminal proceedings in United States courts. How far it may do so in the present case is a matter for the merits. The first objection of the United States to jurisdiction cannot therefore be upheld.

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29. The second jurisdictional objection presented by the United States was addressed to the first of the submissions presented by Mexico in its Memorial (see paragraph 13 above). The United States pointed out that Article 36 of the Vienna Convention "creates no obligations constraining the rights of the United States to arrest a foreign national"; and that

similarly the "detaining, trying, convicting and sentencing" of Mexican nationals could not constitute breaches of Article 36, which merely lays down obligations of notification. The United States deduced from this that the matters raised in Mexico's first submission are outside the jurisdiction of the Court under the Vienna Convention and the Optional Protocol, and it maintains this objection in response to the revised submission, presented by Mexico at the hearings, whereby it asks the Court to adjudge and declare:

> "That the United States of America, in arresting, detaining, trying, convicting, and sentencing the 52 Mexican nationals on death row described in Mexico's Memorial, violated its international legal obligations to Mexico, in its own right and in the exercise of its right to diplomatic protection of its nationals, by failing to inform, without delay, the 52 Mexican nationals after their arrest of their right to consular notification and access under Article 36 (1) *(b)* of the Vienna Convention on Consular Relations, and by depriving Mexico of its right to provide consular protection and the 52 nationals' right to receive such protection as Mexico would provide under Article 36 (1) *(a)* and *(c)* of the Convention."

30. This issue is a question of interpretation of the obligations imposed by the Vienna Convention. It is true that the only obligation of the receiving State toward a foreign national that is specifically enunciated by Article 36, paragraph 1 *(b)*, of the Vienna Convention is to inform such foreign national of his rights, when he is "arrested or committed to prison or to custody pending trial or is detained in any other manner"; the text does not restrain the receiving State from "arresting, detaining, trying, convicting, and sentencing" the foreign national, or limit its power to do so. However, as regards the detention, trial, conviction and sentence of its nationals, Mexico argues that depriving a foreign national facing criminal proceedings of consular notification and assistance renders those proceedings fundamentally unfair. Mexico explains in this respect that:

> "Consular notification constitutes a basic component of due process by ensuring both the procedural equality of a foreign national in the criminal process and the enforcement of other fundamental due process guarantees to which that national is entitled",

and that "It is therefore an essential requirement for fair criminal proceedings against foreign nationals." In Mexico's contention, "consular notification has been widely recognized as a fundamental due process right, and indeed, a human right". On this basis it argues that the rights of the detained Mexican nationals have been violated by the authorities of the United States, and that those nationals have been "subjected to criminal proceedings without the fairness and dignity to which each person is entitled". Consequently, in the contention of Mexico, "the integrity of these proceedings has been hopelessly undermined, their outcomes rendered irrevocably unjust". For Mexico to contend, on this basis, that not merely the failure to notify, but the arrest, detention, trial and conviction of its nationals were unlawful is to argue in favour of a particular interpretation of the Vienna Convention. Such an interpretation may or may not be confirmed on the merits, but is not excluded from the jurisdiction conferred on the Court by the Optional Protocol to the Vienna Convention. The second objection of the United States to jurisdiction cannot therefore be upheld.

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31. The third objection by the United States to the jurisdiction of the Court refers to the first of the submissions in the Mexican Memorial concerning remedies. By that submission, which was confirmed in substance in the final submissions, Mexico claimed that

> "Mexico is entitled to *restitutio in integrum*, and the United States therefore is under an obligation to restore the *status quo ante*, that is, re-establish the situation that existed at the time of the detention and prior to the interrogation of, proceedings against, and convictions and sentences of, Mexico's nationals in violation of the United States' international legal obligations . . ."

On that basis, Mexico went on in its first submission to invite the Court to declare that the United States was bound to vacate the convictions and sentences of the Mexican nationals concerned, to exclude from any subsequent proceedings any statements and confessions obtained from them, to prevent the application of any procedural penalty for failure to raise a timely defence on the basis of the Convention, and to prevent the application of any municipal law rule preventing courts in the United States from providing a remedy for the violation of Article 36 rights.

32. The United States objects that so to require specific acts by the United States in its municipal criminal justice systems would intrude deeply into the independence of its courts; and that for the Court to

declare that the United States is under a specific obligation to vacate convictions and sentences would be beyond its jurisdiction. The Court, the United States claims, has no jurisdiction to review appropriateness of sentences in criminal cases, and even less to determine guilt or innocence, matters which only a court of criminal appeal could go into.

33. For its part, Mexico points out that the United States accepts that the Court has jurisdiction to interpret the Vienna Convention and to determine the appropriate form of reparation under international law. In Mexico's view, these two considerations are sufficient to defeat the third objection to jurisdiction of the United States.

34. For the same reason as in respect of the second jurisdictional objection, the Court is unable to uphold the contention of the United States that, even if the Court were to find that breaches of the Vienna Convention have been committed by the United States of the kind alleged by Mexico, it would still be without jurisdiction to order *restitutio in integrum* as requested by Mexico. The Court would recall in this regard, as it did in the *LaGrand* case, that, where jurisdiction exists over a dispute on a particular matter, no separate basis for jurisdiction is required by the Court in order to consider the remedies a party has requested for the breach of the obligation (*I.C.J. Reports 2001*, p. 485, para. 48). Whether or how far the Court may order the remedy requested by Mexico are matters to be determined as part of the merits of the dispute. The third objection of the United States to jurisdiction cannot therefore be upheld.

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35. The fourth and last jurisdictional objection of the United States is that "the Court lacks jurisdiction to determine whether or not consular notification is a 'human right', or to declare fundamental requirements of substantive or procedural due process". As noted above, it is on the basis of Mexico's contention that the right to consular notification has been widely recognized as a fundamental due process right, and indeed a human right, that it argues that the rights of the detained Mexican nationals have been violated by the authorities of the United States, and that they have been "subjected to criminal proceedings without the fairness and dignity to which each person is entitled". The Court observes that Mexico has presented this argument as being a matter of interpretation of Article 36, paragraph 1 *(b)*, and therefore belonging to the merits. The Court considers that this is indeed a question of interpretation of the Vienna Convention, for which it has jurisdiction; the fourth objection of the United States to jurisdiction cannot therefore be upheld.

* *

—UNITED STATES OBJECTIONS TO ADMISSIBILITY

36. In its Counter-Memorial, the United States has advanced a number of arguments presented as objections to the admissibility of Mexico's claims. It argues that

> "Before proceeding, the Court should weigh whether characteristics of the case before it today, or special circumstances related to particular claims, render either the entire case, or particular claims, inappropriate for further consideration and decision by the Court."

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37. The first objection under this head is that "Mexico's submissions should be found inadmissible because they seek to have this Court function as a court of criminal appeal"; there is, in the view of the United States, "no other apt characterization of Mexico's two submissions in respect of remedies". The Court notes that this contention is addressed solely to the question of remedies. The United States does not contend on this ground that the Court should decline jurisdiction to enquire into the question of breaches of the Vienna Convention at all, but simply that, if such breaches are shown, the Court should do no more than decide that the United States must provide "review and reconsideration" along the lines indicated in the Judgment in the *LaGrand* case (*I.C.J. Reports 2001*, pp. 513-514, para. 125). The Court notes that this is a matter of merits. The first objection of the United States to admissibility cannot therefore be upheld.

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38. The Court now turns to the objection of the United States based on the rule of exhaustion of local remedies. The United States contends that the Court "should find inadmissible Mexico's claim to exercise its right of diplomatic protection on behalf of any Mexican national who has failed to meet the customary legal requirement of exhaustion of municipal remedies". It asserts that in a number of the cases the subject of Mexico's claims, the detained Mexican national, even with the benefit of the provision of Mexican consular assistance, failed to raise the alleged non-compliance with Article 36, paragraph 1, of the Vienna Convention at the trial. Furthermore, it contends that all of the claims relating to cases referred to in the Mexican Memorial are inadmissible because local remedies remain available in every case. It has drawn attention to the fact that litigation is pending before courts in the United States in a large number of the cases the subject of Mexico's claims and that, in those cases where judicial remedies have been exhausted, the defendants have not had recourse to the clemency process available to them; from this it concludes that none

of the cases "is in an appropriate posture for review by an international tribunal".

39. Mexico responds that the rule of exhaustion of local remedies cannot preclude the admissibility of its claims. It first states that a majority of the Mexican nationals referred to in paragraph 16 above have sought judicial remedies in the United States based on the Vienna Convention and that their claims have been barred, notably on the basis of the procedural default doctrine. In this regard, it quotes the Court's statement in the *LaGrand* case that

> "the United States may not . . . rely before this Court on this fact in order to preclude the admissibility of Germany's [claim] . . ., as it was the United States itself which had failed to carry out its obligation under the Convention to inform the LaGrand brothers" (*I.C.J. Reports 2001*, p. 488, para. 60).

Further, in respect of the other Mexican nationals, Mexico asserts that

> "the courts of the United States have never granted a judicial remedy to any foreign national for a violation of Article 36. The United States courts hold either that Article 36 does not create an individual right, or that a foreign national who has been denied his Article 36 rights but given his constitutional and statutory rights, cannot establish prejudice and therefore cannot get relief."

It concludes that the available judicial remedies are thus ineffective. As for clemency procedures, Mexico contends that they cannot count for purposes of the rule of exhaustion of local remedies, because they are not a judicial remedy.

40. In its final submissions Mexico asks the Court to adjudge and declare that the United States, in failing to comply with Article 36, paragraph 1, of the Vienna Convention, has "violated its international legal obligations to Mexico, in its own right and in the exercise of its right of diplomatic protection of its nationals".

The Court would first observe that the individual rights of Mexican nationals under paragraph 1 *(b)* of Article 36 of the Vienna Convention are rights which are to be asserted, at any rate in the first place, within the domestic legal system of the United States. Only when that process is completed and local remedies are exhausted would Mexico be entitled to espouse the individual claims of its nationals through the procedure of diplomatic protection.

In the present case Mexico does not, however, claim to be acting solely on that basis. It also asserts its own claims, basing them on the injury which it contends that *it has itself suffered, directly and through its*

nationals, as a result of the violation by the United States of the obligations incumbent upon it under Article 36, paragraph 1 *(a)*, *(b)* and *(c)*.

The Court would recall that, in the *LaGrand* case, it recognized that

> "Article 36, paragraph 1 [of the Vienna Convention], creates individual rights [for the national concerned], which . . . may be invoked in this Court by the national State of the detained person" (*I.C.J. Reports 2001*, p. 494, para. 77).

It would further observe that violations of the rights of the individual under Article 36 may entail a violation of the rights of the sending State, and that violations of the rights of the latter may entail a violation of the rights of the individual. In these special circumstances of interdependence of the rights of the State and of individual rights, Mexico may, in submitting a claim in its own name, request the Court to rule on the violation of rights which it claims to have suffered both directly and through the violation of individual rights conferred on Mexican nationals under Article 36, paragraph 1 *(b)*. The duty to exhaust local remedies does not apply to such a request. Further, for reasons just explained, the Court does not find it necessary to deal with Mexico's claims of violation under a distinct heading of diplomatic protection. Without needing to pronounce at this juncture on the issues raised by the procedural default rule, as explained by Mexico in paragraph 39 above, the Court accordingly finds that the second objection by the United States to admissibility cannot be upheld.

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41. The Court now turns to the question of the alleged dual nationality of certain of the Mexican nationals the subject of Mexico's claims. This question is raised by the United States by way of an objection to the admissibility of those claims: the United States contends that in its Memorial Mexico had failed to establish that it may exercise diplomatic protection based on breaches of Mexico's rights under the Vienna Convention with respect to those of its nationals who are also nationals of the United States. The United States regards it as an accepted principle that, when a person arrested or detained in the receiving State is a national of that State, then even if he is also a national of another State party to the Vienna Convention, Article 36 has no application, and the authorities of the receiving State are not required to proceed as laid down in that Article; and Mexico has indicated that, for the purposes of the present case it does not contest that dual nationals have no right to be advised of their rights under Article 36.

42. It has however to be recalled that Mexico, in addition to seeking to exercise diplomatic protection of its nationals, is making a claim in its

own right on the basis of the alleged breaches by the United States of Article 36 of the Vienna Convention. Seen from this standpoint, the question of dual nationality is not one of admissibility, but of merits. A claim may be made by Mexico of breach of Article 36 of the Vienna Convention in relation to any of its nationals, and the United States is thereupon free to show that, because the person concerned was also a United States national, Article 36 had no application to that person, so that no breach of treaty obligations could have occurred. Furthermore, as regards the claim to exercise diplomatic protection, the question whether Mexico is entitled to protect a person having dual Mexican and United States nationality is subordinated to the question whether, in relation to such a person, the United States was under any obligation in terms of Article 36 of the Vienna Convention. It is thus in the course of its examination of the merits that the Court will have to consider whether the individuals concerned, or some of them, were dual nationals in law. Without prejudice to the outcome of such examination, the third objection of the United States to admissibility cannot therefore be upheld.

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43. The Court now turns to the fourth objection advanced by the United States to the admissibility of Mexico's claims: the contention that

> "The Court should not permit Mexico to pursue a claim against the United States with respect to any individual case where Mexico had actual knowledge of a breach of the [Vienna Convention] but failed to bring such breach to the attention of the United States or did so only after considerable delay."

In the Counter-Memorial, the United States advances two considerations in support of this contention: that if the cases had been mentioned promptly, corrective action might have been possible; and that by inaction Mexico created an impression that it considered that the United States was meeting its obligations under the Convention, as Mexico understood them. At the hearings, the United States suggested that Mexico had in effect waived its right to claim in respect of the alleged breaches of the Convention, and to seek reparation.

44. As the Court observed in the case of *Certain Phosphate Lands in Nauru (Nauru* v. *Australia)*, "delay on the part of a claimant State may render an application inadmissible", but "international law does not lay down any specific time-limit in that regard" (*I.C.J. Reports 1992*, pp. 253-254, para. 32). In that case the Court recognized that delay might prejudice the respondent State "with regard to both the establishment of the facts and the determination of the content of the applicable law" (*ibid.*, p. 255, para. 36), but it has not been suggested that there is any such risk of prejudice in the present case. So far as inadmissibility might be based on an implied waiver of rights, the Court considers that only a much

more prolonged and consistent inaction on the part of Mexico than any that the United States has alleged might be interpreted as implying such a waiver. Furthermore, Mexico indicated a number of ways in which it brought to the attention of the United States the breaches which it perceived of the Vienna Convention. The fourth objection of the United States to admissibility cannot therefore be upheld.

*

45. The Court has now to examine the objection of the United States that the claim of Mexico is inadmissible in that Mexico should not be allowed to invoke against the United States standards that Mexico does not follow in its own practice. The United States contends that, in accordance with basic principles of administration of justice and the equality of States, both litigants are to be held accountable to the same rules of international law. The objection in this regard was presented in terms of the interpretation of Article 36 of the Vienna Convention, in the sense that, according to the United States, a treaty may not be interpreted so as to impose a significantly greater burden on any one party than the other (*Diversion of Water from the Meuse, Judgment, 1937, P.C.I.J., Series A/B, No. 70*, p. 20).

46. The Court would recall that the United States had already raised an objection of a similar nature before it in the *LaGrand* case; there, the Court held that it need not decide "whether this argument of the United States, if true, would result in the inadmissibility of Germany's submissions", since the United States had failed to prove that Germany's own practice did not conform to the standards it was demanding from the United States (*I.C.J. Reports 2001*, p. 489, para. 63).

47. The Court would recall that it is in any event essential to have in mind the nature of the Vienna Convention. It lays down certain standards to be observed by all States parties, with a view to the "unimpeded conduct of consular relations", which, as the Court observed in 1979, is important in present-day international law "in promoting the development of friendly relations among nations, and ensuring protection and assistance for aliens resident in the territories of other States" (*United States Diplomatic and Consular Staff in Tehran (United States of America* v. *Iran), Provisional Measures, Order of 15 December 1979, I.C.J. Reports 1979*, pp. 19-20, para. 40). Even if it were shown, therefore, that Mexico's practice as regards the application of Article 36 was not beyond reproach, this would not constitute a ground of objection to the admissibility of Mexico's claim. The fifth objection of the United States to admissibility cannot therefore be upheld.

* * *

48. Having established that it has jurisdiction to entertain Mexico's claims and that they are admissible, the Court will now turn to the merits of those claims.

* *

ARTICLE 36, PARAGRAPH 1

49. In its final submissions Mexico asks the Court to adjudge and declare that,

> "the United States of America, in arresting, detaining, trying, convicting, and sentencing the 52 Mexican nationals on death row described in Mexico's Memorial, violated its international legal obligations to Mexico, in its own right and in the exercise of its right to diplomatic protection of its nationals, by failing to inform, without delay, the 52 Mexican nationals after their arrest of their right to consular notification and access under Article 36 (1) *(b)* of the Vienna Convention on Consular Relations, and by depriving Mexico of its right to provide consular protection and the 52 nationals' right to receive such protection as Mexico would provide under Article 36 (1) *(a)* and *(c)* of the Convention".

50. The Court has already in its Judgment in the *LaGrand* case described Article 36, paragraph 1, as "an interrelated régime designed to facilitate the implementation of the system of consular protection" (*I.C.J. Reports 2001*, p. 492, para. 74). It is thus convenient to set out the entirety of that paragraph.

> "With a view toward facilitating the exercise of consular functions relating to nationals of the sending State:
>
> *(a)* consular officers shall be free to communicate with nationals of the sending State and to have access to them. Nationals of the sending State shall have the same freedom with respect to communication with and access to consular officers of the sending State;
>
> *(b)* if he so requests, the competent authorities of the receiving State shall, without delay, inform the consular post of the sending State if, within its consular district, a national of that State is arrested or committed to prison or to custody pending trial or is detained in any other manner. Any communication addressed to the consular post by the person arrested, in prison, custody or detention shall be forwarded by the said authorities

without delay. The said authorities shall inform the person concerned without delay of his rights under this subparagraph;

(c) consular officers shall have the right to visit a national of the sending State who is in prison, custody or detention, to converse and correspond with him and to arrange for his legal representation. They shall also have the right to visit any national of the sending State who is in prison, custody or detention in their district in pursuance of a judgment. Nevertheless, consular officers shall refrain from taking action on behalf of a national who is in prison, custody or detention if he expressly opposes such action."

51. The United States as the receiving State does not deny its duty to perform these obligations. However, it claims that the obligations apply only to individuals shown to be of Mexican nationality alone, and not to those of dual Mexican/United States nationality. The United States further contends *inter alia* that it has not committed any breach of Article 36, paragraph 1 *(b)*, upon the proper interpretation of "without delay" as used in that subparagraph.

52. Thus two major issues under Article 36, paragraph 1 *(b)*, that are in dispute between the Parties are, first, the question of the nationality of the individuals concerned; and second, the question of the meaning to be given to the expression "without delay". The Court will examine each of these in turn.

53. The Parties have advanced their contentions as to nationality in three different legal contexts. The United States has begun by making an objection to admissibility, which the Court has already dealt with (see paragraphs 41 and 42 above). The United States has further contended that a substantial number of the 52 persons listed in paragraph 16 above were United States nationals and that it thus had no obligation to these individuals under Article 36, paragraph 1 *(b)*. The Court will address this aspect of the matter in the following paragraphs. Finally, the Parties disagree as to whether the requirement under Article 36, paragraph 1 *(b)*, for the information to be given "without delay" becomes operative upon arrest or upon ascertainment of nationality. The Court will address this issue later (see paragraph 63 below).

54. The Parties disagree as to what each of them must show as regards nationality in connection with the applicability of the terms of Article 36, paragraph 1, and as to how the principles of evidence have been met on the facts of the cases.

55. Both Parties recognize the well-settled principle in international law that a litigant seeking to establish the existence of a fact bears the burden of proving it (cf. *Military and Paramilitary Activities in and against Nicaragua (Nicaragua* v. *United States of America), Jurisdiction and Admissibility, Judgment, I.C.J. Reports 1984*, p. 437, para. 101). Mexico acknowledges that it has the burden of proof to show that the 52 persons listed in paragraph 16 above were Mexican nationals to whom the provisions of Article 36, paragraph 1 *(b)*, in principle apply. It claims it has met this burden by providing to the Court the birth certificates of these nationals, and declarations from 42 of them that they have not acquired United States nationality. Mexico further contends that the burden of proof lies on the United States should it wish to contend that particular arrested persons of Mexican nationality were, at the relevant time, also United States nationals.

56. The United States accepts that in such cases it has the burden of proof to demonstrate United States nationality, but contends that nonetheless the "burden of evidence" as to this remains with Mexico. This distinction is explained by the United States as arising out of the fact that persons of Mexican nationality may also have acquired United States citizenship by operation of law, depending on their parents' dates and places of birth, places of residency, marital status at time of their birth and so forth. In the view of the United States "virtually all such information is in the hands of Mexico through the now 52 individuals it represents". The United States contends that it was the responsibility of Mexico to produce such information, which responsibility it has not discharged.

57. The Court finds that it is for Mexico to show that the 52 persons listed in paragraph 16 above held Mexican nationality at the time of their arrest. The Court notes that to this end Mexico has produced birth certificates and declarations of nationality, whose contents have not been challenged by the United States.

The Court observes further that the United States has, however, questioned whether some of these individuals were not also United States nationals. Thus, the United States has informed the Court that, "in the case of defendant Ayala (case No. 2) we are close to certain that Ayala is a United States citizen", and that this could be confirmed with absolute certainty if Mexico produced facts about this matter. Similarly Mr. Avena (case No. 1) was said to be "likely" to be a United States citizen, and there was "some possibility" that some 16 other defendants were United States citizens. As to six others, the United States said it "cannot rule out the possibility" of United States nationality. The Court takes the view that it was for the United States to demonstrate that this was so and to furnish the Court with all information on the matter in its possession. In so far as relevant data on that matter are said by the United States to lie within the knowledge of Mexico, it was for the United States to have

sought that information from the Mexican authorities. The Court cannot accept that, because such information may have been in part in the hands of Mexico, it was for Mexico to produce such information. It was for the United States to seek such information, with sufficient specificity, and to demonstrate both that this was done and that the Mexican authorities declined or failed to respond to such specific requests. At no stage, however, has the United States shown the Court that it made specific enquiries of those authorities about particular cases and that responses were not forthcoming. The Court accordingly concludes that the United States has not met its burden of proof in its attempt to show that persons of Mexican nationality were also United States nationals.

The Court therefore finds that, as regards the 52 persons listed in paragraph 16 above, the United States had obligations under Article 36, paragraph 1 *(b)*.

58. Mexico asks the Court to find that

> "the obligation in Article 36, paragraph 1, of the Vienna Convention requires notification of consular rights and a reasonable opportunity for consular access before the competent authorities of the receiving State take any action potentially detrimental to the foreign national's rights".

59. Mexico contends that, in each of the 52 cases before the Court, the United States failed to provide the arrested persons with information as to their rights under Article 36, paragraph 1 *(b)*, "without delay". It alleges that in one case, Mr. Esquivel (case No. 7), the arrested person was informed, but only some 18 months after the arrest, while in another, that of Mr. Juárez (case No. 10), information was given to the arrested person of his rights some 40 hours after arrest. Mexico contends that this still constituted a violation, because "without delay" is to be understood as meaning "immediately", and in any event before any interrogation occurs. Mexico further draws the Court's attention to the fact that in this case a United States court found that there had been a violation of Article 36, paragraph 1 *(b)*, and claims that the United States cannot disavow such a determination by its own courts. In an Annex to its Memorial, Mexico mentions that, in a third case (Mr. Ayala, case No. 2), the accused was informed of his rights upon his arrival on death row, some four years after arrest. Mexico contends that in the remaining cases the Mexicans concerned were in fact never so informed by the United States authorities.

60. The United States disputes both the facts as presented by Mexico and the legal analysis of Article 36, paragraph 1 *(b)*, of the Vienna Convention offered by Mexico. The United States claims that Mr. Solache (case No. 47) was informed of his rights under the Vienna Convention

some seven months after his arrest. The United States further claims that many of the persons concerned were of United States nationality and that at least seven of these individuals "appear to have affirmatively claimed to be United States citizens at the time of their arrest". These cases were said to be those of Avena (case No. 1), Ayala (case No. 2), Benavides (case No. 3), Ochoa (case No. 18), Salcido (case No. 22), Tafoya (case No. 24), and Alvarez (case No. 30). In the view of the United States no duty of consular information arose in these cases. Further, in the contention of the United States, in the cases of Mr. Ayala (case No. 2) and Mr. Salcido (case No. 22) there was no reason to believe that the arrested persons were Mexican nationals at any stage; the information in the case of Mr. Juárez (case No. 10) was given "without delay".

61. The Court thus now turns to the interpretation of Article 36, paragraph 1 *(b)*, having found in paragraph 57 above that it is applicable to the 52 persons listed in paragraph 16. It begins by noting that Article 36, paragraph 1 *(b)*, contains three separate but interrelated elements: the right of the individual concerned to be informed without delay of his rights under Article 36, paragraph 1 *(b)*; the right of the consular post to be notified without delay of the individual's detention, if he so requests; and the obligation of the receiving State to forward without delay any communication addressed to the consular post by the detained person.

62. The third element of Article 36, paragraph 1 *(b)*, has not been raised on the facts before the Court. The Court thus begins with the right of an arrested or detained individual to information.

63. The Court finds that the duty upon the detaining authorities to give the Article 36, paragraph 1 *(b)*, information to the individual arises once it is realized that the person is a foreign national, or once there are grounds to think that the person is probably a foreign national. Precisely when this may occur will vary with circumstances. The United States Department of State booklet, *Consular Notification and Access — Instructions for Federal, State and Local Law Enforcement and Other Officials Regarding Foreign Nationals in the United States and the Rights of Consular Officials to Assist Them*, issued to federal, state and local authorities in order to promote compliance with Article 36 of the Vienna Convention points out in such cases that: "most, but not all, persons born outside the United States are not [citizens]. Unfamiliarity with English may also indicate foreign nationality." The Court notes that when an arrested person himself claims to be of United States nationality, the realization by the authorities that he is not in fact a United States national, or grounds for that realization, is likely to come somewhat later in time.

64. The United States has told the Court that millions of aliens reside, either legally or illegally, on its territory, and moreover that its laws concerning citizenship are generous. The United States has also pointed out that it is a multicultural society, with citizenship being held by persons of diverse appearance, speaking many languages. The Court appreciates that in the United States the language that a person speaks, or his appearance, does not necessarily indicate that he is a foreign national. Nevertheless, and particularly in view of the large numbers of foreign nationals living in the United States, these very circumstances suggest that it would be desirable for enquiry routinely to be made of the individual as to his nationality upon his detention, so that the obligations of the Vienna Convention may be complied with. The United States has informed the Court that some of its law enforcement authorities do routinely ask persons taken into detention whether they are United States citizens. Indeed, were each individual to be told at that time that, should he be a foreign national, he is entitled to ask for his consular post to be contacted, compliance with this requirement under Article 36, paragraph 1 *(b)*, would be greatly enhanced. The provision of such information could parallel the reading of those rights of which any person taken into custody in connection with a criminal offence must be informed prior to interrogation by virtue of what in the United States is known as the "Miranda rule"; these rights include, *inter alia*, the right to remain silent, the right to have an attorney present during questioning, and the right to have an attorney appointed at government expense if the person cannot afford one. The Court notes that, according to the United States, such a practice in respect of the Vienna Convention rights is already being followed in some local jurisdictions.

65. Bearing in mind the complexities explained by the United States, the Court now begins by examining the application of Article 36, paragraph 1 *(b)*, of the Vienna Convention to the 52 cases. In 45 of these cases, the Court has no evidence that the arrested persons claimed United States nationality, or were reasonably thought to be United States nationals, with specific enquiries being made in timely fashion to verify such dual nationality. The Court has explained in paragraph 57 above what enquiries it would have expected to have been made, within a short time period, and what information should have been provided to the Court.

66. Seven persons, however, are asserted by the United States to have stated at the time of arrest that they were United States citizens. Only in the case of Mr. Salcido (case No. 22) has the Court been provided by the United States with evidence of such a statement. This has been acknowledged by Mexico. Further, there has been no evidence before the Court to suggest that there were in this case at the same time also indications of Mexican nationality, which should have caused rapid enquiry by the arresting authorities and the providing of consular information "without delay". Mexico has accordingly not shown that in

the case of Mr. Salcido the United States violated its obligations under Article 36, paragraph 1 *(b)*.

67. In the case of Mr. Ayala (case No. 2), while he was identified in a court record in 1989 (three years after his arrest) as a United States citizen, there is no evidence to show this Court that the accused did indeed claim upon his arrest to be a United States citizen. The Court has not been informed of any enquiries made by the United States to confirm these assertions of United States nationality.

68. In the five other cases listed by the United States as cases where the individuals "appear to have affirmatively claimed to be United States citizens at the time of their arrest", no evidence has been presented that such a statement was made at the time of arrest.

69. Mr. Avena (case No. 1) is listed in his arrest report as having been born in California. His prison records describe him as of Mexican nationality. The United States has not shown the Court that it was engaged in enquiries to confirm United States nationality.

70. Mr. Benavides (case No. 3) was carrying an Immigration and Naturalization Service immigration card at the time of arrest in 1991. The Court has not been made aware of any reason why the arresting authorities should nonetheless have believed at the time of arrest that he was a United States national. The evidence that his defence counsel in June 1993 informed the court that Mr. Benavides had become a United States citizen is irrelevant to what was understood as to his nationality at time of arrest.

71. So far as Mr. Ochoa is concerned (case No. 18), the Court observes that his arrest report in 1990 refers to him as having been born in Mexico, an assertion that is repeated in a second police report. Some two years later details in his court record refer to him as a United States citizen born in Mexico. The Court is not provided with any further details. The United States has not shown this Court that it was aware of, or was engaged in active enquiry as to, alleged United States nationality at the time of his arrest.

72. Mr. Tafoya (case No. 24) was listed on the police booking sheet as having been born in Mexico. No further information is provided by the United States as to why this was done and what, if any, further enquiries were being made concerning the defendant's nationality.

73. Finally, the last of the seven persons referred to by the United States in this group, Mr. Alvarez (case No. 30), was arrested in Texas on 20 June 1998. Texas records identified him as a United States citizen. Within three days of his arrest, however, the Texas authorities were

informed that the Immigration and Naturalization Service was holding investigations to determine whether, because of a previous conviction, Mr. Alvarez was subject to deportation as a foreign national. The Court has not been presented with evidence that rapid resolution was sought as to the question of Mr. Alvarez's nationality.

74. The Court concludes that Mexico has failed to prove the violation by the United States of its obligations under Article 36, paragraph 1 *(b)*, in the case of Mr. Salcido (case No. 22), and his case will not be further commented upon. On the other hand, as regards the other individuals who are alleged to have claimed United States nationality on arrest, whose cases have been considered in paragraphs 67 to 73 above, the argument of the United States cannot be upheld.

75. The question nonetheless remains as to whether, in each of the 45 cases referred to in paragraph 65 and of the six cases mentioned in paragraphs 67 to 73, the United States did provide the required information to the arrested persons "without delay". It is to that question that the Court now turns.

76. The Court has been provided with declarations from a number of the Mexican nationals concerned that attest to their never being informed of their rights under Article 36, paragraph 1 *(b)*. The Court at the outset notes that, in 47 such cases, the United States nowhere challenges this fact of information not being given. Nevertheless, in the case of Mr. Hernández (case No. 34), the United States observes that

> "Although the [arresting] officer did not ask Hernández Llanas whether he wanted them to inform the Mexican Consulate of his arrest, it was certainly not unreasonable for him to assume that an escaped convict would not want the Consulate of the country from which he escaped notified of his arrest."

The Court notes that the clear duty to provide consular information under Article 36, paragraph 1 *(b)*, does not invite assumptions as to what the arrested person might prefer, as a ground for not informing him. It rather gives the arrested person, once informed, the right to say he nonetheless does not wish his consular post to be notified. It necessarily follows that in each of these 47 cases, the duty to inform "without delay" has been violated.

77. In four cases, namely Ayala (case No. 2), Esquivel (case No. 7), Juárez (case No. 10) and Solache (case No. 47), some doubts remain as to whether the information that was given was provided without delay. For these, some examination of the term is thus necessary.

78. This is a matter on which the Parties have very different views.

According to Mexico, the timing of the notice to the detained person "is critical to the exercise of the rights provided by Article 36" and the phrase "without delay" in paragraph 1 *(b)* requires "unqualified immediacy". Mexico further contends that, in view of the object and purpose of Article 36, which is to enable "meaningful consular assistance" and the safeguarding of the vulnerability of foreign nationals in custody,

> "consular notification . . . must occur immediately upon detention and prior to any interrogation of the foreign detainee, so that the consul may offer useful advice about the foreign legal system and provide assistance in obtaining counsel before the foreign national makes any ill-informed decisions or the State takes any action potentially prejudicial to his rights".

79. Thus, in Mexico's view, it would follow that in any case in which a foreign national was interrogated before being informed of his rights under Article 36, there would *ipso facto* be a breach of that Article, however rapidly after the interrogation the information was given to the foreign national. Mexico accordingly includes the case of Mr. Juárez among those where it claims violation of Article 36, paragraph 1 *(b)*, as he was interrogated before being informed of his consular rights, some 40 hours after arrest.

80. Mexico has also invoked the *travaux préparatoires* of the Vienna Convention in support of its interpretation of the requirement that the arrested person be informed "without delay" of the right to ask that the consular post be notified. In particular, Mexico recalled that the phrase proposed to the Conference by the International Law Commission, "without undue delay", was replaced by the United Kingdom proposal to delete the word "undue". The United Kingdom representative had explained that this would avoid the implication that "some delay was permissible" and no delegate had expressed dissent with the USSR and Japanese statements that the result of the amendment would be to require information "immediately".

81. The United States disputed this interpretation of the phrase "without delay". In its view it did not mean "immediately, and before interrogation" and such an understanding was supported neither by the terminology, nor by the object and purpose of the Vienna Convention, nor by its *travaux préparatoires*. In the booklet referred to in paragraph 63 above, the State Department explains that "without delay" means "there should be no deliberate delay" and that the required action should be taken "as soon as reasonably possible under the circumstances". It was normally to be expected that "notification to consular officers" would have been made "within 24 to 72 hours of the arrest or detention". The United States further contended that such an interpretation of the words "without delay" would be reasonable in itself and also allow a consistent

interpretation of the phrase as it occurs in each of three different occasions in Article 36, paragraph 1 *(b)*. As for the *travaux préparatoires*, they showed only that undue or deliberate delay had been rejected as unacceptable.

82. According to the United States, the purpose of Article 36 was to facilitate the exercise of consular functions by a consular officer:

> "The significance of giving consular information to a national is thus limited . . . It is a procedural device that allows the foreign national to trigger the related process of notification . . . [It] cannot possibly be fundamental to the criminal justice process."

83. The Court now addresses the question of the proper interpretation of the expression "without delay" in the light of arguments put to it by the Parties. The Court begins by noting that the precise meaning of "without delay", as it is to be understood in Article 36, paragraph 1 *(b)*, is not defined in the Convention. This phrase therefore requires interpretation according to the customary rules of treaty interpretation reflected in Articles 31 and 32 of the Vienna Convention on the Law of Treaties.

84. Article 1 of the Vienna Convention on Consular Relations, which defines certain of the terms used in the Convention, offers no definition of the phrase "without delay". Moreover, in the different language versions of the Convention various terms are employed to render the phrases "without delay" in Article 36 and "immediately" in Article 14. The Court observes that dictionary definitions, in the various languages of the Vienna Convention, offer diverse meanings of the term "without delay" (and also of "immediately"). It is therefore necessary to look elsewhere for an understanding of this term.

85. As for the object and purpose of the Convention, the Court observes that Article 36 provides for consular officers to be free to communicate with nationals of the sending State, to have access to them, to visit and speak with them and to arrange for their legal representation. It is not envisaged, either in Article 36, paragraph 1, or elsewhere in the Convention, that consular functions entail a consular officer himself or herself acting as the legal representative or more directly engaging in the criminal justice process. Indeed, this is confirmed by the wording of Article 36, paragraph 2, of the Convention. Thus, neither the terms of the Convention as normally understood, nor its object and purpose, suggest that "without delay" is to be understood as "immediately upon arrest and before interrogation".

86. The Court further notes that, notwithstanding the uncertainties in the *travaux préparatoires*, they too do not support such an interpreta-

tion. During the diplomatic conference, the conference's expert, former Special Rapporteur of the International Law Commission, explained to the delegates that the words "without undue delay" had been introduced by the Commission, after long discussion in both the plenary and drafting committee, to allow for special circumstances which might permit information as to consular notification not to be given at once. Germany, the only one of two States to present an amendment, proposed adding "but at latest within one month". There was an extended discussion by many different delegates as to what such outer time-limit would be acceptable. During that debate no delegate proposed "immediately". The shortest specific period suggested was by the United Kingdom, namely "promptly" and no later than "48 hours" afterwards. Eventually, in the absence of agreement on a precise time period, the United Kingdom's other proposal to delete the word "undue" was accepted as the position around which delegates could converge. It is also of interest that there is no suggestion in the *travaux* that the phrase "without delay" might have different meanings in each of the three sets of circumstances in which it is used in Article 36, paragraph 1 *(b)*.

87. The Court thus finds that "without delay" is not necessarily to be interpreted as "immediately" upon arrest. It further observes that during the Conference debates on this term, no delegate made any connection with the issue of interrogation. The Court considers that the provision in Article 36, paragraph 1 *(b)*, that the receiving State authorities "shall inform the person concerned without delay of his rights" cannot be interpreted to signify that the provision of such information must necessarily precede any interrogation, so that the commencement of interrogation before the information is given would be a breach of Article 36.

88. Although, by application of the usual rules of interpretation, "without delay" as regards the duty to inform an individual under Article 36, paragraph 1 *(b)*, is not to be understood as necessarily meaning "immediately upon arrest", there is nonetheless a duty upon the arresting authorities to give that information to an arrested person as soon as it is realized that the person is a foreign national, or once there are grounds to think that the person is probably a foreign national.

89. With one exception, no information as to entitlement to consular notification was given in any of the cases cited in paragraph 77 within any of the various time periods suggested by the delegates to the Conference on the Vienna Convention, or by the United States itself (see paragraphs 81 and 86 above). Indeed, the information was given either not at all or at periods very significantly removed from the time of arrest. In the case of Mr. Juárez (case No. 10), the defendant was informed of his

consular rights 40 hours after his arrest. The Court notes, however, that Mr. Juárez's arrest report stated that he had been born in Mexico; moreover, there had been indications of his Mexican nationality from the time of his initial interrogation by agents of the Federal Bureau of Investigation (FBI) following his arrest. It follows that Mr. Juárez's Mexican nationality was apparent from the outset of his detention by the United States authorities. In these circumstances, in accordance with its interpretation of the expression "without delay" (see paragraph 88 above), the Court concludes that the United States violated the obligation incumbent upon it under Article 36, paragraph 1 *(b)*, to inform Mr. Juárez without delay of his consular rights. The Court notes that the same finding was reached by a California Superior Court, albeit on different grounds.

90. The Court accordingly concludes that, with respect to each of the individuals listed in paragraph 16, with the exception of Mr. Salcido (case No. 22; see paragraph 74 above), the United States has violated its obligation under Article 36, paragraph 1 *(b)*, of the Vienna Convention to provide information to the arrested person.

91. As noted above, Article 36, paragraph 1 *(b)*, contains three elements. Thus far, the Court has been dealing with the right of an arrested person to be informed that he may ask for his consular post to be notified. The Court now turns to another aspect of Article 36, paragraph 1 *(b)*. The Court finds the United States is correct in observing that the fact that a Mexican consular post was not notified under Article 36, paragraph 1 *(b)*, does not of necessity show that the arrested person was not informed of his rights under that provision. He may have been informed and declined to have his consular post notified. The giving of the information is relevant, however, for satisfying the element in Article 36, paragraph 1 *(b)*, on which the other two elements therein depend.

92. In only two cases has the United States claimed that the arrested person was informed of his consular rights but asked for the consular post not to be notified. These are Mr. Juárez (case No. 10) and Mr. Solache (case No. 47).

93. The Court is satisfied that when Mr. Juárez (case No. 10) was informed of his consular rights 40 hours after his arrest (see paragraph 89) he chose not to have his consular post notified. As regards Mr. Solache (case No. 47), however, it is not sufficiently clear to the Court, on the evidence before it, that he requested that his consular post should not be notified. Indeed, the Court has not been provided with any reasons as to why, if a request of non-notification was made, the consular post was then notified some three months later.

94. In a further three cases, the United States alleges that the consular post was formally notified of the detention of one of its Mexican

nationals without prior information to the individual as to his consular rights. These are Mr. Covarrubias (case No. 6), Mr. Hernández (case No. 34) and Mr. Reyes (case No. 54). The United States further contends that the Mexican authorities were contacted regarding the case of Mr. Loza (case No. 52).

95. The Court notes that, in the case of Mr. Covarrubias (case No. 6), the consular authorities learned from third parties of his arrest shortly after it occurred. Some 16 months later, a court-appointed interpreter requested that the consulate intervene in the case prior to trial. It would appear doubtful whether an interpreter can be considered a competent authority for triggering the interrelated provisions of Article 36, paragraph 1 *(b)*, of the Vienna Convention. In the case of Mr. Reyes (case No. 54), the United States has simply told the Court that an Oregon Department of Justice attorney had advised United States authorities that both the District Attorney and the arresting detective advised the Mexican consular authorities of his arrest. No information is given as to when this occurred, in relation to the date of his arrest. Mr. Reyes did receive assistance before his trial. In these two cases, the Court considers that, even on the hypothesis that the conduct of the United States had no serious consequences for the individuals concerned, it did nonetheless constitute a violation of the obligations incumbent upon the United States under Article 36, paragraph 1 *(b)*.

96. In the case of Mr. Loza (case No. 52), a United States Congressman from Ohio contacted the Mexican Embassy on behalf of Ohio prosecutors, some four months after the accused's arrest, "to enquire about the procedures for obtaining a certified copy of Loza's birth certificate". The Court has not been provided with a copy of the Congressman's letter and is therefore unable to ascertain whether it explained that Mr. Loza had been arrested. The response from the Embassy (which is also not included in the documentation provided to the Court) was passed by the Congressman to the prosecuting attorney, who then asked the Civil Registry of Guadalajara for a copy of the birth certificate. This request made no specific mention of Mr. Loza's arrest. Mexico contends that its consulate was never formally notified of Mr. Loza's arrest, of which it only became aware after he had been convicted and sentenced to death. Mexico includes the case of Mr. Loza among those in which the United States was in breach of its obligation of consular notification. Taking account of all these elements, and in particular of the fact that the Embassy was contacted four months after the arrest, and that the consular post became aware of the defendant's detention only after he had been convicted and sentenced, the Court concludes that in the case of Mr. Loza the United States violated the obligation of consular notification without delay incumbent upon it under Article 36, paragraph 1 *(b)*.

97. Mr. Hernández (case No. 34) was arrested in Texas on Wednesday 15 October 1997. The United States authorities had no reason to believe he might have American citizenship. The consular post was notified the following Monday, that is five days (corresponding to only three working days) thereafter. The Court finds that, in the circumstances, the United States did notify the consular post without delay, in accordance with its obligation under Article 36, paragraph 1 *(b)*.

98. In the first of its final submissions, Mexico also asks the Court to find that the violations it ascribes to the United States in respect of Article 36, paragraph 1 *(b)*, have also deprived "Mexico of its right to provide consular protection and the 52 nationals' right to receive such protection as Mexico would provide under Article 36 (1) *(a)* and *(c)* of the Convention".

99. The relationship between the three subparagraphs of Article 36, paragraph 1, has been described by the Court in its Judgment in the *LaGrand* case (*I.C.J. Reports 2001*, p. 492, para. 74) as "an interrelated régime". The legal conclusions to be drawn from that interrelationship necessarily depend upon the facts of each case. In the *LaGrand* case, the Court found that the failure for 16 years to inform the brothers of their right to have their consul notified effectively prevented the exercise of other rights that Germany might have chosen to exercise under subparagraphs *(a)* and *(c)*.

100. It is necessary to revisit the interrelationship of the three subparagraphs of Article 36, paragraph 1, in the light of the particular facts and circumstances of the present case.

101. The Court would first recall that, in the case of Mr. Juárez (case No. 10) (see paragraph 93 above), when the defendant was informed of his rights, he declined to have his consular post notified. Thus in this case there was no violation of either subparagraph *(a)* or subparagraph *(c)* of Article 36, paragraph 1.

102. In the remaining cases, because of the failure of the United States to act in conformity with Article 36, paragraph 1 *(b)*, Mexico was in effect precluded (in some cases totally, and in some cases for prolonged periods of time) from exercising its right under paragraph 1 *(a)* to communicate with its nationals and have access to them. As the Court has already had occasion to explain, it is immaterial whether Mexico would have offered consular assistance, "or whether a different verdict would have been rendered. It is sufficient that the Convention conferred these rights" (*I.C.J. Reports 2001*, p. 492, para. 74), which might have been acted upon.

103. The same is true, *pari passu*, of certain rights identified in subparagraph *(c)*: "consular officers shall have the right to visit a national of the sending State who is in prison, custody or detention, and to converse and correspond with him . . .".

104. On the other hand, and on the particular facts of this case, no such generalized answer can be given as regards a further entitlement mentioned in subparagraph *(c)*, namely, the right of consular officers "to arrange for [the] legal representation" of the foreign national. Mexico has laid much emphasis in this litigation upon the importance of consular officers being able to arrange for such representation before and during trial, and especially at sentencing, in cases in which a severe penalty may be imposed. Mexico has further indicated the importance of any financial or other assistance that consular officers may provide to defence counsel, *inter alia* for investigation of the defendant's family background and mental condition, when such information is relevant to the case. The Court observes that the exercise of the rights of the sending State under Article 36, paragraph 1 *(c)*, depends upon notification by the authorities of the receiving State. It may be, however, that information drawn to the attention of the sending State by other means may still enable its consular officers to assist in arranging legal representation for its national. In the following cases, the Mexican consular authorities learned of their national's detention in time to provide such assistance, either through notification by United States authorities (albeit belatedly in terms of Article 36, paragraph 1 *(b)*) or through other channels: Benavides (case No. 3); Covarrubias (case No. 6); Esquivel (case No. 7); Hoyos (case No. 9); Mendoza (case No. 17); Ramírez (case No. 20); Sánchez (case No. 23); Verano (case No. 27); Zamudio (case No. 29); Gómez (case No. 33); Hernández (case No. 34); Ramirez (case No. 41); Rocha (case No. 42); Solache (case No. 47); Camargo (case No. 49) and Reyes (case No. 54).

105. In relation to Mr. Manríquez (case No. 14), the Court lacks precise information as to when his consular post was notified. It is merely given to understand that it was two years prior to conviction, and that Mr. Manríquez himself had never been informed of his consular rights. There is also divergence between the Parties in regard to the case of Mr. Fuentes (case No. 15), where Mexico claims it became aware of his detention during trial and the United States says this occurred during jury selection, prior to the actual commencement of the trial. In the case of Mr. Arias (case No. 44), the Mexican authorities became aware of his detention less than one week before the commencement of the trial. In those three cases, the Court concludes that the United States violated its obligations under Article 36, paragraph 1 *(c)*.

106. On this aspect of the case, the Court thus concludes:

(1) that the United States committed breaches of the obligation incumbent upon it under Article 36, paragraph 1 *(b)*, of the Vienna Convention to inform detained Mexican nationals of their rights under

that paragraph, in the case of the following 51 individuals: Avena (case No. 1), Ayala (case No. 2), Benavides (case No. 3), Carrera (case No. 4), Contreras (case No. 5), Covarrubias (case No. 6), Esquivel (case No. 7), Gómez (case No. 8), Hoyos (case No. 9), Juárez (case No. 10), López (case No. 11), Lupercio (case No. 12), Maciel (case No. 13), Manríquez (case No. 14), Fuentes (case No. 15), Martínez (case No. 16), Mendoza (case No. 17), Ochoa (case No. 18), Parra (case No. 19), Ramírez (case No. 20), Salazar (case No. 21), Sánchez (case No. 23), Tafoya (case No. 24), Valdez (case No. 25), Vargas (case No. 26), Verano (case No. 27), Zamudio (case No. 29), Alvarez (case No. 30), Fierro (case No. 31), García (case No. 32), Gómez (case No. 33), Hernández (case No. 34), Ibarra (case No. 35), Leal (case No. 36), Maldonado (case No. 37), Medellín (case No. 38), Moreno (case No. 39), Plata (case No. 40), Ramírez (case No. 41), Rocha (case No. 42), Regalado (case No. 43), Arias (case No. 44), Caballero (case No. 45), Flores (case No. 46), Solache (case No. 47), Fong (case No. 48), Camargo (case No. 49), Pérez (case No. 51), Loza (case No. 52), Torres (case No. 53) and Reyes (case No. 54);

(2) that the United States committed breaches of the obligation incumbent upon it under Article 36, paragraph 1 *(b)*, to notify the Mexican consular post of the detention of the Mexican nationals listed in subparagraph (1) above, except in the cases of Mr. Juárez (No. 10) and Mr. Hernández (No. 34);

(3) that by virtue of its breaches of Article 36, paragraph 1 *(b)*, as described in subparagraph (2) above, the United States also violated the obligation incumbent upon it under Article 36, paragraph 1 *(a)*, of the Vienna Convention to enable Mexican consular officers to communicate with and have access to their nationals, as well as its obligation under paragraph 1 *(c)* of that Article regarding the right of consular officers to visit their detained nationals;

(4) that the United States, by virtue of these breaches of Article 36, paragraph 1 *(b)*, also violated the obligation incumbent upon it under paragraph 1 *(c)* of that Article to enable Mexican consular officers to arrange for legal representation of their nationals in the case of the following individuals: Avena (case No. 1), Ayala (case No. 2), Carrera (case No. 4), Contreras (case No. 5), Gómez (case No. 8), López (case No. 11), Lupercio (case No. 12), Maciel (case No. 13), Manríquez (case No. 14), Fuentes (case No. 15), Martínez (case No. 16), Ochoa (case No. 18), Parra (case No. 19), Salazar (case No. 21), Tafoya (case No. 24), Valdez (case No. 25), Vargas (case No. 26), Alvarez (case No. 30), Fierro (case No. 31), García (case No. 32), Ibarra (case No. 35), Leal (case No. 36), Maldonado (case No. 37), Medellín (case No. 38), Moreno (case No. 39), Plata (case No. 40), Regalado (case No. 43), Arias (case No. 44), Caballero (case No. 45),

Flores (case No. 46), Fong (case No. 48), Pérez (case No. 51), Loza (case No. 52) and Torres (case No. 53).

*

ARTICLE 36, PARAGRAPH 2

107. In its third final submission Mexico asks the Court to adjudge and declare that

> "the United States violated its obligations under Article 36 (2) of the Vienna Convention by failing to provide meaningful and effective review and reconsideration of convictions and sentences impaired by a violation of Article 36 (1)".

108. Article 36, paragraph 2, provides:

> "The rights referred to in paragraph 1 of this article shall be exercised in conformity with the laws and regulations of the receiving State, subject to the proviso, however, that the said laws and regulations must enable full effect to be given to the purposes for which the rights accorded under this article are intended."

109. In this connection, Mexico has argued that the United States

> "By applying provisions of its municipal law to defeat or foreclose remedies for the violation of rights conferred by Article 36 — thus failing to provide meaningful review and reconsideration of severe sentences imposed in proceedings that violated Article 36 — . . . has violated, and continues to violate, the Vienna Convention."

More specifically, Mexico contends that:

> "The United States uses several municipal legal doctrines to prevent finding any legal effect from the violations of Article 36. *First*, despite this Court's clear analysis in *LaGrand*, US courts, at both the state and federal level, continue to invoke default doctrines to bar any review of Article 36 violations — even when the national had been unaware of his rights to consular notification and communication and thus his ability to raise their violation as an issue at trial, due to the competent authorities' failure to comply with Article 36."

110. Against this contention by Mexico, the United States argues that:

> "the criminal justice systems of the United States address all errors

in process through both judicial and executive clemency proceedings, relying upon the latter when rules of default have closed out the possibility of the former. That is, the 'laws and regulations' of the United States provide for the correction of mistakes that may be relevant to a criminal defendant to occur through a combination of judicial review and clemency. These processes together, working with other competent authorities, give full effect to the purposes for which Article 36 (1) is intended, in conformity with Article 36 (2). And, insofar as a breach of Article 36 (1) has occurred, these procedures satisfy the remedial function of Article 36 (2) by allowing the United States to provide review and reconsideration of convictions and sentences consistent with *LaGrand*."

111. The "procedural default" rule in United States law has already been brought to the attention of the Court in the *LaGrand* case. The following brief definition of the rule was provided by Mexico in its Memorial in this case and has not been challenged by the United States: "a defendant who could have raised, but fails to raise, a legal issue at trial will generally not be permitted to raise it in future proceedings, on appeal or in a petition for a writ of *habeas corpus*". The rule requires exhaustion of remedies, *inter alia*, at the state level and before a *habeas corpus* motion can be filed with federal courts. In the *LaGrand* case, the rule in question was applied by United States federal courts; in the present case, Mexico also complains of the application of the rule in certain state courts of criminal appeal.

112. The Court has already considered the application of the "procedural default" rule, alleged by Mexico to be a hindrance to the full implementation of the international obligations of the United States under Article 36, in the *LaGrand* case, when the Court addressed the issue of its implications for the application of Article 36, paragraph 2, of the Vienna Convention. The Court emphasized that "a distinction must be drawn between that rule as such and its specific application in the present case". The Court stated:

"In itself, the rule does not violate Article 36 of the Vienna Convention. The problem arises when the procedural default rule does not allow the detained individual to challenge a conviction and sentence by claiming, in reliance on Article 36, paragraph 1, of the Convention, that the competent national authorities failed to comply with their obligation to provide the requisite consular information 'without delay', thus preventing the person from seeking and obtaining consular assistance from the sending State." (*I.C.J. Reports 2001*, p. 497, para. 90.)

On this basis, the Court concluded that "the procedural default rule prevented counsel for the LaGrands to effectively challenge their convictions and sentences other than on United States constitutional grounds" (*I.C.J. Reports 2001*, p. 497, para. 91). This statement of the Court seems equally valid in relation to the present case, where a number of Mexican nationals have been placed exactly in such a situation.

113. The Court will return to this aspect below, in the context of Mexico's claims as to remedies. For the moment, the Court simply notes that the procedural default rule has not been revised, nor has any provision been made to prevent its application in cases where it has been the failure of the United States itself to inform that may have precluded counsel from being in a position to have raised the question of a violation of the Vienna Convention in the initial trial. It thus remains the case that the procedural default rule may continue to prevent courts from attaching legal significance to the fact, *inter alia*, that the violation of the rights set forth in Article 36, paragraph 1, prevented Mexico, in a timely fashion, from retaining private counsel for certain nationals and otherwise assisting in their defence. In such cases, application of the procedural default rule would have the effect of preventing "full effect [from being] given to the purposes for which the rights accorded under this article are intended", and thus violate paragraph 2 of Article 36. The Court notes moreover that in several of the cases cited in Mexico's final submissions the procedural default rule has already been applied, and that in others it could be applied at subsequent stages in the proceedings. However, in none of the cases, save for the three mentioned in paragraph 114 below, have the criminal proceedings against the Mexican nationals concerned already reached a stage at which there is no further possibility of judicial re-examination of those cases; that is to say, all possibility is not yet excluded of "review and reconsideration" of conviction and sentence, as called for in the *LaGrand* case, and as explained further in paragraphs 128 and following below. It would therefore be premature for the Court to conclude at this stage that, in those cases, there is already a violation of the obligations under Article 36, paragraph 2, of the Vienna Convention.

114. By contrast, the Court notes that in the case of three Mexican nationals, Mr. Fierro (case No. 31), Mr. Moreno (case No. 39), and Mr. Torres (case No. 53), conviction and sentence have become final. Moreover, in the case of Mr. Torres the Oklahoma Court of Criminal Appeals has set an execution date (see paragraph 21 above, *in fine*). The Court must therefore conclude that, in relation to these three individuals, the United States is in breach of the obligations incumbent upon it under Article 36, paragraph 2, of the Vienna Convention.

* *

LEGAL CONSEQUENCES OF THE BREACH

115. Having concluded that in most of the cases brought before the Court by Mexico in the 52 instances, there has been a failure to observe the obligations prescribed by Article 36, paragraph 1 *(b)*, of the Vienna Convention, the Court now proceeds to the examination of the legal consequences of such a breach and of what legal remedies should be considered for the breach.

116. Mexico in its fourth, fifth and sixth submissions asks the Court to adjudge and declare:

> "(4) that pursuant to the injuries suffered by Mexico in its own right and in the exercise of diplomatic protection of its nationals, Mexico is entitled to full reparation for these injuries in the form of *restitutio in integrum*;
>
> (5) that this restitution consists of the obligation to restore the *status quo ante* by annulling or otherwise depriving of full force or effect the conviction and sentences of all 52 Mexican nationals; [and]
>
> (6) that this restitution also includes the obligation to take all measures necessary to ensure that a prior violation of Article 36 shall not affect the subsequent proceedings."

117. In support of its fourth and fifth submissions, Mexico argues that "It is well-established that the primary form of reparation available to a State injured by an internationally wrongful act is *restitutio in integrum*", and that "The United States is therefore obliged to take the necessary action to restore the *status quo ante* in respect of Mexico's nationals detained, tried, convicted and sentenced in violation of their internationally recognized rights." To restore the *status quo ante*, Mexico contends that "restitution here must take the form of annulment of the convictions and sentences that resulted from the proceedings tainted by the Article 36 violations", and that "It follows from the very nature of *restitutio* that, when a violation of an international obligation is manifested in a judicial act, that act must be annulled and thereby deprived of any force or effect in the national legal system." Mexico therefore asks in its submissions that the convictions and sentences of the 52 Mexican nationals be annulled, and that, in any future criminal proceedings against these 52 Mexican nationals, evidence obtained in breach of Article 36 of the Vienna Convention be excluded.

118. The United States on the other hand argues:

> "*LaGrand*'s holding calls for the United States to provide, in each case, 'review and reconsideration' that 'takes account of' the viola-

tion, not 'review and reversal', not across-the-board exclusions of evidence or nullification of convictions simply because a breach of Article 36 (1) occurred and without regard to its effect upon the conviction and sentence and, not . . . 'a precise, concrete, stated result: to re-establish the *status quo ante*'".

119. The general principle on the legal consequences of the commission of an internationally wrongful act was stated by the Permanent Court of International Justice in the *Factory at Chorzów* case as follows: "It is a principle of international law that the breach of an engagement involves an obligation to make reparation in an adequate form." (*Factory at Chorzów, Jurisdiction, 1927, P.C.I.J., Series A, No. 9*, p. 21.) What constitutes "reparation in an adequate form" clearly varies depending upon the concrete circumstances surrounding each case and the precise nature and scope of the injury, since the question has to be examined from the viewpoint of what is the "reparation in an adequate form" that corresponds to the injury. In a subsequent phase of the same case, the Permanent Court went on to elaborate on this point as follows:

> "The essential principle contained in the actual notion of an illegal act — a principle which seems to be established by international practice and in particular by the decisions of arbitral tribunals — is that reparation must, as far as possible, wipe out all the consequences of the illegal act and reestablish the situation which would, in all probability, have existed if that act had not been committed." (*Factory at Chorzów, Merits, 1928, P.C.I.J., Series A, No. 17*, p. 47.)

120. In the *LaGrand* case the Court made a general statement on the principle involved as follows:

> "The Court considers in this respect that if the United States, notwithstanding its commitment [to ensure implementation of the specific measures adopted in performance of its obligations under Article 36, paragraph 1 *(b)*], should fail in its obligation of consular notification to the detriment of German nationals, an apology would not suffice in cases where the individuals concerned have been subjected to prolonged detention or convicted and sentenced to severe penalties. In the case of such a conviction and sentence, it would be incumbent upon the United States to allow the review and reconsideration of the conviction and sentence by taking account of the violation of the rights set forth in the Convention. This obligation can be carried out in various ways. The choice of means must be left to the United States." (*I.C.J. Reports 2001*, pp. 513-514, para. 125.)

121. Similarly, in the present case the Court's task is to determine what would be adequate reparation for the violations of Article 36. It should be clear from what has been observed above that the internationally wrongful acts committed by the United States were the failure of its

competent authorities to inform the Mexican nationals concerned, to notify Mexican consular posts and to enable Mexico to provide consular assistance. It follows that the remedy to make good these violations should consist in an obligation on the United States to permit review and reconsideration of these nationals' cases by the United States courts, as the Court will explain further in paragraphs 128 to 134 below, with a view to ascertaining whether in each case the violation of Article 36 committed by the competent authorities caused actual prejudice to the defendant in the process of administration of criminal justice.

122. The Court reaffirms that the case before it concerns Article 36 of the Vienna Convention and not the correctness as such of any conviction or sentencing. The question of whether the violations of Article 36, paragraph 1, are to be regarded as having, in the causal sequence of events, ultimately led to convictions and severe penalties is an integral part of criminal proceedings before the courts of the United States and is for them to determine in the process of review and reconsideration. In so doing, it is for the courts of the United States to examine the facts, and in particular the prejudice and its causes, taking account of the violation of the rights set forth in the Convention.

123. It is not to be presumed, as Mexico asserts, that partial or total annulment of conviction or sentence provides the necessary and sole remedy. In this regard, Mexico cites the recent Judgment of this Court in the case concerning the *Arrest Warrant of 11 April 2000 (Democratic Republic of the Congo* v. *Belgium)*, in which the "Court ordered the cancellation of an arrest warrant issued by a Belgian judicial official in violation of the international immunity of the Congo Minister for Foreign Affairs". However, the present case has clearly to be distinguished from the *Arrest Warrant* case. In that case, the question of the legality under international law of the act of issuing the arrest warrant against the Congolese Minister for Foreign Affairs by the Belgian judicial authorities was itself the subject-matter of the dispute. Since the Court found that act to be in violation of international law relating to immunity, the proper legal consequence was for the Court to order the cancellation of the arrest warrant in question (*I.C.J. Reports 2002*, p. 33). By contrast, in the present case it is not the convictions and sentences of the Mexican nationals which are to be regarded as a violation of international law, but solely certain breaches of treaty obligations which preceded them.

124. Mexico has further contended that the right to consular notification and consular communication under the Vienna Convention is a fundamental human right that constitutes part of due process in criminal proceedings and should be guaranteed in the territory of each of the Contracting Parties to the Vienna Convention; according to Mexico, this

right, as such, is so fundamental that its infringement will *ipso facto* produce the effect of vitiating the entire process of the criminal proceedings conducted in violation of this fundamental right. Whether or not the Vienna Convention rights are human rights is not a matter that this Court need decide. The Court would, however, observe that neither the text nor the object and purpose of the Convention, nor any indication in the *travaux préparatoires*, support the conclusion that Mexico draws from its contention in that regard.

125. For these reasons, Mexico's fourth and fifth submissions cannot be upheld.

126. The reasoning of the Court on the fifth submission of Mexico is equally valid in relation to the sixth submission of Mexico. In elaboration of its sixth submission, Mexico contends that,

> "As an aspect of *restitutio in integrum*, Mexico is also entitled to an order that in any subsequent criminal proceedings against the nationals, statements and confessions obtained prior to notification to the national of his right to consular assistance be excluded."

Mexico argues that "The exclusionary rule applies in both common law and civil law jurisdictions and requires the exclusion of evidence that is obtained in a manner that violates due process obligations", and on this basis concludes that

> "The status of the exclusionary rule as a general principle of law permits the Court to order that the United States is obligated to apply this principle in respect of statements and confessions given to United States law enforcement officials prior to the accused Mexican nationals being advised of their consular rights in any subsequent criminal proceedings against them."

127. The Court does not consider that it is necessary to enter into an examination of the merits of the contention advanced by Mexico that the "exclusionary rule" is "a general principle of law under Article 38 (1) *(c)* of the . . . Statute" of the Court. The issue raised by Mexico in its sixth submission relates to the question of what legal consequences flow from the breach of the obligations under Article 36, paragraph 1 — a question which the Court has already sufficiently discussed above in relation to the fourth and the fifth submissons of Mexico. The Court is of the view that this question is one which has to be examined under the concrete circumstances of each case by the United States courts concerned in the process of their review and reconsideration. For this reason, the sixth submission of Mexico cannot be upheld.

128. While the Court has rejected the fourth, fifth and sixth submissions of Mexico relating to the remedies for the breaches by the United

States of its international obligations under Article 36 of the Vienna Convention, the fact remains that such breaches have been committed, as the Court has found, and it is thus incumbent upon the Court to specify what remedies are required in order to redress the injury done to Mexico and to its nationals by the United States through non-compliance with those international obligations. As has already been observed in paragraph 120, the Court in the *LaGrand* Judgment stated the general principle to be applied in such cases by way of a remedy to redress an injury of this kind (*I.C.J. Reports 2001*, pp. 513-514, para. 125).

129. In this regard, Mexico's seventh submission also asks the Court to adjudge and declare:

> "That to the extent that any of the 52 convictions or sentences are not annulled, the United States shall provide, by means of its own choosing, meaningful and effective review and reconsideration of the convictions and sentences of the 52 nationals, and that this obligation cannot be satisfied by means of clemency proceedings or if any municipal law rule or doctrine [that fails to attach legal significance to an Article 36 (1) violation] is applied."

130. On this question of "review and reconsideration", the United States takes the position that it has indeed conformed its conduct to the *LaGrand* Judgment. In a further elaboration of this point, the United States argues that "[t]he Court said in *LaGrand* that the choice of means for allowing the review and reconsideration it called for 'must be left' to the United States", but that "Mexico would not leave this choice to the United States but have the Court undertake the review instead and decide at once that the breach requires the conviction and sentence to be set aside in each case".

131. In stating in its Judgment in the *LaGrand* case that "the United States of America, *by means of its own choosing*, shall allow the review and reconsideration of the conviction and sentence" (*I.C.J. Reports 2001*, p. 516, para. 128 (7); emphasis added), the Court acknowledged that the concrete modalities for such review and reconsideration should be left primarily to the United States. It should be underlined, however, that this freedom in the choice of means for such review and reconsideration is not without qualification: as the passage of the Judgment quoted above makes abundantly clear, such review and reconsideration has to be carried out "by taking account of the violation of the rights set forth in the Convention" (*I.C.J. Reports 2001*, p. 514, para. 125), including, in particular, the question of the legal consequences of the violation upon the criminal proceedings that have followed the violation.

132. The United States argues (1) "that the Court's decision in *LaGrand* in calling for review and reconsideration called for a process to re-examine a conviction and sentence in light of a breach of Article 36"; (2) that, "in calling for a process of review, the Court necessarily implied that one legitimate result of that process might be a conclusion that the conviction and sentence should stand"; and (3) "that the relief Mexico seeks in this

case is flatly inconsistent with the Judgment in *LaGrand*: it seeks precisely the award of a substantive outcome that the *LaGrand* Court declined to provide".

133. However, the Court wishes to point out that the current situation in the United States criminal procedure, as explained by the Agent at the hearings, is that

> "If the defendant alleged at trial that *a failure of consular information resulted in harm to a particular right essential to a fair trial*, an appeals court can *review how the lower court handled that claim of prejudice*",

but that

> "*If the foreign national did not raise his Article 36 claim at trial, he may face procedural constraints* [i.e., the application of the procedural default rule] on raising that particular claim in direct or collateral judicial appeals" (emphasis added).

As a result, a claim based on the violation of Article 36, paragraph 1, of the Vienna Convention, however meritorious in itself, could be barred in the courts of the United States by the operation of the procedural default rule (see paragraph 111 above).

134. It is not sufficient for the United States to argue that "[w]hatever label [the Mexican defendant] places on his claim, his right . . . must and will be vindicated if it is raised *in some form* at trial" (emphasis added), and that

> "In that way, even though a failure to label the complaint as a breach of the Vienna Convention may mean that he has technically speaking forfeited his right to raise this issue as a Vienna Convention claim, on appeal that failure would not bar him from independently asserting *a claim that he was prejudiced because he lacked this critical protection needed for a fair trial.*" (Emphasis added.)

The crucial point in this situation is that, by the operation of the procedural default rule as it is applied at present, the defendant is effectively barred from raising the issue of the violation of his rights under Article 36 of the Vienna Convention and is limited to seeking the vindication of his rights under the United States Constitution.

*

135. Mexico, in the latter part of its seventh submission, has stated that "this obligation [of providing review and reconsideration] cannot be

satisfied by means of clemency proceedings". Mexico elaborates this point by arguing first of all that "the United States's reliance on clemency proceedings is wholly inconsistent with its obligation to provide a remedy, as that obligation was found by this Court in *LaGrand*". More specifically, Mexico contends:

> "*First*, it is clear that the Court's direction to the United States in *LaGrand* clearly contemplated that 'review and reconsideration' would be carried out by judicial procedures . . . .
>
> *Second*, the Court was fully aware that the LaGrand brothers had received a clemency hearing, during which the Arizona Pardons Board took into account the violation of their consular rights. Accordingly, the Court determined in *LaGrand* that clemency review alone did not constitute the required 'review and reconsideration' . . .
>
> *Finally*, the Court specified that the United States must 'allow the review and reconsideration of the *conviction and sentence* by taking account of the violation of the rights set forth in the Convention' . . . it is a basic matter of U.S. criminal procedural law that courts review convictions; clemency panels do not. With the rare exception of pardons based on actual innocence, the focus of capital clemency review is on the propriety of the sentence and not on the underlying conviction."

Furthermore, Mexico argues that the clemency process is in itself an ineffective remedy to satisfy the international obligations of the United States. It concludes: "clemency review is standardless, secretive, and immune from judicial oversight".

Finally, in support of its contention, Mexico argues that

> "the failure of state clemency authorities to pay heed to the intervention of the US Department of State in cases of death-sentenced Mexican nationals refutes the [United States] contention that clemency review will provide meaningful consideration of the violations of rights conferred under Article 36".

136. Against this contention of Mexico, the United States claims that it "gives 'full effect' to the 'purposes for which the rights accorded under [Article 36, paragraph 1,] are intended' through executive clemency". It argues that "[t]he clemency process . . . is well suited to the task of providing review and reconsideration". The United States explains that "Clemency . . . is more than a matter of grace; it is part of the overall scheme for ensuring justice and fairness in the legal process" and that

"Clemency procedures are an integral part of the existing 'laws and regulations' of the United States through which errors are addressed".

137. Specifically in the context of the present case, the United States contends that the following two points are particularly noteworthy:

> "First, these clemency procedures allow for broad participation by advocates of clemency, including an inmate's attorney and the sending state's consular officer . . . Second, these clemency officials are not bound by principles of procedural default, finality, prejudice standards, or any other limitations on judicial review. They may consider any facts and circumstances that they deem appropriate and relevant, including specifically Vienna Convention claims."

138. The Court would emphasize that the "review and reconsideration" prescribed by it in the *LaGrand* case should be effective. Thus it should "tak[e] account of the violation of the rights set forth in [the] Convention" (*I.C.J. Reports 2001*, p. 516, para. 128 (7)) and guarantee that the violation and the possible prejudice caused by that violation will be fully examined and taken into account in the review and reconsideration process. Lastly, review and reconsideration should be both of the sentence and of the conviction.

139. Accordingly, in a situation of the violation of rights under Article 36, paragraph 1, of the Vienna Convention, the defendant raises his claim in this respect not as a case of "harm to a particular right essential to a fair trial" — a concept relevant to the enjoyment of due process rights under the United States Constitution — but as a case involving the infringement of his rights under Article 36, paragraph 1. The rights guaranteed under the Vienna Convention are treaty rights which the United States has undertaken to comply with in relation to the individual concerned, irrespective of the due process rights under United States constitutional law. In this regard, the Court would point out that what is crucial in the review and reconsideration process is the existence of a procedure which guarantees that full weight is given to the violation of the rights set forth in the Vienna Convention, whatever may be the actual outcome of such review and reconsideration.

140. As has been explained in paragraphs 128 to 134 above, the Court is of the view that, in cases where the breach of the individual rights of Mexican nationals under Article 36, paragraph 1 *(b)*, of the Convention has resulted, in the sequence of judicial proceedings that has followed, in the individuals concerned being subjected to prolonged detention or convicted and sentenced to severe penalties, the legal consequences of this breach have to be examined and taken into account in the course of

review and reconsideration. The Court considers that it is the judicial process that is suited to this task.

141. The Court in the *LaGrand* case left to the United States the choice of means as to how review and reconsideration should be achieved, especially in the light of the procedural default rule. Nevertheless, the premise on which the Court proceeded in that case was that the process of review and reconsideration should occur within the overall judicial proceedings relating to the individual defendant concerned.

142. As regards the clemency procedure, the Court notes that this performs an important function in the administration of criminal justice in the United States and is "the historic remedy for preventing miscarriages of justice where judicial process has been exhausted" (*Herrera* v. *Collins*, 506 US 390 (1993) at pp. 411-412). The Court accepts that executive clemency, while not judicial, is an integral part of the overall scheme for ensuring justice and fairness in the legal process within the United States criminal justice system. It must, however, point out that what is at issue in the present case is not whether executive clemency as an institution is or is not an integral part of the "existing laws and regulations of the United States", but whether the clemency process as practised within the criminal justice systems of different states in the United States can, in and of itself, qualify as an appropriate means for undertaking the effective "review and reconsideration of the conviction and sentence by taking account of the violation of the rights set forth in the Convention", as the Court prescribed in the *LaGrand* Judgment (*I.C.J. Reports 2001*, p. 514, para. 125).

143. It may be true, as the United States argues, that in a number of cases "clemency in fact results in pardons of convictions as well as commutations of sentences". In that sense and to that extent, it might be argued that the facts demonstrated by the United States testify to a degree of effectiveness of the clemency procedures as a means of relieving defendants on death row from execution. The Court notes, however, that the clemency process, as currently practised within the United States criminal justice system, does not appear to meet the requirements described in paragraph 138 above and that it is therefore not sufficient in itself to serve as an appropriate means of "review and reconsideration" as envisaged by the Court in the *LaGrand* case. The Court considers nevertheless that appropriate clemency procedures can supplement judicial review and reconsideration, in particular where the judicial system has failed to take due account of the violation of the rights set forth in the Vienna Convention, as has occurred in the case of the three Mexican nationals referred to in paragraph 114 above.

*

144. Finally, the Court will consider the eighth submission of Mexico, in which it asks the Court to adjudge and declare:

> "That the [United States] shall cease its violations of Article 36 of the Vienna Convention with regard to Mexico and its 52 nationals and shall provide appropriate guarantees and assurances that it shall take measures sufficient to achieve increased compliance with Article 36 (1) and to ensure compliance with Article 36 (2)."

145. In this respect, Mexico recognizes the efforts by the United States to raise awareness of consular assistance rights, through the distribution of pamphlets and pocket cards and by the conduct of training programmes, and that the measures adopted by the United States to that end were noted by the Court in its decision in the *LaGrand* case (*I.C.J. Reports 2001*, pp. 511-513, paras. 121, 123-124). Mexico, however, notes with regret that

> "the United States programme, whatever its components, has proven ineffective to prevent the regular and continuing violation by its competent authorities of consular notification and assistance rights guaranteed by Article 36".

146. In particular, Mexico claims in relation to the violation of the obligations under Article 36, paragraph 1, of the Vienna Convention:

> "*First*, competent authorities of the United States regularly fail to provide the timely notification required by Article 36 (1) *(b)* and thereby to *[sic]* frustrate the communication and access contemplated by Article 36 (1) *(a)* and the assistance contemplated by Article 36 (1) *(c)*. These violations continue notwithstanding the Court's judgment in *LaGrand* and the programme described there.
>
> . . . . . .
>
> Mexico has demonstrated, moreover, that the pattern of regular non-compliance continues. During the first half of 2003, Mexico has identified at least one hundred cases in which Mexican nationals have been arrested by competent authorities of the United States for serious felonies but not timely notified of their consular notification rights."

Furthermore, in relation to the violation of the obligations under Article 36, paragraph 2, of the Vienna Convention, Mexico claims:

> "*Second*, courts in the United States continue to apply doctrines of procedural default and non-retroactivity that prevent those courts from reaching the merits of Vienna Convention claims, and those courts that have addressed the merits of those claims (because no procedural bar applies) have repeatedly held that no remedy is avail-

able for a breach of the obligations of Article 36 . . . Likewise, the United States' reliance on clemency proceedings to meet *LaGrand*'s requirement of review and reconsideration represents a deliberate decision to allow these legal rules and doctrines to continue to have their inevitable effect. Hence, the United States continues to breach Article 36 (2) by failing to give full effect to the purposes for which the rights accorded under Article 36 are intended."

147. The United States contradicts this contention of Mexico by claiming that "its efforts to improve the conveyance of information about consular notification are continuing unabated and are achieving tangible results". It contends that Mexico "fails to establish a 'regular and continuing' pattern of breaches of Article 36 in the wake of *LaGrand*".

148. Mexico emphasizes the necessity of requiring the cessation of the wrongful acts because, it alleges, the violation of Article 36 with regard to Mexico and its 52 nationals still continues. The Court considers, however, that Mexico has not established a continuing violation of Article 36 of the Vienna Convention with respect to the 52 individuals referred to in its final submissions; it cannot therefore uphold Mexico's claim seeking cessation. The Court would moreover point out that, inasmuch as these 52 individual cases are at various stages of criminal proceedings before the United States courts, they are in the state of *pendente lite*; and the Court has already indicated in respect of them what it regards as the appropriate remedy, namely review and reconsideration by reference to the breach of the Vienna Convention.

149. The Mexican request for guarantees of non-repetition is based on its contention that beyond these 52 cases there is a "regular and continuing" pattern of breaches by the United States of Article 36. In this respect, the Court observes that there is no evidence properly before it that would establish a general pattern. While it is a matter of concern that, even in the wake of the *LaGrand* Judgment, there remain a substantial number of cases of failure to carry out the obligation to furnish consular information to Mexican nationals, the Court notes that the United States has been making considerable efforts to ensure that its law enforcement authorities provide consular information to every arrested person they know or have reason to believe is a foreign national. Especially at the stage of pre-trial consular information, it is noteworthy that the United States has been making good faith efforts to implement the obligations incumbent upon it under Article 36, paragraph 1, of the Vienna Convention, through such measures as a new outreach programme launched in 1998, including the dissemination to federal, state and local authorities of the State Department booklet mentioned above in para-

graph 63. The Court wishes to recall in this context what it has said in paragraph 64 about efforts in some jurisdictions to provide the information under Article 36, paragraph 1 *(b)*, in parallel with the reading of the "Miranda rights".

150. The Court would further note in this regard that in the *LaGrand* case Germany sought, *inter alia*, "a straightforward assurance that the United States will not repeat its unlawful acts" (*I.C.J. Reports 2001*, p. 511, para. 120). With regard to this general demand for an assurance of non-repetition, the Court stated:

> "If a State, in proceedings before this Court, repeatedly refers to substantial activities which it is carrying out in order to achieve compliance with certain obligations under a treaty, then this expresses a commitment to follow through with the efforts in this regard. The programme in question certainly cannot provide an assurance that there will never again be a failure by the United States to observe the obligations of notification under Article 36 of the Vienna Convention. But no State could give such a guarantee and Germany does not seek it. The Court considers that the commitment expressed by the United States to ensure implementation of the specific measures adopted in performance of its obligations under Article 36, paragraph 1 *(b)*, must be regarded as meeting Germany's request for a general assurance of non-repetition." (*I.C.J. Reports 2001*, pp. 512-513, para. 124.)

The Court believes that as far as the request of Mexico for guarantees and assurances of non-repetition is concerned, what the Court stated in this passage of the *LaGrand* Judgment remains applicable, and therefore meets that request.

* * *

151. The Court would now re-emphasize a point of importance. In the present case, it has had occasion to examine the obligations of the United States under Article 36 of the Vienna Convention in relation to Mexican nationals sentenced to death in the United States. Its findings as to the duty of review and reconsideration of convictions and sentences have been directed to the circumstance of severe penalties being imposed on foreign nationals who happen to be of Mexican nationality. To avoid any ambiguity, it should be made clear that, while what the Court has stated concerns the Mexican nationals whose cases have been brought before it by Mexico, the Court has been addressing the issues of principle raised in

the course of the present proceedings from the viewpoint of the general application of the Vienna Convention, and there can be no question of making an *a contrario* argument in respect of any of the Court's findings in the present Judgment. In other words, the fact that in this case the Court's ruling has concerned only Mexican nationals cannot be taken to imply that the conclusions reached by it in the present Judgment do not apply to other foreign nationals finding themselves in similar situations in the United States.

* *

152. By its Order of 5 February 2003 the Court, acting on a request by Mexico, indicated by way of provisional measure that

> "The United States of America shall take all measures necessary to ensure that Mr. César Roberto Fierro Reyna, Mr. Roberto Moreno Ramos and Mr. Osvaldo Torres Aguilera are not executed pending final judgment in these proceedings" (*I.C.J. Reports 2003*, pp. 91-92, para. 59 (I)) (see paragraph 21 above).

The Order of 5 February 2003, according to its terms and to Article 41 of the Statute, was effective pending final judgment, and the obligations of the United States in that respect are, with effect from the date of the present Judgment, replaced by those declared in this Judgment. The Court has rejected Mexico's submission that, by way of *restitutio in integrum*, the United States is obliged to annul the convictions and sentences of all of the Mexican nationals the subject of its claims (see above, paragraphs 115-125). The Court has found that, in relation to these three persons (among others), the United States has committed breaches of its obligations under Article 36, paragraph 1 *(b)*, of the Vienna Convention and Article 36, paragraphs 1 *(a)* and *(c)*, of that Convention; moreover, in respect of those three persons alone, the United States has also committed breaches of Article 36, paragraph 2, of the said Convention. The review and reconsideration of conviction and sentence required by Article 36, paragraph 2, which is the appropriate remedy for breaches of Article 36, paragraph 1, has not been carried out. The Court considers that in these three cases it is for the United States to find an appropriate remedy having the nature of review and reconsideration according to the criteria indicated in paragraphs 138 *et seq.* of the present Judgment.

* * *

153. For these reasons,

THE COURT,

(1) By thirteen votes to two,

Rejects the objection by the United Mexican States to the admissibility of the objections presented by the United States of America to the jurisdiction of the Court and the admissibility of the Mexican claims;

IN FAVOUR: *President* Shi; *Vice-President* Ranjeva; *Judges* Guillaume, Koroma, Vereshchetin, Higgins, Kooijmans, Rezek, Al-Khasawneh, Buergenthal, Elaraby, Owada, Tomka;

AGAINST: *Judge* Parra-Aranguren; *Judge* ad hoc Sepúlveda;

(2) Unanimously,

Rejects the four objections by the United States of America to the jurisdiction of the Court;

(3) Unanimously,

Rejects the five objections by the United States of America to the admissibility of the claims of the United Mexican States;

(4) By fourteen votes to one,

Finds that, by not informing, without delay upon their detention, the 51 Mexican nationals referred to in paragraph 106 (1) above of their rights under Article 36, paragraph 1 *(b)*, of the Vienna Convention on Consular Relations of 24 April 1963, the United States of America breached the obligations incumbent upon it under that subparagraph;

IN FAVOUR: *President* Shi; *Vice-President* Ranjeva; *Judges* Guillaume, Koroma, Vereshchetin, Higgins, Kooijmans, Rezek, Al-Khasawneh, Buergenthal, Elaraby, Owada, Tomka; *Judge* ad hoc Sepúlveda;

AGAINST: *Judge* Parra-Aranguren;

(5) By fourteen votes to one,

Finds that, by not notifying the appropriate Mexican consular post without delay of the detention of the 49 Mexican nationals referred to in paragraph 106 (2) above and thereby depriving the United Mexican States of the right, in a timely fashion, to render the assistance provided for by the Vienna Convention to the individuals concerned, the United States of America breached the obligations incumbent upon it under Article 36, paragraph 1 *(b)*;

IN FAVOUR: *President* Shi; *Vice-President* Ranjeva; *Judges* Guillaume, Koroma, Vereshchetin, Higgins, Kooijmans, Rezek, Al-Khasawneh, Buergenthal, Elaraby, Owada, Tomka; *Judge* ad hoc Sepúlveda;

AGAINST: *Judge* Parra-Aranguren;

(6) By fourteen votes to one,

Finds that, in relation to the 49 Mexican nationals referred to in paragraph 106 (3) above, the United States of America deprived the United Mexican States of the right, in a timely fashion, to communicate with and have access to those nationals and to visit them in detention, and thereby

breached the obligations incumbent upon it under Article 36, paragraph 1 *(a)* and *(c)*, of the Convention;

IN FAVOUR: *President* Shi; *Vice-President* Ranjeva; *Judges* Guillaume, Koroma, Vereshchetin, Higgins, Kooijmans, Rezek, Al-Khasawneh, Buergenthal, Elaraby, Owada, Tomka; *Judge* ad hoc Sepúlveda;

AGAINST: *Judge* Parra-Aranguren;

(7) By fourteen votes to one,

Finds that, in relation to the 34 Mexican nationals referred to in paragraph 106 (4) above, the United States of America deprived the United Mexican States of the right, in a timely fashion, to arrange for legal representation of those nationals, and thereby breached the obligations incumbent upon it under Article 36, paragraph 1 *(c)*, of the Convention;

IN FAVOUR: *President* Shi; *Vice-President* Ranjeva; *Judges* Guillaume, Koroma, Vereshchetin, Higgins, Kooijmans, Rezek, Al-Khasawneh, Buergenthal, Elaraby, Owada, Tomka; *Judge* ad hoc Sepúlveda;

AGAINST: *Judge* Parra-Aranguren;

(8) By fourteen votes to one,

Finds that, by not permitting the review and reconsideration, in the light of the rights set forth in the Convention, of the conviction and sentences of Mr. César Roberto Fierro Reyna, Mr. Roberto Moreno Ramos and Mr. Osvaldo Torres Aguilera, after the violations referred to in subparagraph (4) above had been established in respect of those individuals, the United States of America breached the obligations incumbent upon it under Article 36, paragraph 2, of the Convention;

IN FAVOUR: *President* Shi; *Vice-President* Ranjeva; *Judges* Guillaume, Koroma, Vereshchetin, Higgins, Kooijmans, Rezek, Al-Khasawneh, Buergenthal, Elaraby, Owada, Tomka; *Judge* ad hoc Sepúlveda;

AGAINST: *Judge* Parra-Aranguren;

(9) By fourteen votes to one,

Finds that the appropriate reparation in this case consists in the obligation of the United States of America to provide, by means of its own choosing, review and reconsideration of the convictions and sentences of the Mexican nationals referred to in subparagraphs (4), (5), (6) and (7) above, by taking account both of the violation of the rights set forth in Article 36 of the Convention and of paragraphs 138 to 141 of this Judgment;

IN FAVOUR: *President* Shi; *Vice-President* Ranjeva; *Judges* Guillaume, Koroma, Vereshchetin, Higgins, Kooijmans, Rezek, Al-Khasawneh, Buergenthal, Elaraby, Owada, Tomka; *Judge* ad hoc Sepúlveda;

AGAINST: *Judge* Parra-Aranguren;

(10) Unanimously,

Takes note of the commitment undertaken by the United States of America to ensure implementation of the specific measures adopted in performance of its obligations under Article 36, paragraph 1 *(b)*, of the Vienna Convention; and *finds* that this commitment must be regarded as meeting the request by the United Mexican States for guarantees and assurances of non-repetition;

(11) Unanimously,

Finds that, should Mexican nationals nonetheless be sentenced to severe penalties, without their rights under Article 36, paragraph 1 *(b)*, of the Convention having been respected, the United States of America shall provide, by means of its own choosing, review and reconsideration of the conviction and sentence, so as to allow full weight to be given to the violation of the rights set forth in the Convention, taking account of paragraphs 138 to 141 of this Judgment.

Done in English and in French, the English text being authoritative, at the Peace Palace, The Hague, this thirty-first day of March, two thousand and four, in three copies, one of which will be placed in the archives of the Court and the others transmitted to the Government of the United Mexican States and the Government of the United States of America, respectively.

(Signed) SHI Jiuyong,
President.

(Signed) Philippe COUVREUR,
Registrar.

President SHI and Vice-President RANJEVA append declarations to the Judgment of the Court; Judges VERESHCHETIN, PARRA-ARANGUREN and TOMKA and Judge *ad hoc* SEPÚLVEDA append separate opinions to the Judgment of the Court.

(Initialled) J.Y.S.
(Initialled) Ph.C.

Annex 31

COUR INTERNATIONALE DE JUSTICE

RECUEIL DES ARRÊTS,
AVIS CONSULTATIFS ET ORDONNANCES

AFFAIRE
AHMADOU SADIO DIALLO

(RÉPUBLIQUE DE GUINÉE c. RÉPUBLIQUE
DÉMOCRATIQUE DU CONGO)

INDEMNISATION DUE PAR LA RÉPUBLIQUE DÉMOCRATIQUE
DU CONGO À LA RÉPUBLIQUE DE GUINÉE

ARRÊT DU 19 JUIN 2012

2012

INTERNATIONAL COURT OF JUSTICE

REPORTS OF JUDGMENTS,
ADVISORY OPINIONS AND ORDERS

CASE CONCERNING
AHMADOU SADIO DIALLO

(REPUBLIC OF GUINEA *v.* DEMOCRATIC
REPUBLIC OF THE CONGO)

COMPENSATION OWED BY THE DEMOCRATIC REPUBLIC
OF THE CONGO TO THE REPUBLIC OF GUINEA

JUDGMENT OF 19 JUNE 2012

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(Republic of Guinea v. *Democratic Republic of the Congo),*
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ARRÊT

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19 JUNE 2012

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(REPUBLIC OF GUINEA *v.* DEMOCRATIC REPUBLIC OF THE CONGO)

COMPENSATION OWED BY THE DEMOCRATIC REPUBLIC OF THE CONGO TO THE REPUBLIC OF GUINEA

Introductory observations.

Object of the present proceedings pursuant to Court's Judgment of 30 November 2010 — Determination of amount of compensation — Injury resulting from unlawful detentions and expulsion of Mr. Diallo — Guinea's exercise of diplomatic protection — General rules governing compensation — Establishment of injury and causal nexus between the wrongful acts and that injury — Valuation of the injury — General rule that it is for the party which alleges a particular fact to prove existence of that fact — That rule to be applied flexibly in this case as Respondent may be in a better position to establish certain facts — Evidence adduced by Guinea as starting point of the Court's inquiry — Assessment in light of evidence introduced by the Democratic Republic of the Congo (DRC) — Allowance for the difficulty in providing certain evidence because of abruptness of Mr. Diallo's expulsion — The Court's inquiry limited to the injury resulting from the breach of Mr. Diallo's rights as an individual.

*

Claim for compensation for non-material injury suffered by Mr. Diallo.

Non-material injury may take various forms — Establishment of non-material injury even without specific evidence — Non-material injury of Mr. Diallo as an inevitable consequence of the wrongful acts of the DRC already ascertained by the Court in its Judgment on the merits — Reasonable to conclude that the wrongful conduct of the DRC caused Mr. Diallo significant psychological suffering and loss of reputation — Number of days for which Mr. Diallo was detained, as well as fact that he was not mistreated, taken into account — Context in which the wrongful

detentions and expulsion occurred, as well as their arbitrary nature, as factors aggravating Mr. Diallo's non-material injury — Importance of equitable considerations in the quantification of compensation for non-material injury — US$85,000 in compensation awarded.

*

Claim for compensation for material injury suffered by Mr. Diallo.

Alleged loss of personal property.

Property of the two companies not taken into account given the Court's prior decision that claims related thereto were inadmissible — Personal property located in Mr. Diallo's apartment appearing on an inventory prepared 12 days after his expulsion — Failure of Guinea to prove extent of loss of Mr. Diallo's personal property listed on inventory and extent to which any such loss was caused by the unlawful conduct of the DRC — Lack of any evidence regarding value of items on inventory — Mr. Diallo nevertheless required to transport his personal property to Guinea or to arrange for its disposition in the DRC — US$10,000 awarded based on equitable considerations.

High-value items not specified on the inventory — No evidence put forward by Guinea that Mr. Diallo owned these items at the time of his expulsion; that they were in his apartment if he did own them; or that they were lost as a result of Mr. Diallo's treatment by the DRC — No compensation awarded.

Assets alleged to have been contained in bank accounts — No information provided by Guinea about total sum held in bank accounts, the amount of any particular account or the name(s) of bank(s) in which account(s) were held — No evidence put forward by Guinea demonstrating that the unlawful detentions and expulsion of Mr. Diallo caused the loss of any assets held in bank accounts — No compensation awarded.

Alleged loss of remuneration during Mr. Diallo's unlawful detentions and following his expulsion.

Cognizable character, as a component of compensation, of claim for income lost as a result of unlawful detention — Estimation may be appropriate where amount of lost income cannot be calculated precisely — No evidence however offered by Guinea to support the claim that Mr. Diallo was earning US$25,000 per month as gérant *of Africom-Zaire and Africontainers-Zaire — Evidence, on the contrary, that neither of the companies was conducting business during the years immediately prior to Mr. Diallo's detentions — Failure of Guinea to prove how Mr. Diallo's unlawful detentions would have caused him to lose any remuneration he could have been receiving — Guinea's claim for loss of remuneration during period of Mr. Diallo's detention rejected — Reasons for rejecting claim equally applicable to Guinea's highly speculative claim relating to the period following Mr. Diallo's expulsion — No compensation awarded.*

Alleged deprivation of potential earnings.

Guinea's claim concerning "potential earnings" as beyond the scope of the proceedings, given the Court's prior decision on the inadmissibility of Guinea's claims relating to the injuries alleged to have been caused to the companies — No compensation awarded.

*

Total sum awarded and post-judgment interest.

The total sum awarded to Guinea is US$95,000 to be paid by 31 August 2012 — Should payment be delayed, post-judgment interest on the principal sum due to accrue as from 1 September 2012 at an annual rate of 6 per cent — Sum awarded to Guinea in the exercise of diplomatic protection of Mr. Diallo intended to provide reparation for the latter's injury.

*

Procedural costs.

Article 64 of the Statute of the Court as implying that there may be circumstances which would make it appropriate for the Court to allocate costs in favour of one of the parties — No such circumstances exist in the present case.

JUDGMENT

Present: *President* TOMKA; *Vice-President* SEPÚLVEDA-AMOR; *Judges* OWADA, ABRAHAM, KEITH, BENNOUNA, SKOTNIKOV, CANÇADO TRINDADE, YUSUF, GREENWOOD, XUE, DONOGHUE, GAJA, SEBUTINDE; *Judges* ad hoc MAHIOU, MAMPUYA; *Registrar* COUVREUR.

In the case concerning Ahmadou Sadio Diallo,

between

the Republic of Guinea,

represented by

Mr. Mohamed Camara, First Counsellor for Political Affairs, Embassy of Guinea in the Benelux countries and in the European Union,

as Agent;

Mr. Hassane II Diallo, Counsellor and *chargé de mission* at the Ministry of Justice,

as Co-Agent,

and

the Democratic Republic of the Congo,

represented by

H.E. Mr. Henri Mova Sakanyi, Ambassador of the Democratic Republic of the Congo to the Kingdom of Belgium, the Kingdom of the Netherlands and the Grand Duchy of Luxembourg,

as Agent;

Mr. Tshibangu Kalala, Professor of International Law at the University of Kinshasa, member of the Kinshasa and Brussels Bars, and member of the Congolese Parliament,

as Co-Agent,

THE COURT,

composed as above,

after deliberation,

delivers the following Judgment:

1. On 28 December 1998, the Government of the Republic of Guinea (hereinafter "Guinea") filed in the Registry of the Court an Application instituting proceedings against the Democratic Republic of the Congo (hereinafter the "DRC", named Zaire between 1971 and 1997) in respect of a dispute concerning "serious violations of international law" alleged to have been committed upon the person of Mr. Ahmadou Sadio Diallo, a Guinean national.

In the Application, Guinea maintained that:

> "Mr. Ahmadou Sadio Diallo, a businessman of Guinean nationality, was unjustly imprisoned by the authorities of the Democratic Republic of the Congo, after being resident in that State for thirty-two (32) years, despoiled of his sizable investments, businesses, movable and immovable property and bank accounts, and then expelled."

Guinea added:

> "[t]his expulsion came at a time when Mr. Ahmadou Sadio Diallo was pursuing recovery of substantial debts owed to his businesses [Africom-Zaire and Africontainers-Zaire] by the [Congolese] State and by oil companies established in its territory and of which the State is a shareholder".

According to Guinea, Mr. Diallo's arrests, detentions and expulsion constituted, *inter alia*, violations of

> "the principle that aliens should be treated in accordance with 'a minimum standard of civilization', [of] the obligation to respect the freedom and property of aliens, [and of] the right of aliens accused of an offence to a fair trial on adversarial principles by an impartial court".

To found the jurisdiction of the Court, Guinea invoked in the Application the declarations whereby the two States have recognized the compulsory jurisdiction of the Court under Article 36, paragraph 2, of the Statute of the Court.

2. On 3 October 2002, the DRC raised preliminary objections in respect of the admissibility of Guinea's Application. In its Judgment of 24 May 2007 on these preliminary objections, the Court declared the Application of the Republic of Guinea to be admissible "in so far as it concerns protection of Mr. Diallo's rights as an individual" and "in so far as it concerns protection of [his] direct rights as *associé* in Africom-Zaire and Africontainers-Zaire". However, the Court declared the Application of the Republic of Guinea to be inadmissible "in so far as it concerns protection of Mr. Diallo in respect of alleged violations of rights of Africom-Zaire and Africontainers-Zaire" (*Ahmadou Sadio Diallo*

(Republic of Guinea v. *Democratic Republic of the Congo), Preliminary Objections, Judgment, I.C.J. Reports 2007 (II)*, pp. 617-618, para. 98, subpara. 3 *(a)*, *(b)*, and *(c)* of the operative part).

3. In its Judgment of 30 November 2010 on the merits, the Court found that, in respect of the circumstances in which Mr. Diallo had been expelled on 31 January 1996, the DRC had violated Article 13 of the International Covenant on Civil and Political Rights (hereinafter the "Covenant") and Article 12, paragraph 4, of the African Charter on Human and Peoples' Rights (hereinafter the "African Charter") (*Ahmadou Sadio Diallo (Republic of Guinea* v. *Democratic Republic of the Congo), Merits, Judgment, I.C.J. Reports 2010 (II)*, p. 692, para. 165, subpara. (2) of the operative part). The Court also found that, in respect of the circumstances in which Mr. Diallo had been arrested and detained in 1995-1996 with a view to his expulsion, the DRC had violated Article 9, paragraphs 1 and 2, of the Covenant and Article 6 of the African Charter (*ibid.*, p. 692, para. 165, subpara. (3) of the operative part).

4. The Court further decided that

> "the Democratic Republic of the Congo [was] under obligation to make appropriate reparation, in the form of compensation, to the Republic of Guinea for the injurious consequences of the violations of international obligations referred to in subparagraphs (2) and (3) [of the operative part]" (*ibid.*, p. 693, para. 165, subpara. (7) of the operative part),

namely the unlawful arrests, detentions and expulsion of Mr. Diallo.

5. In addition, the Court found that the DRC had violated Mr. Diallo's rights under Article 36, paragraph 1 *(b)*, of the Vienna Convention on Consular Relations (*ibid.*, p. 692, para. 165, subpara. (4) of the operative part). It did not however order the DRC to pay compensation for this violation (*ibid.*, p. 693, para. 165, subpara. (7) of the operative part).

6. In the same Judgment, the Court rejected all other submissions by Guinea relating to the arrests and detentions of Mr. Diallo, including the contention that he was subjected to treatment prohibited by Article 10, paragraph 1, of the Covenant during his detentions (*ibid.*, subpara. (5) of the operative part). Furthermore, the Court found that the DRC had not violated Mr. Diallo's direct rights as an *associé* in the companies Africom- Zaire and Africontainers-Zaire (*ibid.*, subpara. (6) of the operative part).

7. Finally, the Court decided, with respect to the question of compensation owed by the DRC to Guinea, that "failing agreement between the Parties on this matter within six months from the date of [the said] Judgment, [this] question . . . shall be settled by the Court" (*ibid.*, subpara. (8) of the operative part). Considering itself to have been "sufficiently informed of the facts of the . . . case", the Court found that "a single exchange of written pleadings by the Parties would then be sufficient in order for it to decide on the amount of compensation" (*ibid*, p. 692, para. 164).

8. The time-limit of six months thus fixed by the Court having expired on 30 May 2011 without an agreement being reached between the Parties on the question of compensation due to Guinea, the President of the Court held a meeting with the representatives of the Parties on 14 September 2011 in order to ascertain their views on the time-limits to be fixed for the filing of the two pleadings envisaged by the Court.

9. By an Order of 20 September 2011, the Court fixed 6 December 2011 and 21 February 2012 as the respective time-limits for the filing of the Memorial of Guinea and the Counter-Memorial of the DRC on the question of compensa-

tion due to Guinea. The Memorial and the Counter-Memorial were duly filed within the time-limits thus prescribed.

10. In the written proceedings relating to compensation, the following submissions were presented by the Parties:

On behalf of the Government of Guinea,

in the Memorial:

> "In compensation for the damage suffered by Mr. Ahmadou Sadio Diallo as a result of his arbitrary detentions and expulsion, the Republic of Guinea begs the Court to order the Democratic Republic of the Congo to pay it (on behalf of its national) the following sums:
>
> — US$250,000 for mental and moral damage, including injury to his reputation;
> — US$6,430,148 for loss of earnings during his detention and following his expulsion;
> — US$550,000 for other material damage; and
>
> — US$4,360,000 for loss of potential earnings;
>
> amounting to a total of eleven million five hundred and ninety thousand one hundred and forty-eight American dollars (US$11,590,148), not including statutory default interest.
>
> Furthermore, as a result of having been forced to institute the present proceedings, the Guinean State has incurred unrecoverable costs which it should not, in equity, be required to bear and which are assessed at US$500,000. The Republic of Guinea also begs the Court to order the DRC to pay it that sum.
>
> The Democratic Republic of the Congo should also be ordered to pay all the costs."

On behalf of the Government of the DRC,

in the Counter-Memorial:

> "Having regard to all of the arguments of fact and law set out above, the Democratic Republic of the Congo asks the Court to adjudge and declare that:
>
> (1) compensation in an amount of US$30,000 is due to Guinea to make good the non-pecuniary injury suffered by Mr. Diallo as a result of his wrongful detentions and expulsion in 1995-1996;
> (2) no default interest is due on the amount of compensation as fixed above;
> (3) the DRC shall have a time-limit of six months from the date of the Court's judgment in which to pay to Guinea the above amount of compensation;
> (4) no compensation is due in respect of the other material damage claimed by Guinea;
> (5) each Party shall bear its own costs of the proceedings, including costs and fees of its counsel, advocates, advisers, assistants and others."

* * *

I. Introductory Observations

11. It falls to the Court at this stage of the proceedings to determine the amount of compensation to be awarded to Guinea as a consequence of the unlawful arrests, detentions and expulsion of Mr. Diallo by the DRC, pursuant to the findings of the Court set out in its Judgment of 30 November 2010 and recalled above. In that Judgment, the Court indicated that the amount of compensation was to be based on "the injury flowing from the wrongful detentions and expulsion of Mr. Diallo in 1995-96, including the resulting loss of his personal belongings" (*I.C.J. Reports 2010 (II)*, p. 691, para. 163).

12. The Court begins by recalling certain of the facts on which it based its Judgment of 30 November 2010. Mr. Diallo was continuously detained for 66 days, from 5 November 1995 until 10 January 1996 (*ibid.*, p. 662, para. 59), and was detained for a second time between 25 and 31 January 1996 (*ibid.*, p. 662, para. 60), that is, for a total of 72 days. The Court also observed that Guinea failed to demonstrate that Mr. Diallo was subjected to inhuman or degrading treatment during his detentions (*ibid.*, p. 671, paras. 88-89). In addition, the Court found that Mr. Diallo was expelled by the DRC on 31 January 1996 and that he received notice of his expulsion on the same day (*ibid.*, p. 659, para. 50, and p. 668, para. 78).

13. The Court turns to the question of compensation for the violations of Mr. Diallo's human rights established in its Judgment of 30 November 2010. It recalls that it has fixed an amount of compensation once, in the *Corfu Channel* case (*(United Kingdom* v. *Albania), Assessment of Amount of Compensation, Judgment, I.C.J. Reports 1949*, p. 244). In the present case, Guinea is exercising diplomatic protection with respect to one of its nationals, Mr. Diallo, and is seeking compensation for the injury caused to him. As the Permanent Court of International Justice stated in the *Factory of Chorzów* case (*Merits, Judgment No. 13, 1928, P.C.I.J., Series A, No. 17*, pp. 27-28), "[i]t is a principle of international law that the reparation of a wrong may consist in an indemnity corresponding to the damage which the nationals of the injured State have suffered as a result of the act which is contrary to international law". The Court has taken into account the practice in other international courts, tribunals and commissions (such as the International Tribunal for the Law of the Sea, the European Court of Human Rights (ECHR), the Inter-American Court of Human Rights (IACHR), the Iran-United States Claims Tribunal, the Eritrea-Ethiopia Claims Commission, and the United Nations Compensation Commission), which have applied general principles governing compensation when fixing its amount, including in respect of injury resulting from unlawful detention and expulsion.

14. Guinea seeks compensation under four heads of damage: non-material injury (referred to by Guinea as "mental and moral dam-

age"); and three heads of material damage: alleged loss of personal property; alleged loss of professional remuneration (referred to by Guinea as "loss of earnings") during Mr. Diallo's detentions and after his expulsion; and alleged deprivation of "potential earnings". As to each head of damage, the Court will consider whether an injury is established. It will then "ascertain whether, and to what extent, the injury asserted by the Applicant is the consequence of wrongful conduct by the Respondent", taking into account "whether there is a sufficiently direct and certain causal nexus between the wrongful act . . . and the injury suffered by the Applicant" (*Application of the Convention on the Prevention and Punishment of the Crime of Genocide (Bosnia and Herzegovina* v. *Serbia and Montenegro), Judgment, I.C.J. Reports 2007 (I)*, pp. 233-234, para. 462). If the existence of injury and causation is established, the Court will then determine the valuation.

15. The assessment of compensation owed to Guinea in this case will require the Court to weigh the Parties' factual contentions. The Court recalled in its Judgment of 30 November 2010 that, as a general rule, it is for the party which alleges a particular fact in support of its claims to prove the existence of that fact (*I.C.J. Reports 2010 (II)*, p. 660, para. 54; see also *Application of the Interim Accord of 13 September 1995 (the former Yugoslav Republic of Macedonia* v. *Greece), Judgment, I.C.J. Reports 2011 (II)*, p. 668, para. 72; *Pulp Mills on the River Uruguay (Argentina* v. *Uruguay), Judgment, I.C.J. Reports 2010 (I)*, p. 71, para. 162). The Court also recognized that this general rule would have to be applied flexibly in this case and, in particular, that the Respondent may be in a better position to establish certain facts (*I.C.J. Reports 2010 (II)*, pp. 660-661, paras. 54-56).

16. In the present stage of the proceedings, the Court once again will be guided by the approach summarized in the preceding paragraph. Thus, the starting point in the Court's inquiry will be the evidence adduced by Guinea to support its claim under each head of damage, which the Court will assess in light of evidence introduced by the DRC. The Court also recognizes that the abruptness of Mr. Diallo's expulsion may have diminished the ability of Mr. Diallo and Guinea to locate certain documents, calling for some flexibility by the Court in considering the record before it.

17. Before turning to the various heads of damage, the Court also recalls that the scope of the present proceedings is determined in important respects by the Court's Judgments of 24 May 2007 and of 30 November 2010. Having declared Guinea's Application inadmissible as to alleged violations of the rights of Africom-Zaire and Africontainers-Zaire (*I.C.J. Reports 2007 (II)*, p. 616, para. 94), the Court will not take account of any claim for injury sustained by the two companies, rather than by Mr. Diallo himself. Moreover, the Court will award no compensation in respect of Guinea's claim that the DRC violated Mr. Diallo's direct rights as an *associé* in Africom-Zaire and Africontainers-Zaire,

because the Court found that there was no such violation in its Judgment of 30 November 2010 (*I.C.J. Reports 2010 (II)*, p. 690, para. 157, and pp. 690-691, para. 159). The Court's inquiry will be limited to the injury resulting from the breach of Mr. Diallo's rights as an individual, that is, "the injury flowing from the wrongful detentions and expulsion of Mr. Diallo in 1995-1996, including the resulting loss of his personal belongings" (*ibid.*, p. 691, para. 163).

II. Heads of Damage in respect of which Compensation Is Requested

A. Claim for Compensation for Non-Material Injury Suffered by Mr. Diallo

18. "Mental and moral damage", referred to by Guinea, or "non-pecuniary injury", referred to by the DRC, covers harm other than material injury which is suffered by an injured entity or individual. Non-material injury to a person which is cognizable under international law may take various forms. For instance, the umpire in the *Lusitania* cases before the Mixed Claims Commission (United States/Germany) mentioned "mental suffering, injury to [a claimant's] feelings, humiliation, shame, degradation, loss of social position or injury to his credit or to his reputation" (opinion in the *Lusitania* cases, 1 November 1923, United Nations, *Reports of International Arbitral Awards (RIAA)*, Vol. VII, p. 40). The Inter-American Court of Human Rights observed in *Gutiérrez-Soler* v. *Colombia* that "[n]on pecuniary damage may include distress, suffering, tampering with the victim's core values, and changes of a non-pecuniary nature in the person's everyday life" (judgment of 12 September 2005 (merits, reparations and costs), IACHR, Series C, No. 132, para. 82).

19. In the present case, Guinea contends that

> "Mr. Diallo suffered moral and mental harm, including emotional pain, suffering and shock, as well as the loss of his position in society and injury to his reputation as a result of his arrests, detentions and expulsion by the DRC."

No specific evidence regarding this head of damage is submitted by Guinea.

20. The DRC, for its part, does not contest the fact that Mr. Diallo suffered "non-pecuniary injury". However, the DRC requests the Court to

> "take into account the specific circumstances of this case, the brevity of the detention complained of, the absence of any mistreatment of

> Mr. Diallo, [and] the fact that Mr. Diallo was expelled to his country of origin, with which he had been able to maintain ongoing and high-level contacts throughout his lengthy stay in the Congo".

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21. In the view of the Court, non-material injury can be established even without specific evidence. In the case of Mr. Diallo, the fact that he suffered non-material injury is an inevitable consequence of the wrongful acts of the DRC already ascertained by the Court. In its Judgment on the merits, the Court found that Mr. Diallo had been arrested without being informed of the reasons for his arrest and without being given the possibility to seek a remedy (*I.C.J. Reports 2010 (II)*, p. 666, para. 74, and p. 670, para. 84); that he was detained for an unjustifiably long period pending expulsion (*ibid.*, pp. 668-669, para. 79); that he was made the object of accusations that were not substantiated (*ibid.*, p. 669, para. 82); and that he was wrongfully expelled from the country where he had resided for 32 years and where he had engaged in significant business activities (*ibid.*, pp. 666-667, paras. 73 and 74). Thus, it is reasonable to conclude that the DRC's wrongful conduct caused Mr. Diallo significant psychological suffering and loss of reputation.

22. The Court has taken into account the number of days for which Mr. Diallo was detained and its earlier conclusion that it had not been demonstrated that Mr. Diallo was mistreated in violation of Article 10, paragraph 1, of the Covenant (*ibid.*, p. 671, para. 89).

23. The circumstances of the case point to the existence of certain factors which aggravate Mr. Diallo's non-material injury. One is the context in which the wrongful detentions and expulsion occurred. As the Court noted in its Judgment on the merits,

> "it is difficult not to discern a link between Mr. Diallo's expulsion and the fact that he had attempted to recover debts which he believed were owed to his companies by, amongst others, the Zairean State or companies in which the State holds a substantial portion of the capital" (*I.C.J. Reports 2010 (II)*, p. 669, para. 82).

In addition, Mr. Diallo's

> "arrest and detention aimed at allowing such an expulsion measure, one without any defensible basis, to be effected can only be characterized as arbitrary within the meaning of Article 9, paragraph 1, of the Covenant and Article 6 of the African Charter" *(ibid.)*.

24. Quantification of compensation for non-material injury necessarily rests on equitable considerations. As the umpire noted in the *Lusitania* cases, non-material injuries "are very real, and the mere fact that they are difficult to measure or estimate by money standards makes them none the

less real and affords no reason why the injured person should not be compensated therefore as compensatory damages" (*RIAA*, Vol. VII, p. 40). When considering compensation for material or non-material injury caused by violations of the Covenant or the African Charter, respectively, the Human Rights Committee and the African Commission on Human and Peoples' Rights recommended "adequate compensation" without specifying the sum to be paid (see, for example, *A.* v. *Australia*, HRC, 3 April 1997, communication No. 560/1993, United Nations doc. CCPR/C/59/D/560/1993, para. 11; *Kenneth Good* v. *Republic of Botswana*, ACHPR, 26 May 2010, communication No. 313/05, *28th Activity Report*, Ann. IV, p. 110, para. 244). Arbitral tribunals and regional human rights courts have been more specific, given the power to assess compensation granted by their respective constitutive instruments. Equitable considerations have guided their quantification of compensation for non-material harm. For instance, in *Al-Jedda* v. *United Kingdom*, the Grand Chamber of the European Court of Human Rights stated that, for determining damage,

> "[i]ts guiding principle is equity, which above all involves flexibility and an objective consideration of what is just, fair and reasonable in all the circumstances of the case, including not only the position of the applicant but the overall context in which the breach occurred" (application No. 27021/08, judgment of 7 July 2011, *ECHR Reports* 2011, para. 114).

Similarly, the Inter-American Court of Human Rights has said that the payment of a sum of money as compensation for non-pecuniary damages may be determined by that court "in reasonable exercise of its judicial authority and on the basis of equity" (*Cantoral Benavides* v. *Peru*, judgment of 3 December 2001 (reparations and costs), IACHR, Series C, No. 88, para. 53).

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25. With regard to the non-material injury suffered by Mr. Diallo, the circumstances outlined in paragraphs 21 to 23 lead the Court to consider that the amount of US$85,000 would provide appropriate compensation. The sum is expressed in the currency to which both Parties referred in their written pleadings on compensation.

B. Claim for Compensation for Material Injury Suffered by Mr. Diallo

26. As previously noted (see paragraph 14), Guinea claims compensation for three heads of material damage. The Court will begin by address-

ing Guinea's claim relating to the loss of Mr. Diallo's personal property; it will then consider Guinea's claims concerning loss of professional remuneration during Mr. Diallo's unlawful detentions and following his unlawful expulsion from the DRC; and, finally, it will turn to Guinea's claim in respect of "potential earnings".

1. Alleged loss of Mr. Diallo's personal property (including assets in bank accounts)

27. Guinea claims that Mr. Diallo's abrupt expulsion prevented him from making arrangements for the transfer or disposal of personal property that was in his apartment and also caused the loss of certain assets in bank accounts. Guinea refers to an inventory of items in Mr. Diallo's apartment that was prepared 12 days after he was expelled, claiming that the inventory understated his personal property because it failed to include a number of high-value items that were in the apartment. It states that all of these assets have been irretrievably lost and estimates the value of lost tangible and intangible assets (including bank accounts) at US$550,000.

28. The DRC contends that Guinea was responsible for having produced the inventory in question as evidence before the Court, only later to declare it incomplete. Citing Guinea's role in preparing the inventory, the DRC characterizes that inventory as "credible" and "serious", and contends that Guinea cannot now claim that Mr. Diallo owned additional assets not reflected in it. The DRC further asserts that it cannot be held responsible for the alleged loss of any property that was in the apartment because the DRC did not order Mr. Diallo's eviction from the apartment and because Mr. Diallo's personal property was under the control of officials from the Guinean embassy and of Mr. Diallo's friends and relatives. Further, the DRC states that Guinea has provided no evidence regarding bank assets.

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29. The Court here addresses Guinea's claim for the loss of Mr. Diallo's personal property, without taking into account property of the two companies (to which Guinea also refers), given the Court's prior decision that Guinea's claims relating to the companies were inadmissible (see paragraph 17 above). The personal property at issue in Guinea's claim may be divided into three categories: furnishings of Mr. Diallo's apartment that appear on the above-referenced inventory; certain high-value items alleged to have been in Mr. Diallo's apartment, which are not specified on that inventory; and assets in bank accounts.

30. As to personal property that was located in Mr. Diallo's apartment, it appears that the inventory of the property in Mr. Diallo's apart-

ment, which both Parties have submitted to the Court, was prepared approximately 12 days after Mr. Diallo's expulsion from the DRC. While Guinea complains about omissions from the inventory (the high-value items discussed below), both Parties appear to accept that the items that are listed on the inventory were in the apartment at the time the inventory was prepared.

31. There is, however, uncertainty about what happened to the property listed on the inventory. Guinea does not point to any evidence that Mr. Diallo attempted to transport or to dispose of the property in the apartment, and there is no evidence before the Court that the DRC barred him from doing so. The DRC states that it did not take possession of the apartment and that it did not evict Mr. Diallo from the apartment. Mr. Diallo himself stated in 2008 that the company from which the apartment was leased took possession of it soon after his expulsion and that, as a result, he had lost all of his personal effects. Therefore, taken as a whole, Guinea has failed to prove the extent of the loss of Mr. Diallo's personal property listed on the inventory and the extent to which any such loss was caused by the DRC's unlawful conduct.

32. Even assuming that it could be established that the personal property on the inventory was lost and that any such loss was caused by the DRC's unlawful conduct, Guinea offers no evidence regarding the value of the items on the inventory (either with respect to individual items or in the aggregate).

33. Despite the shortcomings in the evidence related to the property listed on the inventory, the Court recalls that Mr. Diallo lived and worked in the territory of the DRC for over thirty years, during which time he surely accumulated personal property. Even assuming that the DRC is correct in its contention that Guinean officials and Mr. Diallo's relatives were in a position to dispose of that personal property after Mr. Diallo's expulsion, the Court considers that, at a minimum, Mr. Diallo would have had to transport his personal property to Guinea or to arrange for its disposition in the DRC. Thus, the Court is satisfied that the DRC's unlawful conduct caused some material injury to Mr. Diallo with respect to personal property that had been in the apartment in which he lived, although it would not be reasonable to accept the very large sum claimed by Guinea for this head of damage. In such a situation, the Court considers it appropriate to award an amount of compensation based on equitable considerations (see paragraph 36 below). Other courts, including the European Court of Human Rights and the Inter-American Court of Human Rights, have followed this approach where warranted (see, e.g., *Lupsa* v. *Romania*, application No. 10337/04, judgment of 8 June 2006, *ECHR Reports* 2006-VII, paras. 70-72; *Chaparro Alvarez and Lapo Iñiguez* v. *Ecuador*, judgment of 21 November 2007 (preliminary objections, merits, reparations and costs), IACHR, Series C, No. 170, paras. 240 and 242).

34. The Court next considers Guinea's contention that Mr. Diallo's apartment contained certain high-value items not specified on the inven-

tory described above. Guinea mentions several items in its Memorial (e.g., a diamond-studded watch and two paintings by a renowned artist), but offers few details and provides no evidence to support the assertion that the items were located in Mr. Diallo's apartment at the time of his detentions and expulsion. There is no statement by Mr. Diallo describing these goods. There are no records of purchase, even as to items allegedly purchased from well-known establishments selling high-value luxury items that can be expected to keep records of sales, and which are located outside the territory of the DRC, thus making them accessible to Mr. Diallo. Guinea has put forward no evidence whatsoever that Mr. Diallo owned these items at the time of his expulsion, that they were in his apartment if he did own them, or that they were lost as a result of his treatment by the DRC. For these reasons, the Court rejects Guinea's claims as to the loss of high-value items not specified on the inventory.

35. As to assets alleged to have been contained in bank accounts, Guinea offers no details and no evidence to support its claim. There is no information about the total sum held in bank accounts, the amount of any particular account or the name(s) of the bank(s) in which the account(s) were held. Further, there is no evidence demonstrating that the unlawful detentions and expulsion of Mr. Diallo caused the loss of any assets held in bank accounts. For example, Guinea does not explain why Mr. Diallo could not access any such accounts after leaving the DRC. Thus, it has not been established that Mr. Diallo lost any assets held in his bank accounts in the DRC or that the DRC's unlawful acts caused Mr. Diallo to lose any such financial assets. Accordingly, the Court rejects Guinea's claim as to the loss of bank account assets.

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36. The Court therefore awards no compensation in respect of the high-value items and bank account assets described in paragraphs 34 and 35 above. However, in view of the Court's conclusions above (see paragraph 33) regarding the personal property of Mr. Diallo and on the basis of equitable considerations, the Court awards the sum of US$10,000 under this head of damage.

2. Alleged loss of remuneration during Mr. Diallo's unlawful detentions and following his unlawful expulsion

37. At the outset, the Court notes that, in its submissions at the conclusion of its Memorial, Guinea claims US$6,430,148 for Mr. Diallo's loss of earnings during his detentions and following his expulsion. How-

ever, Guinea makes reference elsewhere in its Memorial to a sum of US$80,000 for Mr. Diallo's loss of earnings during his detentions. As presented by Guinea, this claim for US$80,000, although not reflected as a separate submission, is clearly distinct from its claim for US$6,430,148 which, in the reasoning of the Memorial, only concerns the alleged "loss of earnings" following Mr. Diallo's expulsion. The Court will interpret Guinea's submissions in light of the reasoning of its Memorial, as it is entitled to do (see, e.g., *Nuclear Tests (Australia* v. *France), Judgment, I.C.J. Reports 1974*, p. 262, para. 29; *Nuclear Tests (New Zealand* v. *France), Judgment, I.C.J. Reports 1974*, p. 466, para. 30). Therefore, in the present Judgment, it will first consider the claim of US$80,000 for loss of professional remuneration during Mr. Diallo's detentions (see paragraphs 38-46) and then will examine the claim of US$6,430,148 for loss of professional remuneration following his expulsion (see paragraphs 47-49).

38. Guinea asserts that, prior to his arrest on 5 November 1995, Mr. Diallo received monthly remuneration of US$25,000 in his capacity as *gérant* of Africom-Zaire and Africontainers-Zaire. Based on that figure, Guinea estimates that Mr. Diallo suffered a loss totalling US$80,000 during the 72 days he was detained, an amount that, according to Guinea, takes account of inflation. Guinea states that remuneration from the two companies was Mr. Diallo's "main source of income" and does not ask the Court to award compensation in respect of any other income relating to the period of Mr. Diallo's detentions. Guinea further asserts that Mr. Diallo was unable to carry out his "normal management activities" while in detention and thus to ensure that his companies were being properly run.

39. In response, the DRC contends that Guinea has not produced any documentary evidence to support the claim for loss of remuneration. The DRC also takes the view that Guinea has failed to show that Mr. Diallo's detentions caused a loss of remuneration that he otherwise would have received. In particular, the DRC asserts that Guinea has failed to explain why Mr. Diallo, as the sole *gérant* and *associé* of the two companies, could not have directed that payments be made to him. According to the DRC, no compensation for loss of remuneration during the period of Mr. Diallo's detention is warranted.

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40. The Court observes that, in general, a claim for income lost as a result of unlawful detention is cognizable as a component of compensation. This approach has been followed, for example, by the European

Court of Human Rights (see, e.g., *Teixeira de Castro* v. *Portugal*, application No. 44/1997/828/1034, judgment of 9 June 1998, *ECHR Reports* 1998-IV, paras. 46-49), by the Inter-American Court of Human Rights (see, e.g., *Suárez-Rosero* v. *Ecuador*, judgment of 20 January 1999 (reparations and costs), IACHR, Series C, No. 44, para. 60), and by the Governing Council of the United Nations Compensation Commission (see United Nations Compensation Commission Governing Council, *Report and Recommendations Made by the Panel of Commissioners concerning the Fourteenth Instalment of "E3" Claims*, United Nations doc. S/AC. 26/2000/19, 29 September 2000, para. 126). Moreover, if the amount of the lost income cannot be calculated precisely, estimation may be appropriate (see, e.g., *Elci and Others* v. *Turkey*, applications Nos. 23145/93 and 25091/94, judgment of 13 November 2003, ECHR, para. 721; *Case of the "Street Children" (Villagrán-Morales et al.)* v. *Guatemala*, judgment of 26 May 2001 (reparations and costs), IACHR, Series C, No. 77, para. 79). Thus, the Court must first consider whether Guinea has established that Mr. Diallo was receiving remuneration prior to his detentions and that such remuneration was in the amount of US$25,000 per month.

41. The claim that Mr. Diallo was earning US$25,000 per month as *gérant* of the two companies is made for the first time in the present phase of the proceedings, devoted to compensation. Guinea offers no evidence to support the claim. There are no bank account or tax records. There are no accounting records of either company showing that it had made such payments. It is plausible, of course, that Mr. Diallo's abrupt expulsion impeded or precluded his access to such records. That said, the absence of any evidence in support of the claim for loss of remuneration at issue here stands in stark contrast to the evidence adduced by Guinea at an earlier stage of this case in support of the claims relating to the two companies, which included various documents from the records of the companies.

42. Moreover, there is evidence suggesting that Mr. Diallo was not receiving US$25,000 per month in remuneration from the two companies prior to his detentions. First, the evidence regarding Africom-Zaire and Africontainers-Zaire strongly indicates that neither of the companies was conducting business — apart from the attempts to collect debts allegedly owed to each company — during the years immediately prior to Mr. Diallo's detentions. In particular, the record indicates that the operations of Africontainers-Zaire had, even according to Guinea, experienced a serious decline by 1990. In addition, as the Court noted previously, the DRC asserted that Africom-Zaire had ceased all commercial activities by the end of the 1980s and for that reason had been struck from the Trade Register (*I.C.J. Reports 2007 (II)*, p. 593, para. 22; *I.C.J. Reports 2010 (II)*, p. 677, para. 108); this assertion was not challenged by Guinea. It appears that disputes about the amounts payable by various entities to Africom-Zaire and Africontainers-Zaire continued into

the 1990s, in some cases even after Mr. Diallo's expulsion in 1996. But there is no evidence of operating activity that would have generated a flow of income during the years just prior to Mr. Diallo's detentions.

43. Secondly, in contrast to Guinea's claim in the present phase of the proceedings devoted to compensation that Mr. Diallo was receiving monthly remuneration of US$25,000, Guinea told the Court, during the preliminary objections phase, that Mr. Diallo was "already impoverished in 1995". This statement to the Court is consistent with the fact that, on 12 July 1995, Mr. Diallo obtained in the DRC, at his request, a "Certificate of Indigency" declaring him "temporarily destitute" and thus permitting him to avoid payments that would otherwise have been required in order to register a judgment in favour of one of the companies.

44. The Court therefore concludes that Guinea has failed to establish that Mr. Diallo was receiving remuneration from Africom-Zaire and Africontainers-Zaire on a monthly basis in the period immediately prior to his detentions in 1995-1996 or that such remuneration was at the rate of US$25,000 per month.

45. Guinea also does not explain to the satisfaction of the Court how Mr. Diallo's detentions caused an interruption in any remuneration that Mr. Diallo might have been receiving in his capacity as *gérant* of the two companies. If the companies were in fact in a position to pay Mr. Diallo as of the time that he was detained, it is reasonable to expect that employees could have continued to make the necessary payments to the *gérant* (their managing director and the owner of the companies). Moreover, as noted above (see paragraph 12), Mr. Diallo was detained from 5 November 1995 to 10 January 1996, then released and then detained again from 25 January 1996 to 31 January 1996. Thus, there was a period of two weeks during which there was an opportunity for Mr. Diallo to make arrangements to receive any remuneration that the companies allegedly had failed to pay him during the initial 66-day period of detention.

*

46. Under these circumstances, Guinea has not proven to the satisfaction of the Court that Mr. Diallo suffered a loss of professional remuneration as a result of his unlawful detentions.

* *

47. In addition to the claim for loss of remuneration during his unlawful detentions, Guinea asserts that the unlawful expulsion of Mr. Diallo by the DRC deprived him of the ability to continue receiving remuneration as the *gérant* of Africom-Zaire and Africontainers-Zaire. Based on its claim (described above) that Mr. Diallo received remuneration of US$25,000 per month prior to his detentions in 1995-1996, Guinea asserts

that, during the period that has elapsed since Mr. Diallo's expulsion on 31 January 1996, he has lost additional "professional income" in the amount of US$4,755,500. Guinea further asserts that this amount should be adjusted upward to account for inflation, such that its estimate of Mr. Diallo's loss of professional remuneration since his expulsion is US$6,430,148.

48. The DRC reiterates its position regarding the claim for unpaid remuneration from the period of Mr. Diallo's detentions, in particular the lack of evidence to support the claim that Mr. Diallo was receiving remuneration of US$25,000 per month prior to his detentions and expulsion.

*

49. For the reasons indicated above, the Court has already rejected the claim for loss of professional remuneration during the period of Mr. Diallo's detentions (see paragraphs 38-46). Those reasons also apply with respect to Guinea's claim relating to the period following Mr. Diallo's expulsion. Moreover, Guinea's claim with respect to Mr. Diallo's post-expulsion remuneration is highly speculative and assumes that Mr. Diallo would have continued to receive US$25,000 per month had he not been unlawfully expelled. While an award of compensation relating to loss of future earnings inevitably involves some uncertainty, such a claim cannot be purely speculative (cf. *Khamidov* v. *Russia*, application No. 72118/01, judgment of 15 November 2007 (merits and just satisfaction), ECHR, para. 197; *Chaparro Alvarez and Lapo Iñiguez* v. *Ecuador*, judgment of 21 November 2007 (preliminary objections, merits, reparations and costs), IACHR, Series C, No. 170, paras. 235-236; see also Commentary to Article 36, Draft Articles on Responsibility of States for Internationally Wrongful Acts, *Yearbook of the International Law Commission*, 2001, Vol. II (2), pp. 104-105 (concerning "lost profits" claims)). Thus, the Court concludes that no compensation can be awarded for Guinea's claim relating to unpaid remuneration following Mr. Diallo's expulsion.

* *

50. The Court therefore awards no compensation for remuneration that Mr. Diallo allegedly lost during his detentions and following his expulsion.

3. Alleged deprivation of potential earnings

51. Guinea makes an additional claim that it describes as relating to Mr. Diallo's "potential earnings". Specifically, Guinea states that Mr. Diallo's unlawful detentions and subsequent expulsion resulted in a

decline in the value of the two companies and the dispersal of their assets. Guinea also asserts that Mr. Diallo was unable to assign his holdings *(parts sociales)* in these companies to third parties and that his loss of potential earnings can be valued at 50 per cent of the "exchange value of the holdings", a sum that, according to Guinea, totals US$4,360,000.

52. The DRC points out that Guinea's calculation of the alleged loss to Mr. Diallo is based on assets belonging to the two companies, and not assets that belong to Mr. Diallo in his individual capacity. Furthermore, the DRC contends that Guinea provides no proof that the companies' assets have, in fact, been lost or that specific assets of Africom-Zaire or Africontainers-Zaire to which Guinea refers could not be sold on the open market.

*

53. The Court considers that Guinea's claim concerning "potential earnings" amounts to a claim for a loss in the value of the companies allegedly resulting from Mr. Diallo's detentions and expulsion. Such a claim is beyond the scope of these proceedings, given this Court's prior decision that Guinea's claims relating to the injuries alleged to have been caused to the companies are inadmissible (*I.C.J. Reports 2007 (II)*, p. 617, para. 98, subpara. (1) *(b)* of the operative part).

*

54. For these reasons, the Court awards no compensation to Guinea in respect of its claim relating to the "potential earnings" of Mr. Diallo.

* *

55. Having analysed the components of Guinea's claim in respect of material injury caused to Mr. Diallo as a result of the DRC's unlawful conduct, the Court awards compensation to Guinea in the amount of US$10,000.

III. Total Sum Awarded and Post-Judgment Interest

56. The total sum awarded to Guinea is US$95,000 to be paid by 31 August 2012. The Court expects timely payment and has no reason to assume that the DRC will not act accordingly. Nevertheless, considering that the award of post-judgment interest is consistent with the practice of other international courts and tribunals (see, for example, *The M/V "Saiga" (No. 2) (Saint Vincent and the Grenadines* v. *Guinea)*, judgment of 1 July 1999, ITLOS, para. 175; *Bámaca-Velásquez* v. *Guatemala*, judgment of 22 February 2002 (reparations and costs), IACHR, Series C, No. 91, para. 103; *Papamichalopoulos and Others* v. *Greece (Article 50)*,

application No. 33808/02, judgment of 31 October 1995, ECHR, Series A, No. 330-B, para. 39; *Lordos and Others* v. *Turkey*, application No. 15973/90, judgment of 10 January 2012 (just satisfaction), ECHR, para. 76 and *dispositif*, para. 1 *(b)*), the Court decides that, should payment be delayed, post-judgment interest on the principal sum due will accrue as from 1 September 2012 at an annual rate of 6 per cent. This rate has been fixed taking into account the prevailing interest rates on the international market and the importance of prompt compliance.

57. The Court recalls that the sum awarded to Guinea in the exercise of diplomatic protection of Mr. Diallo is intended to provide reparation for the latter's injury.

IV. Procedural Costs

58. Guinea requests the Court to award costs in its favour, in the amount of US$500,000, because, "as a result of having been forced to institute the present proceedings, the Guinean State has incurred unrecoverable costs which it should not, in equity, be required to bear".

59. The DRC asks the Court "to dismiss the request for the reimbursement of costs submitted by Guinea and to leave each State to bear its own costs of the proceedings, including the costs of its counsel, advocates and others". The DRC contends that Guinea lost the major part of the case and that, moreover, the amount claimed "represents an arbitrary, lump-sum determination, unsupported by any serious and credible evidence".

*

60. The Court recalls that Article 64 of the Statute provides that, "[u]nless otherwise decided by the Court, each party shall bear its own costs". While the general rule has so far always been followed by the Court, Article 64 implies that there may be circumstances which would make it appropriate for the Court to allocate costs in favour of one of the parties. However, the Court does not consider that any such circumstances exist in the present case. Accordingly, each Party shall bear its own costs.

* * *

61. For these reasons,

THE COURT,

(1) By fifteen votes to one,

Fixes the amount of compensation due from the Democratic Republic of the Congo to the Republic of Guinea for the non-material injury suffered by Mr. Diallo at US$85,000;

IN FAVOUR: *President* Tomka; *Vice-President* Sepúlveda-Amor; *Judges* Owada, Abraham, Keith, Bennouna, Skotnikov, Cançado Trindade, Yusuf, Greenwood, Xue, Donoghue, Gaja, Sebutinde; *Judge* ad hoc Mahiou;

AGAINST: *Judge* ad hoc Mampuya;

(2) By fifteen votes to one,

Fixes the amount of compensation due from the Democratic Republic of the Congo to the Republic of Guinea for the material injury suffered by Mr. Diallo in relation to his personal property at US$10,000;

IN FAVOUR: *President* Tomka; *Vice-President* Sepúlveda-Amor; *Judges* Owada, Abraham, Keith, Bennouna, Skotnikov, Cançado Trindade, Yusuf, Greenwood, Xue, Donoghue, Gaja, Sebutinde; *Judge* ad hoc Mahiou;

AGAINST: *Judge* ad hoc Mampuya;

(3) By fourteen votes to two,

Finds that no compensation is due from the Democratic Republic of the Congo to the Republic of Guinea with regard to the claim concerning material injury allegedly suffered by Mr. Diallo as a result of a loss of professional remuneration during his unlawful detentions and following his unlawful expulsion;

IN FAVOUR: *President* Tomka; *Vice-President* Sepúlveda-Amor; *Judges* Owada, Abraham, Keith, Bennouna, Skotnikov, Cançado Trindade, Greenwood, Xue, Donoghue, Gaja, Sebutinde; *Judge* ad hoc Mampuya;

AGAINST: *Judge* Yusuf; *Judge* ad hoc Mahiou;

(4) Unanimously,

Finds that no compensation is due from the Democratic Republic of the Congo to the Republic of Guinea with regard to the claim concerning material injury allegedly suffered by Mr. Diallo as a result of a deprivation of potential earnings;

(5) Unanimously,

Decides that the total amount of compensation due under points 1 and 2 above shall be paid by 31 August 2012 and that, in case it has not been paid by this date, interest on the principal sum due from the Democratic Republic of the Congo to the Republic of Guinea will accrue as from 1 September 2012 at an annual rate of 6 per cent;

(6) By fifteen votes to one,

Rejects the claim of the Republic of Guinea concerning the costs incurred in the proceedings.

IN FAVOUR: *President* Tomka; *Vice-President* Sepúlveda-Amor; *Judges* Owada, Abraham, Keith, Bennouna, Skotnikov, Cançado Trindade, Yusuf, Greenwood, Xue, Donoghue, Gaja, Sebutinde; *Judge* ad hoc Mampuya;

AGAINST: *Judge* ad hoc Mahiou.

Done in French and in English, the French text being authoritative, at the Peace Palace, The Hague, this nineteenth day of June, two thousand and twelve, in three copies, one of which will be placed in the archives of the Court and the others transmitted to the Government of the Republic of Guinea and the Government of the Democratic Republic of the Congo, respectively.

(Signed) Peter TOMKA,
President.

(Signed) Philippe COUVREUR,
Registrar.

Judge CANÇADO TRINDADE appends a separate opinion to the Judgment of the Court; Judges YUSUF and GREENWOOD append declarations to the Judgment of the Court; Judges *ad hoc* MAHIOU and MAMPUYA append separate opinions to the Judgment of the Court.

(Initialled) P.T.

(Initialled) Ph.C.

Annex 32

COUR INTERNATIONALE DE JUSTICE

RECUEIL DES ARRÊTS,
AVIS CONSULTATIFS ET ORDONNANCES

CERTAINES ACTIVITÉS MENÉES PAR LE NICARAGUA DANS LA RÉGION FRONTALIÈRE

(COSTA RICA c. NICARAGUA)

INDEMNISATION DUE PAR LA RÉPUBLIQUE DU NICARAGUA
À LA RÉPUBLIQUE DU COSTA RICA

ARRÊT DU 2 FÉVRIER 2018

2018

INTERNATIONAL COURT OF JUSTICE

REPORTS OF JUDGMENTS,
ADVISORY OPINIONS AND ORDERS

CERTAIN ACTIVITIES CARRIED OUT BY NICARAGUA IN THE BORDER AREA

(COSTA RICA *v.* NICARAGUA)

COMPENSATION OWED BY THE REPUBLIC OF NICARAGUA
TO THE REPUBLIC OF COSTA RICA

JUDGMENT OF 2 FEBRUARY 2018

Mode officiel de citation :
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ARRÊT

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JUDGMENT

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(COSTA RICA *v.* NICARAGUA)

COMPENSATION OWED BY THE REPUBLIC OF NICARAGUA TO THE REPUBLIC OF COSTA RICA

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* *

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* *

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* *

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*

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*

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* *

Total compensation for costs and expenses.

* *

Costa Rica's claim for pre-judgment and post-judgment interest — Costa Rica not entitled to pre-judgment interest on amount of compensation for environmental damage — Costa Rica awarded pre-judgment interest on costs and expenses found compensable — Period over which pre-judgment interest shall accrue — Post-

judgment interest to be paid should payment of total amount of compensation be delayed.

* *

Total sum awarded to Costa Rica.

JUDGMENT

Present: *President* ABRAHAM; *Vice-President* YUSUF; *Judges* OWADA, TOMKA, BENNOUNA, CANÇADO TRINDADE, GREENWOOD, XUE, DONOGHUE, GAJA, SEBUTINDE, BHANDARI, ROBINSON, GEVORGIAN; *Judges* ad hoc GUILLAUME, DUGARD; *Registrar* COUVREUR.

In the case concerning certain activities carried out by Nicaragua in the border area,

between

the Republic of Costa Rica,

represented by

H.E. Mr. Edgar Ugalde Alvarez, Ambassador on Special Mission,

as Agent;

H.E. Mr. Sergio Ugalde, Ambassador of Costa Rica to the Kingdom of the Netherlands, member of the Permanent Court of Arbitration,

as Co-Agent,

and

the Republic of Nicaragua,

represented by

H.E. Mr. Carlos José Argüello Gómez, Ambassador of Nicaragua to the Kingdom of the Netherlands, member of the International Law Commission,

as Agent,

THE COURT,

composed as above,

after deliberation,

delivers the following Judgment:

1. By an Application filed in the Registry of the Court on 18 November 2010, the Republic of Costa Rica (hereinafter "Costa Rica") instituted proceedings

against the Republic of Nicaragua (hereinafter "Nicaragua") for "the incursion into, occupation of and use by Nicaragua's army of Costa Rican territory", as well as for "serious damage inflicted to its protected rainforests and wetlands" (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua)*, hereinafter referred to as the "*Costa Rica* v. *Nicaragua* case").

2. By an Order dated 8 March 2011 (hereinafter referred to as the "2011 Order"), the Court indicated provisional measures addressed to both Parties in the *Costa Rica* v. *Nicaragua* case (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua), Provisional Measures, Order of 8 March 2011, I.C.J. Reports 2011 (I)*, pp. 27-28, para. 86).

3. By an Application filed in the Registry on 22 December 2011, Nicaragua instituted proceedings against Costa Rica for "violations of Nicaraguan sovereignty and major environmental damages on its territory", resulting from the road construction works being carried out by Costa Rica in the border area between the two countries along the San Juan River (*Construction of a Road in Costa Rica along the San Juan River (Nicaragua* v. *Costa Rica)*, hereinafter referred to as the "*Nicaragua* v. *Costa Rica* case").

4. By two separate Orders dated 17 April 2013, the Court joined the proceedings in the *Costa Rica* v. *Nicaragua* and *Nicaragua* v. *Costa Rica* cases.

5. By an Order of 22 November 2013 (hereinafter referred to as the "2013 Order"), the Court indicated further provisional measures in the *Costa Rica* v. *Nicaragua* case (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua)* and *Construction of a Road in Costa Rica along the San Juan River (Nicaragua* v. *Costa Rica), Provisional Measures, Order of 22 November 2013, I.C.J. Reports 2013*, pp. 369-370, para. 59).

6. Public hearings were held in the joined cases between 14 April 2015 and 1 May 2015.

7. In its Judgment dated 16 December 2015 on the merits, issued in the joined cases, the Court found, *inter alia*, with regard to the *Costa Rica* v. *Nicaragua* case, that Costa Rica had sovereignty over the "disputed territory", as defined by the Court in paragraphs 69-70 (*I.C.J. Reports 2015 (II)*, p. 740, para. 229, subpara. (1) of the operative part), and that, by excavating three *caños* and establishing a military presence on Costa Rican territory, Nicaragua had violated the territorial sovereignty of Costa Rica (*ibid.*, subpara. (2) of the operative part). The Court also found that, by excavating two *caños* in 2013 and establishing a military presence in the disputed territory, Nicaragua had breached the obligations incumbent upon it under the 2011 Order (*ibid.*, subpara. (3) of the operative part).

8. In the same Judgment, the Court found that Nicaragua had "the obligation to compensate Costa Rica for material damages caused by Nicaragua's unlawful activities on Costa Rican territory" (*ibid.*, p. 740, para. 229, subpara. (5) *(a)* of the operative part).

9. With respect to the question of compensation owed by Nicaragua to Costa Rica, the Court decided that "failing agreement between the Parties on this matter within 12 months from the date of [the] Judgment, [this] question . . . [would], at the request of one of the Parties, be settled by the Court" (*ibid.*, p. 741, para. 229, subpara. (5) *(b)* of the operative part).

10. Paragraph 142 of the same Judgment provided that the Court would, in such a case, determine the amount of compensation on the basis of further written pleadings limited to this issue.

11. By means of a letter dated 16 January 2017, the Co-Agent of Costa Rica, referring to paragraph 229, subparagraph (5) *(b)* of the operative part of the Court's Judgment of 16 December 2015, noted that "[r]egrettably, the Parties ha[d] been unable to agree on the compensation due to Costa Rica for material damages caused by Nicaragua's unlawful activities" as determined by the Court in the *Costa Rica* v. *Nicaragua* case. The Government of Costa Rica accordingly requested the Court "to settle the question of the compensation" due to Costa Rica.

12. At a meeting held by the President of the Court with the representatives of the Parties on 26 January 2017, pursuant to Article 31 of the Rules of Court, the latter expressed the views of their respective Governments regarding the time-limits required in order to prepare written pleadings. The Co-Agent of Costa Rica indicated that his Government wished to have at its disposal a period of two months for the preparation of its Memorial on the question of compensation. The Agent of Nicaragua stated that his Government would agree to a period of two months for the preparation of its Counter-Memorial on the same question.

13. Having ascertained the views of the Parties, and taking into account their agreement, by an Order of 2 February 2017, the Court fixed 3 April 2017 and 2 June 2017 as the respective time-limits for the filing of a Memorial by Costa Rica and a Counter-Memorial by Nicaragua on the question of compensation due to Costa Rica.

14. The Memorial and Counter-Memorial on compensation were filed within the time-limits thus fixed.

15. By a letter dated 20 June 2017, Costa Rica stated that, in its Counter-Memorial, Nicaragua had introduced evidence, and raised a number of arguments, in particular in respect of Costa Rica's expert evidence, which Costa Rica "ha[d] not yet had [the] opportunity to address". In the same letter, Costa Rica, *inter alia*, contested the methodology used by Nicaragua for the assessment of environmental harm and requested the Court that it be given an opportunity to respond by way of a short reply.

16. By a letter dated 23 June 2017, Nicaragua objected to Costa Rica's request and asked the Court "to proceed and assess the relevant material damage and the amount of compensation based on the evidence that the Parties have provided in their Memorial and Counter-Memorial".

17. The Court, noting that the Parties held different views as to the methodology for the assessment of environmental harm, considered it necessary for them to address that issue in a brief second round of written pleadings.

18. By an Order dated 18 July 2017, the President of the Court accordingly authorized the submission of a Reply by Costa Rica and a Rejoinder by Nicaragua on the sole question of the methodology adopted in the expert reports presented by the Parties in the Memorial and Counter-Memorial, respectively, on the question of compensation. By the same Order, the President fixed 8 August 2017 and 29 August 2017 as the respective time-limits for the filing of a Reply by Costa Rica and a Rejoinder by Nicaragua.

19. The Reply and Rejoinder were filed within the time-limits thus fixed.

20. In the written proceedings relating to compensation, the following submissions were presented by the Parties:

On behalf of the Government of the Republic of Costa Rica,

in the Memorial:

"1. Costa Rica respectfully requests the Court to order Nicaragua to pay immediately to Costa Rica:

(a) US$6,708,776.96; and
(b) pre-judgment interest in a total amount of US$522,733.19 until 3 April 2017, which amount should be updated to reflect the date of the Court's Judgment on this claim for compensation.

2. In the event that Nicaragua does not make immediate payment, Costa Rica respectfully requests the Court to order Nicaragua to pay post-judgment interest at an annual rate of 6 per cent."

in the Reply:

"1. Costa Rica respectfully requests the Court to reject Nicaragua's submissions and to order Nicaragua to pay immediately to Costa Rica:

(a) US$6,711,685.26; and
(b) pre-judgment interest in a total amount of US$501,997.28 until 3 April 2017, which amount should be updated to reflect the date of the Court's Judgment on this claim for compensation.

2. In the event that Nicaragua does not make immediate payment, Costa Rica respectfully requests the Court to order Nicaragua to pay post-judgment interest at an annual rate of 6 per cent."

On behalf of the Government of the Republic of Nicaragua,

in the Counter-Memorial:

"For the reasons given herein, the Republic of Nicaragua requests the Court to adjudge and declare that the Republic of Costa Rica is not entitled to more than $188,504 for material damages caused by Nicaragua's wrongful acts."

in the Rejoinder:

"For the reasons given herein, the Republic of Nicaragua requests the Court to adjudge and declare that the Republic of Costa Rica is not entitled to more than $188,504 for material damages caused by the actions of Nicaragua in the Disputed Area that the Court adjudged unlawful."

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I. Introductory Observations

21. In view of the lack of agreement between the Parties and of the request made by Costa Rica, it falls to the Court to determine the amount of compensation to be awarded to Costa Rica for material damage caused by Nicaragua's unlawful activities on Costa Rican territory, pursuant to

the findings of the Court set out in its Judgment of 16 December 2015. The Court begins by recalling certain facts on which it based that Judgment.

22. The issues before the Court have their origin in a territorial dispute between Costa Rica and Nicaragua over an area abutting the easternmost stretch of the Parties' mutual land boundary. This area, referred to by the Court as the "disputed territory", was defined by the Court as follows: "the northern part of Isla Portillos, that is to say, the area of wetland of some 3 square kilometres between the right bank of the [2010] disputed *caño*, the right bank of the San Juan River up to its mouth at the Caribbean Sea and the Harbor Head Lagoon" (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua), Provisional Measures, Order of 8 March 2011, I.C.J. Reports 2011 (I)*, p. 19, para. 55).

23. On 18 October 2010, Nicaragua started dredging the San Juan River in order to improve its navigability. It also carried out works in the northern part of Isla Portillos, excavating a channel (*"caño"*) on the disputed territory between the San Juan River and Harbor Head Lagoon (hereinafter referred to as the "2010 *caño*"). Nicaragua also sent some military units and other personnel to that area (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua)* and *Construction of a Road in Costa Rica along the San Juan River (Nicaragua* v. *Costa Rica), Judgment, I.C.J. Reports 2015 (II)*, p. 694, para. 63; p. 703, paras. 92-93).

24. By its 2011 Order, the Court indicated the following provisional measures:

"(1) Each Party shall refrain from sending to, or maintaining in the disputed territory, including the *caño*, any personnel, whether civilian, police or security;

(2) Notwithstanding point (1) above, Costa Rica may dispatch civilian personnel charged with the protection of the environment to the disputed territory, including the *caño*, but only in so far as it is necessary to avoid irreparable prejudice being caused to the part of the wetland where that territory is situated; Costa Rica shall consult with the Secretariat of the Ramsar Convention in regard to these actions, give Nicaragua prior notice of them and use its best endeavours to find common solutions with Nicaragua in this respect;

(3) Each Party shall refrain from any action which might aggravate or extend the dispute before the Court or make it more difficult to resolve;

(4) Each Party shall inform the Court as to its compliance with the above provisional measures." (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua), Provisional Measures, Order of 8 March 2011, I.C.J. Reports 2011 (I)*, pp. 27-28, para. 86.)

25. In its 2013 Order, the Court found that two new *caños* had been constructed by Nicaragua in the disputed territory (hereinafter referred to as the "2013 *caños*") (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua)* and *Construction of a Road in Costa Rica along the San Juan River (Nicaragua* v. *Costa Rica), Provisional Measures, Order of 22 November 2013, I.C.J. Reports 2013*, p. 364, para. 44). Both Costa Rica and Nicaragua acknowledged that the excavation of the 2013 *caños* took place after the 2011 Order on provisional measures had been adopted, that this activity was attributable to Nicaragua, and that a military encampment had been installed on the disputed territory as defined by the Court. Nicaragua also acknowledged that the excavation of the *caños* represented an infringement of its obligations under the 2011 Order (*ibid., Judgment, I.C.J. Reports 2015 (II)*, p. 713, para. 125).

26. In its 2013 Order, the Court stated that

> "[f]ollowing consultation with the Secretariat of the Ramsar Convention [Convention on Wetlands of International Importance especially as Waterfowl Habitat, signed at Ramsar on 2 February 1971 (hereinafter the 'Ramsar Convention')] and after giving Nicaragua prior notice, Costa Rica may take appropriate measures related to the two new *caños*, to the extent necessary to prevent irreparable prejudice to the environment of the disputed territory" (*ibid., Provisional Measures, Order of 22 November 2013, I.C.J. Reports 2013*, p. 370, para. 59, subpara. (2) (E)).

After consultation with the Secretariat, Costa Rica constructed, during a short period in late March and early April 2015, a dyke across the eastern of the two 2013 *caños* (hereinafter referred to as the "2013 eastern *caño*").

27. In its Judgment of 16 December 2015, the Court found that sovereignty over the "disputed territory" belonged to Costa Rica and that consequently Nicaragua's activities, including the excavation of three *caños* and the establishment of a military presence in that territory, were in breach of Costa Rica's sovereignty. Nicaragua therefore incurred the obligation to make reparation for the damage caused by its unlawful activities (*I.C.J. Reports 2015 (II)*, p. 703, para. 93). The Court found that its declaration that Nicaragua had breached Costa Rica's territorial sovereignty provided adequate satisfaction for the non-material damage suffered. However, it held that Costa Rica was entitled to receive compensation for material damage caused by those breaches of obligations by Nicaragua that had been ascertained by the Court (*ibid.*, pp. 717-718, paras. 139 and 142). The present Judgment determines the amount of compensation due to Costa Rica.

28. The sketch-map below shows the approximate locations of the three *caños* in the northern part of Isla Portillos as excavated in 2010 and 2013.

II. Legal Principles Applicable to the Compensation Due to Costa Rica

29. Before turning to the consideration of the issue of compensation due in the present case, the Court will recall some of the principles relevant to its determination. It is a well-established principle of international law that "the breach of an engagement involves an obligation to make reparation in an adequate form" (*Factory at Chorzów, Jurisdiction, Judgment No. 8, 1927, P.C.I.J., Series A, No. 9*, p. 21). The Permanent Court elaborated on this point as follows:

> "The essential principle contained in the actual notion of an illegal act — a principle which seems to be established by international practice and in particular by the decisions of arbitral tribunals — is that reparation must, as far as possible, wipe out all the consequences of the illegal act and reestablish the situation which would, in all probability, have existed if that act had not been committed." (*Factory at Chorzów, Merits, Judgment No. 13, 1928, P.C.I.J., Series A, No. 17*, p. 47; see also *Avena and Other Mexican Nationals (Mexico* v. *United States of America), Judgment, I.C.J. Reports 2004 (I)*, p. 59, para. 119.)

30. The obligation to make full reparation for the damage caused by a wrongful act has been recognized by the Court in other cases (see for example, *Ahmadou Sadio Diallo (Republic of Guinea* v. *Democratic Republic of the Congo), Merits, Judgment, I.C.J. Reports 2010 (II)*, p. 691, para. 161; *Avena and Other Mexican Nationals (Mexico* v. *United States of America), Judgment, I.C.J. Reports 2004 (I)*, p. 59, para. 119; *Gabčíkovo-Nagymaros Project (Hungary/Slovakia), Judgment, I.C.J. Reports 1997*, p. 80, para. 150).

31. The Court has held that compensation may be an appropriate form of reparation, particularly in those cases where restitution is materially impossible or unduly burdensome (*Pulp Mills on the River Uruguay (Argentina* v. *Uruguay), Judgment, I.C.J. Reports 2010 (I)*, pp. 103-104, para. 273). Compensation should not, however, have a punitive or exemplary character.

32. In the present case, the Court has been asked to determine compensation for the damage caused by Nicaragua's unlawful activities, in accordance with its Judgment of 16 December 2015 (see paragraph 27 above). In order to award compensation, the Court will ascertain whether, and to what extent, each of the various heads of damage claimed by the Applicant can be established and whether they are the consequence of wrongful conduct by the Respondent, by determining "whether there is a sufficiently direct and certain causal nexus between the wrongful act . . . and the injury suffered by the Applicant". Finally, the Court will determine the amount of compensation due (*Ahmadou Sadio Diallo (Republic of Guinea* v. *Democratic Republic of the Congo), Compensation, Judgment, I.C.J. Reports 2012 (I)*, p. 332, para. 14).

33. The Court recalls that, "as a general rule, it is for the party which alleges a particular fact in support of its claims to prove the existence of that fact". Nevertheless, the Court has recognized that this general rule may be applied flexibly in certain circumstances, where, for example, the respondent may be in a better position to establish certain facts (*ibid.*, p. 332, para. 15, referring to the Judgment on the merits of 30 November 2010, *I.C.J. Reports 2010 (II)*, pp. 660-661, paras. 54-56).

34. In cases of alleged environmental damage, particular issues may arise with respect to the existence of damage and causation. The damage may be due to several concurrent causes, or the state of science regarding the causal link between the wrongful act and the damage may be uncertain. These are difficulties that must be addressed as and when they arise in light of the facts of the case at hand and the evidence presented to the Court. Ultimately, it is for the Court to decide whether there is a sufficient causal nexus between the wrongful act and the injury suffered.

35. In respect of the valuation of damage, the Court recalls that the absence of adequate evidence as to the extent of material damage will not, in all situations, preclude an award of compensation for that damage. For example, in the *Ahmadou Sadio Diallo* case, the Court determined the

amount of compensation due on the basis of equitable considerations (see *Ahmadou Sadio Diallo (Republic of Guinea* v. *Democratic Republic of the Congo), Compensation, Judgment, I.C.J. Reports 2012 (I)*, p. 337, para. 33). A similar approach was adopted by the Tribunal in the *Trail Smelter* case, which, quoting the Supreme Court of the United States of America in *Story Parchment Company* v. *Paterson Parchment Paper Company* (*United States Reports*, 1931, Vol. 282, p. 555), stated:

> "Where the tort itself is of such a nature as to preclude the ascertainment of the amount of damages with certainty, it would be a perversion of fundamental principles of justice to deny all relief to the injured person, and thereby relieve the wrongdoer from making any amend for his acts. In such case, while the damages may not be determined by mere speculation or guess, it will be enough if the evidence show the extent of the damages as a matter of just and reasonable inference, although the result be only approximate." (*Trail Smelter case (United States, Canada), 16 April 1938 and 11 March 1941*, United Nations, *Reports of International Arbitral Awards (RIAA)*, Vol. III, p. 1920.)

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36. In the present case, Costa Rica claims compensation for two categories of damage. First, Costa Rica claims compensation for quantifiable environmental damage caused by Nicaragua's excavation of the 2010 *caño* and the 2013 eastern *caño*. It makes no claim in respect of the 2013 western *caño*. Secondly, Costa Rica claims compensation for costs and expenses incurred as the result of Nicaragua's unlawful activities, including expenses incurred to monitor or remedy the environmental damage caused.

37. Nicaragua argues that Costa Rica is entitled to compensation for "material damages", the scope of which is limited to "damage to property or other interests of the State . . . which is assessable in financial terms". Nicaragua contends that the 2015 Judgment of the Court in this case further limits the scope *ratione materiae* and *ratione loci* of compensation to losses or expenses caused by the activities that the Court determined were unlawful.

38. The Court will address the Parties' submissions related to environmental damage in Section III. The Parties' submissions on costs and expenses incurred as a result of Nicaragua's activities are addressed in Section IV. The issue of interest is dealt with in Section V. The total sum awarded is stated in Section VI.

III. Compensation for Environmental Damage

1. The Compensability of Environmental Damage

39. Costa Rica argues that it is "settled" that environmental damage is compensable under international law. It notes that other international adjudicative bodies have awarded compensation for environmental damage, including for harm to environmental resources that have no commercial value. Costa Rica contends that its position is supported by the practice of the United Nations Compensation Commission ("UNCC"), which awarded compensation to several States for environmental damage caused by Iraq's illegal invasion and occupation of Kuwait in 1990 and 1991.

40. Nicaragua does not contest Costa Rica's contention that damage to the environment is compensable. In this connection, Nicaragua also refers to the approach adopted by the UNCC panels with respect to environmental claims arising from the first Gulf War. However, Nicaragua contends that, following that approach, Costa Rica is entitled to compensation for "restoration costs" and "replacement costs". According to Nicaragua, "restoration costs" comprise the costs that Costa Rica reasonably incurred in the construction of a dyke across the 2013 eastern *caño* while remediating the impact of Nicaragua's works. Nicaragua also recognizes that Costa Rica is entitled to "replacement costs" for the environmental goods and services that either have been or may be lost prior to the recovery of the impacted area.

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41. The Court has not previously adjudicated a claim for compensation for environmental damage. However, it is consistent with the principles of international law governing the consequences of internationally wrongful acts, including the principle of full reparation, to hold that compensation is due for damage caused to the environment, in and of itself, in addition to expenses incurred by an injured State as a consequence of such damage. The Parties also agree on this point.

42. The Court is therefore of the view that damage to the environment, and the consequent impairment or loss of the ability of the environment to provide goods and services, is compensable under international law. Such compensation may include indemnification for the impairment or loss of environmental goods and services in the period prior to recovery and payment for the restoration of the damaged environment.

43. Payment for restoration accounts for the fact that natural recovery may not always suffice to return an environment to the state in which it

was before the damage occurred. In such instances, active restoration measures may be required in order to return the environment to its prior condition, in so far as that is possible.

2. Methodology for the Valuation of Environmental Damage

44. Costa Rica accepts that there is no single method for the valuation of environmental damage and acknowledges that a variety of techniques have been used in practice at both the international and national level. It concludes that the appropriate method of valuation will depend, *inter alia*, on the nature, complexity, and homogeneity of the environmental damage sustained.

45. In the present case, the methodology that Costa Rica considers most appropriate, which it terms the "ecosystem services approach" (or "environmental services framework"), follows the recommendations of an expert report commissioned from Fundación Neotrópica, a Costa Rican non-governmental organization. Costa Rica claims that the valuation of environmental damage pursuant to an ecosystem services approach is well recognized internationally, up-to-date, and is also appropriate for the wetland protected under the Ramsar Convention that Nicaragua has harmed.

46. In Costa Rica's view, the ecosystem services approach finds support in international and domestic practice. First, Costa Rica notes that the "Guidelines for the Development of Domestic Legislation on Liability, Response Action and Compensation for Damage Caused by Activities Dangerous to the Environment" of the United Nations Environment Programme ("UNEP"), which were adopted by its Governing Council in 2010, recognize that environmental damage may be calculated on the basis of factors such as the "reduction or loss of the ability of the environment to provide goods and services". Secondly, Costa Rica highlights that Decision XII/14 of the Conference of the Parties to the Convention on Biological Diversity invites parties to take into account, as appropriate, the above-mentioned UNEP Guidelines. Furthermore, Decision XII/14 invites parties to take into account a "synthesis report" on technical information, which states that "[l]iability and redress rules might also address . . . the loss of [the ecosystem's] ability to provide actual or potential goods and services". Thirdly, Costa Rica notes that the ecosystem services methodology is employed by several States in the context of their domestic legislation on environmental damage. Finally, Costa Rica argues that the Report of the Ramsar Advisory Mission No. 69, which assessed environmental damage resulting from the excavation of the 2010 *caño*, adopted the ecosystem services approach.

47. Costa Rica explains that, according to the ecosystem services approach, the value of an environment is comprised of goods and services

that may or may not be traded on the market. Goods and services that are traded on the market (such as timber) have a "direct use value" whereas those that are not (such as flood prevention or gas regulation) have an "indirect use value". In Costa Rica's view, the valuation of environmental damage must take into account both the direct and indirect use values of environmental goods and services in order to provide an accurate reflection of the value of the environment. In order to ascribe a monetary value to the environmental goods and services that Nicaragua purportedly damaged, Costa Rica uses a value transfer approach for most of the goods and services affected. Under the value transfer approach, the damage caused is assigned a monetary value by reference to a value drawn from studies of ecosystems considered to have similar conditions to the ecosystem concerned. However, Costa Rica uses a direct valuation approach where the data for such valuation is available.

48. Costa Rica claims that the methodology adopted by Nicaragua is the same as that used by the UNCC in relation to environmental claims, which dealt with a subject-matter that was radically different to that of the present case. Costa Rica argues that valuation practices have evolved since the UNCC concluded claims processing in 2005, and that more recent methodologies, such as the ecosystem services approach, "recognize the full and potentially long lasting extent of harm to the environment".

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49. For its part, Nicaragua considers that Costa Rica is entitled to compensation "to replace the environmental services that either have been or may be lost prior to recovery of the impacted area", which it terms the "ecosystem service replacement cost" or "replacement costs". According to Nicaragua, the proper method for calculating this value is by reference to the price that would have to be paid to preserve an equivalent area until the services provided by the impacted area have recovered.

50. Nicaragua considers its methodology to be the standard approach to natural resource damage assessment. In particular, it notes that this was one of the methodologies followed by the UNCC when assessing claims for environmental damage. Nicaragua argues that there is no merit to Costa Rica's claim that this methodology has been displaced by more recent methods of valuation of environmental damage.

51. Nicaragua contends that the methodology that Costa Rica adopts is a "benefits transfer" approach, which seeks to value the damaged environmental services by reference to values assigned to such services in other places and in other contexts. In Nicaragua's view, such an approach is unreliable and has not been used widely in practice. Furthermore,

Nicaragua argues that the UNCC declined to accept the "benefits transfer" approach, even though it was asked to do so.

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52. The Court notes that the valuation methods proposed by the Parties are sometimes used for environmental damage valuation in the practice of national and international bodies, and are not therefore devoid of relevance to the task at hand. However, they are not the only methods used by such bodies for that purpose, nor is their use limited to valuation of damage since they may also be used to carry out cost/benefit analysis of environmental projects and programmes for the purpose of public policy setting (see for example UNEP, "Guidance Manual on Valuation and Accounting of Ecosystem Services for Small Island Developing States" (2014), p. 4). The Court will not therefore choose between them or use either of them exclusively for the purpose of valuation of the damage caused to the protected wetland in Costa Rica. Wherever certain elements of either method offer a reasonable basis for valuation, the Court will nonetheless take them into account. This approach is dictated by two factors: first, international law does not prescribe any specific method of valuation for the purposes of compensation for environmental damage; secondly, it is necessary, in the view of the Court, to take into account the specific circumstances and characteristics of each case.

53. In its analysis, the Court will be guided by the principles and rules set out in paragraphs 29 to 35 above. In determining the compensation due for environmental damage, the Court will assess, as outlined in paragraph 42, the value to be assigned to the restoration of the damaged environment as well as to the impairment or loss of environmental goods and services prior to recovery.

3. Determination of the Extent of the Damage Caused to the Environment and of the Amount of Compensation Due

54. The Court notes that, for both Costa Rica and Nicaragua, the size of the area affected by the unlawful activities of Nicaragua was 6.19 hectares.

55. Although Costa Rica identifies 22 categories of goods and services that could have been impaired or lost as a result of Nicaragua's wrongful actions, it claims compensation in respect of only six of them: standing timber; other raw materials (fibre and energy); gas regulation and air quality; natural hazards mitigation; soil formation and erosion control; and biodiversity, in terms of habitat and nursery.

56. Costa Rica claims that it is appropriate to calculate the total loss sustained as the result of Nicaragua's actions over a period of 50 years, which it considers to be a conservative estimate of the time required for the affected area to recover. Consequently, it provides a net present value for the total loss on the basis of a recovery period of 50 years with a discount rate of 4 per cent. According to Fundación Neotrópica, the discount rate is representative of the rate at which the ecosystem will recover. In its view, as the ecosystem goods and services recover, the yearly value of the environmental damage caused will gradually decrease.

57. Based on the above approach, Costa Rica claims, as compensation for the impairment or loss of environmental goods and services as a result of Nicaragua's activities, payment of US$2,148,820.82 in respect of the 2010 *caño* and US$674,290.92 in respect of the 2013 eastern *caño*. Costa Rica also claims US$57,634.08 for restoration costs, comprising US$54,925.69 for the cost of replacement soil in the 2010 *caño* and the 2013 eastern *caño* and US$2,708.39 for the restoration of the wetland. Costa Rica claims a total amount of compensation of US$2,880,745.82 for the environmental damage sustained as the result of Nicaragua's actions.

58. For its part, Nicaragua asserts, on the basis of its own method (see paragraph 49 above), that Costa Rica is entitled to replacement costs of US$309 per hectare per year, the figure which Costa Rica pays landowners and communities as an incentive to protect habitat under its domestic environmental conservation scheme (adjusted to 2017 prices). Over a reasonable period for full recovery, which it estimates to be 20 to 30 years, and taking into account a 4 per cent discount rate, Nicaragua concludes that the present value of the replacement costs amounts to between US$27,034 and US$34,987.

59. Nicaragua argues that even if, *quod non*, the ecosystem services approach proposed by Costa Rica was an appropriate method for quantifying environmental damage, Costa Rica implemented it incorrectly in ways that create a dramatic overvaluation of the impairment or loss of environmental goods and services as a result of the damage caused. In particular, Nicaragua claims that: Costa Rica wrongly assumes the presence of environmental services that were not provided by the area impacted by Nicaragua's activities; Costa Rica incorrectly values the gas regulation and air quality services provided by the area; and Costa Rica erroneously assumes that all goods and services will be impacted for 50 years.

60. Costa Rica claims, following the six categories of environmental goods and services that it contends have been lost, under a first head of

damage, compensation for trees that were felled in the construction of the 2010 *caño* and the 2013 eastern *caño*. The valuation it provides is based on the average price of standing timber for the species that were present in the 2010 *caño* (US$64.65 per cubic metre) and the 2013 eastern *caño* (US$40.05 per cubic metre), using figures taken from the Costa Rican National Forestry Office. Using these figures, Costa Rica values the eliminated stock and the growth potential of that stock over 50 years, assuming a volume of standing timber of 211 cubic metres per hectare, a harvest rate of 50 per cent per year, and a growth rate of 6 cubic metres per hectare per year. Fundación Neotrópica, whose figures Costa Rica adopts, explains that it does not assume, by referring to a harvest rate of 50 per cent per year, that it is possible to remove half of the annual growth of the trees each year. It maintains that it does this because the asset degradation caused by Nicaragua's unlawful activities will be reflected in Costa Rica's physical, natural, and economic accounts every year as a decrease in the monetary value of the country's natural assets until it has fully recovered.

61. Nicaragua contests Costa Rica's valuation of the trees felled in the excavation of the 2010 *caño* and the 2013 eastern *caño*. First, it claims that the only material damage caused by Nicaragua's activities was the felling of trees in the vicinity of the 2010 *caño*. It argues that the 2013 eastern *caño* has quickly revegetated and is now virtually indistinguishable from the surrounding areas. Secondly, Nicaragua contends that Costa Rica is mistaken in its calculation of the value of the felled trees over a period of 50 years, because trees can only be harvested once. Thirdly, Nicaragua claims that Costa Rica's figures do not demonstrate that it has accounted for the cost that would be required to harvest the timber and transport it to market, thus contravening accepted valuation methodology.

62. Costa Rica claims compensation, under a second head of damage, for "other raw materials" (namely, fibre and energy) that Nicaragua allegedly removed from the affected area in the course of its excavation works. The figures that Costa Rica adopts are based on studies that quantify the value of raw materials in other ecosystems (namely, in Mexico and the Philippines), from which a unit price is constructed (US$175.76 per hectare for the first year after the loss was caused, adjusted to 2016 prices). It uses this unit price to estimate the loss of raw materials in an area of 5.76 hectares (the area cleared during excavation of the 2010 *caño*) and 0.43 hectares (the area damaged in the construction of the 2013 eastern *caño*).

63. With regard to "other raw materials" (namely, fibre and energy), Nicaragua argues that, due to its rapid recovery, the area impacted by its activities has regained the ability to provide those goods and services.

In the alternative, Nicaragua contends that, even if Fundación Neotrópica had accurately assigned a unit value to other raw materials, it vastly inflated the valuation by assuming that the losses will extend for 50 years.

64. Thirdly, Costa Rica claims compensation for the impaired ability of the affected area to provide gas regulation and air quality services, such as carbon sequestration, which was allegedly caused by Nicaragua's unlawful activities. Costa Rica's estimate for the loss of this service is based on an academic study that values carbon stocks and flows in Costa Rican wetlands. Drawing on this study, Costa Rica estimates the loss of gas regulation and air quality services to amount to US$14,982.06 per hectare (for the first year after the loss was caused, adjusted to 2016 prices). Costa Rica argues that the fact that some of the gas regulation and air quality services impaired or lost may also have benefitted the citizens of other countries is irrelevant to Nicaragua's liability to provide compensation for the unlawful harm caused to Costa Rica on its own territory.

65. Nicaragua contests Costa Rica's valuation of the gas regulation and air quality services in several respects. First, Nicaragua argues that the benefits from gas regulation and air quality services are distributed across the entire world, and thus that Costa Rica is entitled only to a small share of the value of this service. Secondly, it criticizes the study upon which Costa Rica's figures are based, arguing that Costa Rica does not demonstrate why that study is relevant to the affected area and does not explain why it ignores studies that assign lower values to the services. Thirdly, Nicaragua notes that the figure used by Costa Rica is a stock value, which reflects the total value of all carbon sequestered in the vegetation, soil, leaf litter, and organic debris in one hectare. In Nicaragua's view, this carbon stock can only be released once into the atmosphere. Nicaragua argues that it is therefore incorrect for Costa Rica to calculate its loss on the basis of the value of carbon stock each year for 50 years.

66. Under the fourth head of damage, Costa Rica contends that freshwater wetlands, such as the affected area, are valuable assets to mitigate natural hazards, such as coastal flooding, saline intrusion and coastal erosion. In Costa Rica's view, the ability of the affected area to provide such services has been impaired by Nicaragua's actions. It argues that this conclusion is supported by the Report of the Ramsar Advisory Mission No. 69, which explains that changes in the pattern of freshwater flow in wetlands can impact both the salinity of the water and flood control capacity of the area. Costa Rica values this service at US$2,949.74 per hectare (for the first year after the loss was caused, adjusted to 2016 prices), based on the selection of a "low value" from a range of studies from Belize, Thailand and Mexico.

67. In Nicaragua's view, Costa Rica identifies no natural hazards that the affected area mitigated nor does it explain how Nicaragua's works impacted any natural hazard mitigation services provided. Furthermore, Nicaragua argues that Costa Rica's valuation is based entirely on a value transferred from a study that is irrelevant to the present case (namely, a study on the hazard mitigation services provided by coastal mangroves in Thailand).

68. Under the fifth head of damage, Costa Rica claims that the sediment that has refilled the 2010 *caño* and the 2013 eastern *caño* is both of a poorer quality and is more susceptible to erosion. It thus claims for the cost of replacement soil, which it values at US$5.78 per cubic metre.

69. Nicaragua argues that the 2010 *caño* and the 2013 eastern *caño* have refilled rapidly with sediment and are now covered with vegetation. In Nicaragua's view, Costa Rica has not presented any evidence that the new soil is of a poorer quality nor has it demonstrated that the soil is more vulnerable to erosion as a result of Nicaragua's actions. Moreover, it notes that Costa Rica has not presented any indication of its intention to carry out further restoration work on the two *caños*.

70. Finally, Costa Rica claims compensation for the loss of biodiversity services in the affected area, both in terms of habitat and nursery services. Costa Rica's valuation of biodiversity services is based on studies that quantify the value of biodiversity in other ecosystems (namely, in Mexico, Thailand and the Philippines), from which it constructs a unit price (US$855.13 per hectare for the first year after the loss was caused, adjusted to 2016 prices).

71. Nicaragua argues that, due to its rapid recovery, the affected area has regained the ability to provide biodiversity services. In the alternative, Nicaragua contends that, even if Fundación Neotrópica had accurately assigned a unit value to such services, it vastly inflated the valuation by assuming that the losses will extend for 50 years.

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72. Before assigning a monetary value to the damage to the environmental goods and services caused by Nicaragua's wrongful activities, the Court will determine the existence and extent of such damage, and whether there exists a direct and certain causal link between such damage and Nicaragua's activities. It will then establish the compensation due.

73. In this context, the Court notes that the Parties disagree on two issues: first, whether certain environmental goods and services have been impaired or lost, namely natural hazards mitigation and soil formation/erosion control; and secondly, the valuation of the environmental goods and services, which they consider have been impaired or lost, taking into account the length of the period necessary for their recovery.

74. In relation to the first of these issues, the Court is of the view that Costa Rica has not demonstrated that the affected area, due to a change in its ecological character, has lost its ability to mitigate natural hazards or that such services have been impaired. As regards soil formation and erosion control, Nicaragua does not dispute that it removed approximately 9,500 cubic metres of soil from the sites of the 2010 *caño* and the 2013 eastern *caño*. However, the evidence before the Court establishes that both *caños* have subsequently refilled with soil and there has been substantial revegetation. Accordingly, Costa Rica's claim for the cost of replacing all of the soil removed by Nicaragua cannot be accepted. There is some evidence that the soil which was removed by Nicaragua was of a higher quality than that which has now refilled the two *caños* but Costa Rica has not established that this difference has affected erosion control and the evidence before the Court regarding the quality of the two types of soil is not sufficient to enable the Court to determine any loss which Costa Rica might have suffered.

75. Concerning the four other categories of environmental goods and services for which Costa Rica claims compensation (namely, trees, other raw materials, gas regulation and air quality services, and biodiversity), the evidence before the Court indicates that, in excavating the 2010 *caño* and the 2013 eastern *caño*, Nicaragua removed close to 300 trees and cleared 6.19 hectares of vegetation. These activities have significantly affected the ability of the two impacted sites to provide the above-mentioned environmental goods and services. It is therefore the view of the Court that impairment or loss of these four categories of environmental goods and services has occurred and is a direct consequence of Nicaragua's activities.

76. With regard to the second issue, relating to the valuation of the damage caused to environmental goods and services, the Court cannot accept the valuations proposed by the Parties. In respect of the valuation proposed by Costa Rica, the Court has doubts regarding the reliability of certain aspects of its methodology, particularly in light of the criticism raised by Nicaragua and its experts in the written pleadings. Costa Rica assumes, for instance, that a 50-year period represents the time necessary for recovery of the ecosystem to the state prior to the damage caused. However, in the first instance, there is no clear evidence before the Court of the baseline condition of the totality of the environmental goods and services that existed in the area concerned prior to Nicaragua's activities. Secondly, the Court observes that different components of the ecosystem

require different periods of recovery and that it would be incorrect to assign a single recovery time to the various categories of goods and services identified by Costa Rica.

77. In the view of the Court, Nicaragua's valuation of US$309 per hectare per year must also be rejected. This valuation is based on the amount of money that Costa Rica pays landowners and communities as an incentive to protect habitat under its domestic environmental conservation scheme. Compensation for environmental damage in an internationally protected wetland, however, cannot be based on the general incentives paid to particular individuals or groups to manage a habitat. The prices paid under a scheme such as that employed by Costa Rica are designed to offset the opportunity cost of preserving the environment for those individuals and groups, and are not necessarily appropriate to reflect the value of the goods and services provided by the ecosystem. Accordingly, the Court is of the view that Nicaragua's proposed valuation does not provide an adequate reflection of the value of the environmental goods and services impaired or lost in the affected area.

78. The Court considers, for the reasons specified below, that it is appropriate to approach the valuation of environmental damage from the perspective of the ecosystem as a whole, by adopting an overall assessment of the impairment or loss of environmental goods and services prior to recovery, rather than attributing values to specific categories of environmental goods and services and estimating recovery periods for each of them.

79. First, the Court observes, in relation to the environmental goods and services that have been impaired or lost, that the most significant damage to the area, from which other harms to the environment arise, is the removal of trees by Nicaragua during the excavation of the *caños*. An overall valuation can account for the correlation between the removal of the trees and the harm caused to other environmental goods and services (such as other raw materials, gas regulation and air quality services, and biodiversity in terms of habitat and nursery).

80. Secondly, an overall valuation approach is dictated by the specific characteristics of the area affected by the activities of Nicaragua, which is situated in the Northeast Caribbean Wetland, a wetland protected under the Ramsar Convention, where there are various environmental goods and services that are closely interlinked. Wetlands are among the most diverse and productive ecosystems in the world. The interaction of the physical, biological and chemical components of a wetland enable it to perform many vital functions, including supporting rich biological diversity, regulating water régimes, and acting as a sink for sediments and pollutants.

81. Thirdly, such an overall valuation will allow the Court to take into account the capacity of the damaged area for natural regeneration. As stated by the Secretariat of the Ramsar Convention, the area in the vicinity of the 2010 *caño* demonstrates a "high capability for natural regeneration of the vegetation . . . provided the physical conditions of the area are maintained".

82. These considerations also lead the Court to conclude, with regard to the length of the period of recovery, that a single recovery period cannot be established for all of the affected environmental goods and services. Despite the close relationship between these goods and services, the period of time for their return to the pre-damage condition necessarily varies.

83. In its overall valuation, the Court will take into account the four categories of environmental goods and services the impairment or loss of which has been established (see paragraph 75).

84. The Court recalls that, in addition to the two valuations considered above, respectively submitted by Costa Rica and Nicaragua, Nicaragua also provides an alternative valuation of damage, calculated on the basis of the four categories of environmental goods and services. This valuation adopts Costa Rica's ecosystems services approach but makes significant adjustments to it. Nicaragua refers to this valuation as a "corrected analysis" and assigns a total monetary value of US$84,296 to the damage caused to the four categories of environmental goods and services.

85. The Court considers that Nicaragua's "corrected analysis" underestimates the value to be assigned to certain categories of goods and services prior to recovery. First, for other raw materials (fibre and energy), the "corrected analysis" assigns a value that is based on the assumption that there will be no loss in those goods and services after the first year. Such an assumption is not supported by any evidence before the Court. Secondly, with respect to biodiversity services (in terms of nursery and habitat), the "corrected analysis" does not sufficiently account for the particular importance of such services in an internationally protected wetland where the biodiversity was described to be of high value by the Secretariat of the Ramsar Convention. Whatever regrowth may occur naturally is unlikely to match in the near future the pre-existing richness of biodiversity in the area. Thirdly, in relation to gas regulation and air quality services, Nicaragua's "corrected analysis" does not account for the loss of future annual carbon sequestration ("carbon flows"), since it characterizes the loss of those services as a one-time loss. The Court does not consider that the impairment or loss of gas regulation and air quality services can be valued as a one-time loss.

86. The Court recalls, as outlined in paragraph 35 above, that the absence of certainty as to the extent of damage does not necessarily pre-

clude it from awarding an amount that it considers approximately to reflect the value of the impairment or loss of environmental goods and services. In this case, the Court, while retaining some of the elements of the "corrected analysis", considers it reasonable that, for the purposes of its overall valuation, an adjustment be made to the total amount in the "corrected analysis" to account for the shortcomings identified in the preceding paragraph. The Court therefore awards to Costa Rica the sum of US$120,000 for the impairment or loss of the environmental goods and services of the impacted area in the period prior to recovery.

87. In relation to restoration, the Court rejects Costa Rica's claim of US$54,925.69 for replacement soil for the reasons given in paragraph 74. The Court, however, considers that the payment of compensation for restoration measures in respect of the wetland is justified in view of the damage caused by Nicaragua's activities. Costa Rica claims compensation in the sum of US$2,708.39 for this purpose. The Court upholds this claim.

IV. Compensation Claimed by Costa Rica for Costs and Expenses

88. In addition to its claims of compensation for environmental damage, Costa Rica requested that the Court award it compensation for costs and expenses incurred as a result of Nicaragua's unlawful activities.

89. On the basis of the principles described above (see paragraphs 29 to 35), the Court must determine whether the costs and expenses allegedly incurred by Costa Rica are supported by the evidence, and whether Costa Rica has established a sufficiently direct and certain causal nexus between the internationally wrongful conduct of Nicaragua identified by the Court in its 2015 Judgment and the heads of expenses for which Costa Rica seeks compensation.

1. Costs and Expenses Incurred in relation to Nicaragua's Unlawful Activities in the Northern Part of Isla Portillos between October 2010 and April 2011

90. Costa Rica alleges that between October 2010 (when it became aware of Nicaragua's military presence on its territory) and April 2011 (when Nicaragua's military withdrew from Costa Rica's territory following the Court's 2011 Order on provisional measures), it has incurred a range of expenses in relation to Nicaragua's presence and unlawful activities, in the total amount of US$80,926.45. Costa Rica provides the following breakdown of these expenses: *(a)* cost of fuel and maintenance services for police aircraft used to reach and to overfly the "disputed ter-

ritory" (US$37,585.60); *(b)* salaries of Air Surveillance Service personnel required to attend access flights and overflights of the "disputed territory" (US$1,044.66); *(c)* purchase of satellite images to verify Nicaragua's presence and unlawful activities in the "disputed territory" (US$17,600); *(d)* cost of obtaining a report from the United Nations Institute for Training and Research/United Nations Operational Satellite Applications Programme (UNITAR/UNOSAT) to verify Nicaragua's unlawful activities in the "disputed territory" (US$15,804); *(e)* salaries of National Coast Guard Service personnel required to provide water transportation to the area near the "disputed territory" (US$6,780.60); *(f)* salaries of Tortuguero Conservation Area (ACTo) personnel required to attend missions in or near the "disputed territory" (US$1,309.90); *(g)* food and water supplies for ACTo personnel required to attend environmental monitoring missions in or near the "disputed territory" (US$446.12); *(h)* fuel for fluvial transportation for ACTo personnel required to attend missions in or near the "disputed territory" (US$92); and *(i)* fuel for land transportation for ACTo personnel required to attend missions in or near the "disputed territory" (US$263.57).

91. Nicaragua asserts that Costa Rica's claims for expenses allegedly incurred in connection with its police deployment are not compensable. Indeed, in its view, Costa Rican security forces were not employed to prevent or remedy any of the material damage caused by Nicaragua between October 2010 and January 2011. Nicaragua is also of the opinion that the flights allegedly carried out by Costa Rica were not related to its monitoring activities in the "disputed territory", nor were they substantiated by documentation. Nicaragua further argues that the salaries of Air Surveillance Service personnel, National Coast Guard Service personnel and ACTo personnel are not compensable as these staff were already employed as government officials. Finally, Nicaragua argues that the claims for satellite imagery and reports are "non-compensable litigation expenses" since they were largely commissioned by Costa Rica in connection with the presentation of its case on the merits. Moreover, Nicaragua asserts that they cover not only the "disputed territory" but also other areas.

* *

92. The Court now turns to its assessment of the compensation due for costs and expenses incurred by Costa Rica as a consequence of Nicaragua's presence and unlawful activities in the northern part of Isla Portillos between October 2010 and April 2011. Upon examination of all the relevant evidence and documents, the Court considers that Costa Rica has, with reference to two heads of expenses relating to the cost of fuel and maintenance services and the cost of obtaining a UNITAR/UNOSAT report, provided adequate evidence demonstrating that some of these costs have a sufficiently direct and certain causal nexus with the internationally wrongful conduct of Nicaragua identified by the Court in its 2015 Judgment.

93. With regard to the first head of expenses relating to fuel and maintenance services for police aircraft used to reach and overfly the northern part of Isla Portillos, the Court finds part of these expenses compensable. It appears from the evidence submitted to the Court that the Costa Rican Air Surveillance Service carried out several overflights of the relevant area in the period in question. The Court is satisfied that some of these flights were undertaken in order to ensure effective inspection of the northern part of Isla Portillos, and thus considers that these ancillary costs are directly connected to the monitoring of that area that was made necessary as a result of Nicaragua's wrongful conduct.

94. Turning to the quantification of the amount of compensation with respect to that first head of expenses, the Court notes that Costa Rica claims US$37,585.60 "for fuel and maintenance services for the police aircraft used" to reach and to overfly the "disputed territory" on 20, 22, 27 and 31 October 2010 and on 1 and 26 November 2010.

95. Costa Rica has presented evidence in the form of relevant flight logs, and an official communication dated 2 March 2016 (from the Administrative Office of the Air Surveillance Service of the Department of Air Operations of the Ministry of Public Security) with regard to the cost of overflights performed by the Air Surveillance Service on, *inter alia*, 20, 22, 27 and 31 October 2010 (US$31,740.60), as well as on 1 and 26 November 2010 (US$5,845), totalling US$37,585.60. The Court notes that Costa Rica calculated these expenses on the basis of the operating costs for the hourly use of each aircraft deployed; these operating costs included expenses for "fuel", "overhaul", "insurance" and "miscellaneous". With regard to the "insurance" costs, the Court considers that Costa Rica has failed to demonstrate that it incurred any additional expense as a result of the specific missions of the police aircraft over the northern part of Isla Portillos. This insurance expense is thus not compensable. As to the "miscellaneous" costs, Costa Rica has failed to specify the nature of this expense. Thus, the evidence before the Court is not sufficient to show that this expense relates to the operating costs of the aircraft used. Moreover, the Court observes that Costa Rica itself has specified in its Memorial on compensation that it claimed expenses only

for fuel and maintenance services. The Court therefore considers that these miscellaneous expenses are not compensable.

96. The Court also excludes the cost of flights to transport cargo or members of the press, the cost of flights with a destination other than the northern part of Isla Portillos, as well as the cost of flights for which, in the relevant flight logs, no indication of the persons on board has been given. Costa Rica has failed to demonstrate why these missions were necessary to respond to Nicaragua's unlawful activities and has therefore not established the requisite causal nexus between Nicaragua's unlawful activities and the expenses relating to these flights. In addition, the Court has corrected a mistake in Costa Rica's calculations for October 2010 in the list attached to the above-mentioned communication of 2 March 2016 concerning the duration of a flight on 22 October 2010. The compensation claim was calculated by Costa Rica on the basis of the duration of the flight indicated as 11.6 hours (aircraft registration number MSP018, Soloy), while the flight log indicates an actual duration of 4.6 hours.

97. The Court considers it necessary to recalculate the compensable expenses based on the information provided in the above official communication of 2 March 2016 and in the flight logs, by reference to the number and duration of the flights actually conducted in October and November 2010 in connection with the inspection of the northern part of Isla Portillos, and only taking into account the costs of "fuel" and "overhaul". The Court therefore finds that, under this head of expenses, Costa Rica is entitled to compensation in the amount of US$4,177.30 for October 2010, and US$1,665.90 for November 2010, totalling US$5,843.20.

98. The second head of expenses that the Court finds compensable relates to Costa Rica's claim for the cost of obtaining a report from UNITAR/UNOSAT dated 4 January 2011. The evidence shows that Costa Rica incurred this expense in order to detect and assess the environmental impact of Nicaragua's presence and unlawful activities in Costa Rican territory. The Court has reviewed this UNITAR/UNOSAT report (entitled "Morphological and Environmental Change Assessment: San Juan River Area (including Isla Portillos and Calero), Costa Rica") and is satisfied that the analysis given in this report provides a technical evaluation of the damage that has occurred as a consequence of Nicaragua's unlawful activities in the northern part of Isla Portillos. In particular, the report states that, based on high-resolution satellite imagery acquired on 8 August 2010, there are "strong signature indicators of recent tree cover removal", with "hundreds of fallen or cut trees [being] visible". According to the report, it is likely that the removal of this tree cover occurred "during the period of May-August 2010". The report also states that, "[b]ased on an analysis of satellite imagery recorded on 19 November and 14 December 2010, there is strong evidence to suggest that a new river

channel leading from the San Juan River to the Los Portillos Lagoon was constructed between August and November 2010".

99. Turning to the quantification of the amount of compensation, the Court notes that Costa Rica has presented evidence in the form of a numbered and dated invoice from UNITAR/UNOSAT, with an annexed cost breakdown, where reference is made to "Satellite-based assessment of environmental and geomorphological changes in Costa Rica". The invoice for this report totals US$15,804. In light of the Court's finding that the analysis contained in the UNITAR/UNOSAT report is directly relevant to Nicaragua's unlawful activities, the Court considers that there is a sufficiently direct and certain causal nexus between those activities and the cost of commissioning the report. The Court therefore finds that Costa Rica is entitled to full compensation in the sum of US$15,804.

100. The Court now turns to those heads of expenses with reference to which it considers that Costa Rica has failed to meet its burden of proof.

101. The Court notes that three heads of expenses (incurred between October 2010 and April 2011) for which Costa Rica seeks compensation relate to salaries of Costa Rican personnel allegedly involved in monitoring activities in the northern part of Isla Portillos, namely, the salaries of personnel employed with the Air Surveillance Service, the National Coast Guard Service and ACTo. The total amount claimed by Costa Rica for this category of expense is US$9,135.16. In this regard, the Court considers that salaries of government officials dealing with a situation resulting from an internationally wrongful act are compensable only if they are temporary and extraordinary in nature. In other words, a State is not, in general, entitled to compensation for the regular salaries of its officials. It may, however, be entitled to compensation for salaries in certain cases, for example, where it has been obliged to pay its officials over the regular wage or where it has had to hire supplementary personnel, whose wages were not originally envisaged in its budget. This approach is in line with international practice (see UNCC, Report and Recommendations made by the Panel of Commissioners concerning the First Instalment of "F2" Claims, United Nations doc. S/AC.26/1999/23, 9 December 1999, para. 101; UNCC, Report and Recommendations made by the Panel of Commissioners concerning the Second Instalment of "F2" Claims, United Nations doc. S/AC.26/2000/26, 7 December 2000, paras. 52-58; see also *M/V "SAIGA" (No. 2) (Saint Vincent and the Grenadines* v. *Guinea), Judgment, ITLOS Reports 1999*, p. 67, para. 177).

102. The Court observes that, in the present proceedings, Costa Rica has not produced evidence that, between October 2010 and April 2011, it incurred any extraordinary expenses in terms of the payment of salaries

of government officials. There is some indication in the evidence adduced that Costa Rican government officials were assigned functions and duties in connection with Costa Rica's response to Nicaragua's wrongful conduct. For example, Annex 7 to the Memorial includes a document from the Department of Salaries and Wages of the National Coast Guard Service, entitled "Report on working hours by personnel . . . in missions that took place on [the] occasion of Nicaragua's occupation of Costa Rican territory — 21 October 2010 to 19 January 2015". There is no evidence, however, that any of these functions and duties were carried out by personnel other than regular government officials. The Court therefore finds that Costa Rica is not entitled to compensation for the salaries of personnel employed by the Air Surveillance Service, the National Coast Guard Service and ACTo.

103. The Court further observes that three other heads of expenses are closely related to the functions of those personnel employed by ACTo (to conduct environmental monitoring missions in or near the northern part of Isla Portillos), for which Costa Rica claims costs totalling US$801.69 incurred in connection with food and water supplies (US$446.12), fuel for fluvial transportation (US$92) and fuel for land transportation (US$263.57). As evidence of the costs incurred under these heads of expenses, Costa Rica refers to Annex 6 to its Memorial. This annex is comprised of a letter (with attachment) dated 6 January 2016 from the National System of Conservation Areas (Tortuguero Conservation Area Natural Resource Management) of the Costa Rican Ministry of the Environment and Energy, and addressed to the Ministry of Foreign Affairs of Costa Rica. It is stated in the letter that the purpose of the communication is "the formal transmittal of two binders containing printed information" including "copies of logs, reports, among other documents, which provide evidence of the participation of government officials and ACTo teams in addressing the problems arising from the Nicaraguan invasion of Isla Calero". However, Annex 6 to the Memorial does not contain any such "logs" or "reports"; it only contains two tables which, for evidentiary purposes, are difficult to follow. The Court notes that, in terms of entries for costs related to land transportation, and to food and water, no specific information is provided to show in what way these expenses were connected to Costa Rica's monitoring activities undertaken as a direct consequence of Nicaragua's unlawful activities in the northern part of Isla Portillos in the period between October 2010 and April 2011. Moreover, these tables do not provide any information whatsoever regarding costs incurred in connection with fluvial transportation.

104. In light of the above, the Court considers that Costa Rica has failed to provide sufficient evidence to support its claims for the expenses under these three heads.

105. The Court finally turns to Costa Rica's claim that it be compensated in the amount of US$17,600 for the cost of purchasing two satellite images, which, in its view, were necessary in order to verify Nicaragua's presence and unlawful activities in the northern part of Isla Portillos. The Court considers that, to the extent that such images did provide information as to Nicaragua's conduct in the northern part of Isla Portillos, this head of expenses could be compensable on the ground that there was a sufficiently direct and certain causal nexus between Nicaragua's unlawful activities and the cost thus incurred. However, having reviewed the evidence adduced by Costa Rica in support of this claim — in the form of two invoices dated 1 and 10 December 2010 (invoice Nos. 106 and 108), respectively, from INGEO innovaciones geográficas S.A. — the Court notes that neither of these invoices provides any indication as to the area covered by the two satellite images. It follows that the Court cannot conclude, on the basis of these documents, that these images related to the northern part of Isla Portillos, and that they were used for the verification of Nicaragua's presence and unlawful activities in that area. The Court therefore finds that Costa Rica has not provided sufficient evidence in support of its claim for compensation under this head of expenses.

106. In conclusion, the Court finds that Costa Rica is entitled to compensation in the amount of US$21,647.20 for the expenses it incurred in relation to Nicaragua's presence and unlawful activities in the northern part of Isla Portillos between October 2010 and April 2011. This figure is made up of US$5,843.20 for the cost of fuel and maintenance services for police aircraft used to reach and to overfly the northern part of Isla Portillos, and US$15,804 for the cost of obtaining a report from UNITAR/UNOSAT to verify Nicaragua's unlawful activities in that area.

2. Costs and Expenses Incurred in Monitoring the Northern Part of Isla Portillos following the Withdrawal of Nicaragua's Military Personnel and in Implementing the Court's 2011 and 2013 Orders on Provisional Measures

107. Costa Rica recalls that the Court, in its 2011 Order, stated that

> "in order to prevent the development of criminal activity in the disputed territory in the absence of any police or security forces of either Party, each Party has the responsibility to monitor [the disputed] territory from the territory over which it unquestionably holds sovereignty" (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua), Provisional Measures, Order of 8 March 2011, I.C.J. Reports 2011 (I)*, p. 25, para. 78).

Costa Rica adds that the Court, in operative paragraph 59, subparagraph (1) of its 2013 Order, reaffirmed the measures indicated in its 2011 Order. Costa Rica states that, in fulfilment of its obligations under the Court's 2011 and 2013 Orders, it incurred expenses in monitoring the "disputed territory" following the withdrawal of Nicaragua's military personnel, so as to avoid irreparable prejudice being caused to the protected wetland. These expenses related, *inter alia*, to visits and overflights of the "disputed territory"; establishment and staffing of new police posts in close proximity to the area; transportation; instruments, tools, materials and supplies; salaries of monitoring personnel; food and water supplies; and the purchase of satellite images and a report from UNITAR/UNOSAT. According to Costa Rica, the total amount of these expenses is US$3,551,433.67.

108. Costa Rica gives the following individual breakdown of the expenses it has incurred as a result of Nicaragua's unlawful activities: *(a)* cost of fuel and maintenance services of police aircraft and salaries of Air Surveillance Service personnel for the inspection carried out in co-ordination with the Secretariat of the Ramsar Convention on 5 and 6 April 2011 (US$21,128.55); *(b)* cost of equipment and repairs to equipment for the two new police posts established at Laguna de Agua Dulce and Isla Portillos (US$24,065.87); *(c)* staffing of police posts in Laguna de Agua Dulce and Isla Portillos (US$3,092,834.17); *(d)* cost of fluvial transportation provided by the National Coast Guard Service to the Public Force personnel and the Border Police (US$22,678.80); *(e)* cost of four all-terrain vehicles (ATVs) for the police posts in Laguna de Agua Dulce and Isla Portillos (US$81,208.40); *(f)* cost of a tractor for the equipment and maintenance of the biological station at Laguna Los Portillos to allow monitoring of the environment of the "disputed territory" (US$35,500); *(g)* salaries of ACTo personnel taking part in monitoring activities in different site visits (US$25,161.41); *(h)* cost of food and water supplies for ACTo personnel (US$8,412.55); *(i)* cost of fuel for transportation of ACTo personnel (US$3,213.04); *(j)* acquisition price of two ATVs and three cargo trailers, dedicated to the biological station (US$42,752.76); *(k)* cost of fuel for transportation of personnel and supplies to the biological station (US$6,435.12); *(l)* purchase of satellite images of the "disputed territory" (US$160,704); and *(m)* cost of obtaining a report from UNITAR/UNOSAT to assess damage caused in the "disputed territory" as a consequence of Nicaragua's unlawful activities (US$27,339).

109. Nicaragua contends that nearly all of Costa Rica's "purported 'monitoring' expenses" (US$3,092,834.17) are salaries of Costa Rican

security personnel deployed between March 2011 and December 2015 to police newly constructed posts in order to "protect against the imagined threat of Nicaragua reoccupying the disputed area and, especially, occupying other parts of Costa Rica". As such, it maintains, they are unrelated to the material damage caused by Nicaragua's works in the "disputed territory" and are thus "inappropriate claims" for compensation. Nicaragua argues that even if the salaries of the Costa Rican police were, in principle, compensable, a State is only entitled to compensation for extraordinary expenses, such as costs of hiring new personnel or the payment of overtime. According to Nicaragua, Costa Rica, however, simply redeployed existing personnel from elsewhere. Moreover, Nicaragua contends that Costa Rica's compensation claim for the wages it paid to its security personnel is not substantiated by appropriate evidence.

110. Nicaragua asserts that Costa Rica's claims for expenses it allegedly incurred in connection with its police deployment — such as the wages paid to personnel who provided fluvial transport for the police deployment and the purchase of various items of equipment — are not compensable because the deployment of Costa Rican security forces was not to prevent or remedy any of the material damage caused by Nicaragua between October 2010 and January 2011 and in September 2013. Furthermore, according to Nicaragua, none of these expenses were extraordinary, nor were they supported by evidence.

111. Nicaragua maintains that claims for compensation for satellite images taken between September 2011 and September 2015 and for reports prepared by UNITAR/UNOSAT are "non-compensable litigation expenses" since they were largely commissioned by Costa Rica in connection with the presentation of its case on the merits. Moreover, Nicaragua asserts that they cover not only the "disputed territory" but also other areas.

* *

112. With regard to compensation for monitoring activities claimed to have been carried out in implementation of the Court's 2011 and 2013 Orders, the Court considers that Costa Rica has, with reference to three heads of expenses, provided adequate evidence demonstrating that some of these expenses have a sufficiently direct and certain causal nexus with the internationally wrongful conduct of Nicaragua identified by the Court in its 2015 Judgment.

113. First, the Court finds partially compensable Costa Rica's expenses for its two-day inspection of the northern part of Isla Portillos on 5 and 6 April 2011, both in co-ordination and together with the Secretariat of

the Ramsar Convention. This mission was carried out by Costa Rican technical experts accompanied by the technical experts of the Secretariat for the purposes of making an assessment of the environmental situation in the area and of identifying actions to prevent further irreparable damage in that part of the wetland as a consequence of Nicaragua's unlawful activities. In particular, according to the technical report produced by the officials of the Secretariat of the Ramsar Convention,

> "[t]he main aims of the visit to the site were the identification and technical evaluation of the environmental situation of the study area to determine the consequences of the works carried out, the impact chains initiated, their implications and the preventive, corrective, mitigating or compensatory environmental measures that would need to be implemented to restore the natural environmental balance of the site to avoid new, irreparable changes to the wetland".

In the view of the Court, the inspection carried out by Costa Rica on 5 and 6 April 2011 was therefore directly connected to the monitoring of the northern part of Isla Portillos that was made necessary as a result of Nicaragua's wrongful conduct.

114. Turning to the quantification of the amount of compensation, the Court notes that Costa Rica claims US$20,110.84 "for fuel and maintenance services on the police aircrafts used" and US$1,017.71 "for the salaries of air surveillance service personnel".

115. As evidence, Costa Rica has presented relevant flight logs and an official communication dated 2 March 2016 from the Administrative Office of the Air Surveillance Service of the Department of Air Operations of the Ministry of Public Security (as already referred to above in paragraph 95) which includes details of the cost of overflights performed by the Air Surveillance Service on 5 and 6 April 2011 totalling US$20,110.84. The Court observes that there are shortcomings similar to those it identified earlier in paragraphs 95 and 96 when it reviewed Costa Rica's evidentiary approach in establishing the cost of fuel and maintenance services for police aircraft. In particular, regarding the expenses linked to its monitoring activities for the period now under review, the Court notes that Costa Rica calculated these expenses on the basis of the operating costs for the hourly use of each aircraft deployed; these operating costs included expenses for "fuel", "overhaul", "insurance" and "miscellaneous". As already noted above (see paragraph 95), the Court considers that such insurance cannot be a compensable expense. As to the "miscellaneous" costs, Costa Rica has failed to specify the nature of this expense. Moreover, the Court observes that Costa Rica itself has specified in its Memorial on compensation that it claimed expenses only for fuel and maintenance services. The Court therefore

considers that this head of expenses is not compensable. The Court also excludes the cost of flights to transport members of the press, for the same reasons given in paragraph 96 above.

116. The Court considers it necessary to evaluate the compensable expenses based on the information provided in the above official communication of 2 March 2016, and in the flight logs, by reference to the number and duration of the flights conducted on 5 and 6 April 2011 in connection with the inspection of the northern part of Isla Portillos, and only taking into account the costs of "fuel" and "overhaul". The Court therefore finds that, under this head of expenses, Costa Rica is entitled to compensation in the amount of US$3,897.40.

117. The Court notes that Costa Rica has also advanced a claim of US$1,017.71 for salaries of Air Surveillance Service personnel involved in aircraft missions. The Court does not however find that Costa Rica is entitled to claim the cost of salaries for the April 2011 inspection mission. As already noted above (see paragraph 101), a State cannot recover salaries for government officials that it would have paid regardless of any unlawful activity committed on its territory by another State.

118. Secondly, the Court finds partially compensable Costa Rica's claim for the purchase, in the period running from September 2011 to October 2015, of satellite images effectively to monitor and verify the impact of Nicaragua's unlawful activities. To the extent that these satellite images cover the northern part of Isla Portillos, the Court considers that there is a sufficiently direct and certain causal nexus between the internationally wrongful conduct of Nicaragua identified by the Court in its Judgment on the merits and the head of expenses for which Costa Rica seeks compensation.

119. Turning to the quantification of the amount of compensation, the Court notes that Costa Rica has presented evidence in the form of numbered and dated invoices and delivery reports corresponding to the purchase of satellite images from INGEO innovaciones geográficas S.A. and from GeoSolutions Consulting, Inc. S.A. Under this head of expenses, Costa Rica claims a total of US$160,704. Having carefully reviewed these invoices and delivery reports, the Court notes that, by reference to the area covered by the satellite images, these invoices can be divided into three sets. The first set relates to the satellite images that cover the northern part of Isla Portillos (see invoice Nos. 204, 205, 215, 216, 218, 219, 224, 62, 65, 70, 73 and 86); the second set relates to the satellite images that cover the general area of the northern border with Nicaragua (see invoice Nos. 172, 174, 179, 188, 189, 191 and 90); and the third set provides no indication of the area covered by the satellite images (invoice Nos. 144, 150, 157, 163, 164, 169 and 171).

120. The Court considers that, as the satellite images contained in the first and second sets of invoices all cover the northern part of Isla Portillos, their purchase is, in principle, compensable. However, the Court notes that most of these satellite images cover an area that extends beyond the northern part of Isla Portillos, often covering an area of around 200 square kilometres. Moreover, these images are charged by unit price per square kilometre, mostly at the rate of US$28. The Court finds that it would not be reasonable to award compensation to Costa Rica for these images in full. Given the size of the northern part of Isla Portillos, the Court is of the view that a coverage area of 30 square kilometres was sufficient for Costa Rica effectively to monitor and verify Nicaragua's unlawful activities. The Court therefore awards Costa Rica, for each of the invoices in the first and second sets, compensation for one satellite image covering an area of 30 square kilometres at a unit price of US$28 per square kilometre.

121. With regard to the third set of invoices, the Court considers that Costa Rica has not established the necessary causal nexus between Nicaragua's unlawful activities and the purchase of the satellite images in question.

122. Consequently, the Court finds that Costa Rica is entitled to compensation in the amount of US$15,960 for the expenses incurred in purchasing the satellite images corresponding to the first and second sets of invoices, within the limits specified in paragraph 120.

123. Thirdly, the Court finds partially compensable Costa Rica's claim for the cost of obtaining a report from UNITAR/UNOSAT dated 8 November 2011. Costa Rica incurred this expense in order to detect and assess the environmental impact of Nicaragua's presence and unlawful activities in Costa Rican territory. The Court has reviewed this UNITAR/UNOSAT report and observes that the analysis given in Section 1 (entitled "Review of dredging activities at divergence of Río San Juan and Río Colorado (maps 2-3)") and in Section 3 (entitled "Review of meander cut sites (maps 5-6)") does not have any bearing on Costa Rica's efforts to detect and assess the environmental damage caused in its territory by Nicaragua. It notes, however, that the analysis given in Section 2, entitled "Updated status of the new channel along [the] Río San Juan (map 4)", provides a technical evaluation of the damage that occurred as a consequence of Nicaragua's unlawful activities in the northern part of Isla Portillos. The Court concludes that Costa Rica has proven that there exists a sufficiently direct and certain causal nexus between the internationally wrongful conduct of Nicaragua identified by the Court in its Judgment on the merits and the purchase of the UNITAR/UNOSAT report.

124. Turning to the quantification of the amount of compensation, the Court notes that Costa Rica has presented evidence in the form of a numbered and dated invoice from UNITAR/UNOSAT, with an annexed cost breakdown, where reference is made to "Satellite-based assessment of environmental and geomorphological changes in Costa Rica". The invoice for this report, which includes the cost of analysis, satellite imagery, procurement processing of imagery, operating expenses and programme support costs, totals US$27,339. In light of the fact that only the content of Section 2 of the UNITAR/UNOSAT report is directly relevant, and given that the three sections of the report are separable (in the sense that each section is self-standing), the Court considers that the total amount of compensation should be limited to one-third of the total cost of the report. On that basis, the Court finds that Costa Rica is entitled to compensation under this head of expenses in the amount of US$9,113.

125. With regard to the other heads of expenses for compensation, Costa Rica's claims can be separated into three categories: (i) those claims which relate to two new police stations in Laguna Los Portillos and Laguna de Agua Dulce, (ii) those claims which relate to a biological station at Laguna Los Portillos, and (iii) those claims which relate to the salaries of personnel involved in monitoring activities, as well as the ancillary costs of supplying food and water, and the costs of fuel for transportation of ACTo personnel.

126. The Court notes that Costa Rica has made it clear that it does not seek to claim compensation for the construction of the police posts or the biological station. With regard to the first category, however, Costa Rica has advanced a claim for the costs of some equipment, as well as for operational expenses. For the two police posts, Costa Rica claims expenses covering equipment costs (US$24,065.87), staffing (US$3,092,834.17), fluvial transportation of personnel and supplies provided by the National Coast Guard (US$22,678.80); and the purchase of four all-terrain vehicles for the police posts (US$81,208.40).

127. The Court finds that none of the costs incurred in connection with the equipment and operation of the police stations are compensable because the purpose of the said stations was to provide security in the border area, and not in particular to monitor Nicaragua's unlawful activities in the northern part of Isla Portillos. Moreover, Costa Rica has not presented any evidence to demonstrate that the equipment purchased and the operational costs were sufficiently linked with the implementation of the provisional measures ordered by the Court.

128. With regard to the second category relating to the biological station, the Court recalls that Costa Rica has claimed expenses covering the cost of a tractor for the equipment and maintenance of the biological station (US$35,500), the acquisition price of two all-terrain vehicles and

three cargo trailers (US$42,752.76), and the cost of fuel for the transportation of personnel and supplies (US$6,435.12).

129. As to the costs incurred in connection with the maintenance of the biological station, the Court similarly finds that none of the expenses incurred under this head are compensable because there was no sufficiently direct causal link between the maintenance of this station and Nicaragua's wrongful conduct in the northern part of Isla Portillos. In particular, the Court observes that in the Report for the Executive Secretariat of the Ramsar Convention on Wetlands, dated July 2013 and entitled "New Works in the Northeast Caribbean Wetland", prepared by the Costa Rican Ministry of Foreign Affairs, it is stated that the purpose of the biological station was to "[c]onsolidate the management of the Northeast Caribbean Wetland through a research program[me]", to "[c]reate an appropriate programme for biological monitoring of the status of existing resources", and to "[c]onsolidate a prevention and control programme to prevent the alteration of the existing natural resources".

130. With reference to the third category, as already explained earlier in the context of similar claims for compensation made by Costa Rica (see paragraphs 101 and 117), the Court does not accept that a State is entitled to compensation for the regular salaries of its officials. With regard to the other two heads of expenses within this category, the Court considers that Costa Rica has not provided any specific information to show in what way the expenses claimed for food and water, and for fuel for transportation of ACTo personnel, were connected with Costa Rica's monitoring of the northern part of Isla Portillos following the withdrawal of Nicaragua's military personnel.

131. In conclusion, the Court finds that Costa Rica is entitled to compensation in the amount of US$28,970.40 for the expenses it incurred in relation to the monitoring of the northern part of Isla Portillos following the withdrawal of Nicaragua's military personnel and in implementing the Court's 2011 and 2013 Orders on provisional measures. This figure is made up of US$3,897.40 for the cost of overflights performed by the Air Surveillance Service on 5 and 6 April 2011, US$15,960 for the purchase, in the period running from September 2011 to October 2015, of satellite images of the northern part of Isla Portillos, and US$9,113 for the cost of obtaining a report from UNITAR/UNOSAT providing, *inter alia*, a technical evaluation of the damage that occurred as a consequence of Nicaragua's unlawful activities in the northern part of Isla Portillos.

3. Costs and Expenses Incurred in Preventing Irreparable Prejudice to the Environment (The Construction of a Dyke and Assessment of Its Effectiveness)

132. According to Costa Rica, it incurred a third category of expenses when implementing the Court's 2013 Order on provisional measures, in

terms of works carried out to prevent irreparable prejudice to the environment of the "disputed territory". Costa Rica argues that, in accordance with the Order, after consultation with the Secretariat of the Ramsar Convention, it carried out the necessary works on the 2013 eastern *caño* (namely, the construction of a dyke) over a period of seven days, from 31 March to 6 April 2015. Subsequently, Costa Rica carried out overflights of the "disputed territory" in June, July and October 2015 in order to assess the effectiveness of the works that had been completed to construct the dyke across the 2013 eastern *caño*. Costa Rica states that the expenses thus incurred amounted to US$195,671.02.

133. Nicaragua accepts that compensation may be appropriate for costs reasonably incurred by Costa Rica in 2015 in connection with the construction of the dyke across the 2013 eastern *caño*. It nevertheless argues that the amount of US$195,671.02 claimed by Costa Rica is inflated because certain materials charged were not actually used for the construction of the dyke and certain overflights were made for purposes unrelated to activities that the Court found to be unlawful. Thus, according to Nicaragua's evaluation, Costa Rica is entitled to no more than US$153,517 which represents the real figure for the expenses incurred in connection with the construction of the dyke in 2015.

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134. The Court recalls that in its Order of 22 November 2013 on the request presented by Costa Rica for the indication of new provisional measures, it indicated, in particular, that

> "[f]ollowing consultation with the Secretariat of the Ramsar Convention and after giving Nicaragua prior notice, Costa Rica may take appropriate measures related to the two new *caños*, to the extent necessary to prevent irreparable prejudice to the environment of the disputed territory" (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua)* and *Construction of a Road in Costa Rica along the San Juan River (Nicaragua* v. *Costa Rica), Provisional Measures, Order of 22 November 2013, I.C.J. Reports 2013*, p. 370, para. 59, subpara. (2) (E)).

135. From 10 to 13 March 2013, the Secretariat of the Ramsar Convention carried out an onsite visit to the northern part of Isla Portillos to assess the damage caused by Nicaragua's constructions of the two new *caños*. Following this site visit, in August 2014, the Secretariat produced a report (Ramsar Advisory Mission No. 77) with recommendations on mitigation measures focused on the 2013 eastern *caño*. It requested that Costa Rica submit an implementation plan and recommended that it commence a monitoring programme. In accordance with that request, Costa Rica's Ministry of the Environment and Energy formulated an implementation

plan, dated 12 August 2014. That plan set out in detail the proposed measures, consisting of the construction of a dyke to ensure that the waters of the San Juan River were not diverted through the 2013 eastern *caño*.

136. Costa Rica proposed to begin works in September 2014 and requested that Nicaragua grant it access to the San Juan River to facilitate the undertaking. Since no agreement had been reached between the Parties, Costa Rica made arrangements to contract a private civilian helicopter for the purposes of the construction works. According to Costa Rica, this was necessary because its Air Surveillance Service did not possess any type of aircraft with the capacity to carry out such works. Costa Rica states that its police and ACTo personnel provided ground support for the operation. The works to construct the dyke were carried out over a period of seven days, from 31 March to 6 April 2015. Costa Rican personnel charged with the protection of the environment monitored the works by means of periodic inspections. Costa Rica also carried out overflights of the northern part of Isla Portillos in June, July and October 2015, in order to assess the effectiveness of the works that had been completed to construct the dyke.

*

137. The Court observes that with regard to this category of expenses incurred by Costa Rica, Nicaragua "accepts that compensation may be appropriate for costs that were reasonably incurred". The Parties however differ as to the amount of compensation owed by Nicaragua to Costa Rica under this head. In particular, Nicaragua asserts that the amount claimed by Costa Rica should be reduced by excluding the cost of surplus materials (which it estimates at US$9,112.50) and the cost of three overflights (which it estimates at US$33,041.75) carried out on 9 June, 8 July and 3 October 2015, after the construction of the dyke across the 2013 eastern *caño*. According to Nicaragua, these overflights were, at least in part, "for purposes unrelated to the activities that the Court determined were wrongful".

138. The Court finds that the costs incurred by Costa Rica in connection with the construction in 2015 of a dyke across the 2013 eastern *caño* are partially compensable. Costa Rica has provided evidence that it incurred expenses that were directly related to the remedial action it undertook in order to prevent irreparable prejudice to the environment of the northern part of Isla Portillos following Nicaragua's unlawful activities. In this regard, Costa Rica advances three heads of expenses: (i) overflight costs prior to the construction of the dyke; (ii) costs connected with the actual construction of the dyke; and (iii) overflight costs subsequent to the construction of the dyke.

139. With reference to the first head of expenses, Costa Rica states that on 25 July 2014, it hired a private civilian helicopter to conduct a site visit to the northern part of Isla Portillos, in order to assess the situation of the two 2013 *caños* for the purposes of determining the measures required to

prevent irreparable prejudice to the environment of that area. According to Costa Rica, the cost of the flight for this mission amounted to US$6,183. The invoice submitted by Costa Rica for the cost of this flight indicates that the purpose of the flight was "for transportation of staff on observation and logistics flight to Isla Calero". The flight description also shows that this flight was nowhere near the construction site. In light of this evidence, the Court considers that Costa Rica has not proven that the 2014 helicopter mission was directly connected with the intended construction of the dyke across the 2013 eastern *caño*. Therefore, the expenses for this flight are not compensable.

140. With reference to the second head of expenses, Costa Rica refers to the costs incurred in terms of the purchase of construction materials and the hiring of a private civilian helicopter to transport personnel and materials required to construct the dyke across the 2013 eastern *caño*.

141. Costa Rica has divided these costs under the second head of expenses into two categories, namely, helicopter flight hours (US$131,067.50) and "purchase of billed supplies" (US$26,378.77). With regard to the first category, the Court is satisfied that the evidence adduced fully supports Costa Rica's claim.

142. In so far as the second category is concerned, the Court is of the view that the purchase of construction materials should, in principle, be fully compensated. With regard to the surplus construction materials, the Court considers that, given the difficulty of access to the construction site of the dyke, located in the wetlands, it was justified for Costa Rica to adopt a cautious approach and to ensure, at the start, that the construction materials it purchased and transported were sufficient for the completion of the work. The costs incurred for the purchase of construction materials which turned out to be more than what was actually used are, in the present circumstances, compensable. What matters, for the consideration of the claim, is reasonableness. The Court does not consider the amount of materials purchased by Costa Rica unreasonable or disproportionate to the actual needs of the construction work.

143. The Court notes, however, that in the "Breakdown of Invoices for Calero — Billed Supplies and Expenses" which gives a total amount of the expenses for the construction of the dyke, Costa Rica included an entry which refers to "Boarding — CNP and El Dólar", with a claim for compensation totalling US$3,706.41. It does not provide clarification as to the nature of this expense in any of its pleadings or annexes, including the "Report of works carried out from 26 March to 10 April 2015" prepared by the Costa Rican Ministry of Environment and Energy. The Court thus finds this expense to be non-compensable. The Court also points out that there is a mistake in the calculation of the item "fuel for boat". Costa Rica is claiming a total of US$5,936.54 whereas the calcula-

tion of the quantity (5,204) multiplied by the price of the unit (US$1.07) equals US$5,568.28. The Court has also corrected other minor miscalculations. Thus the Court, after recalculation, finds that Costa Rica should be compensated in the total amount of US$152,372.81 for the costs of the construction of the dyke (made up of the cost for the helicopter flight hours in the amount of US$131,067.50 and the purchase of billed supplies in the amount of US$21,305.31).

144. With reference to the third head of expenses, the Court recalls that Costa Rica is claiming expenses in connection with overflights made on 9 June, 8 July and 3 October 2015 for the purposes of monitoring the effectiveness of the completed dyke. The Court considers that these expenses are compensable as there is a sufficiently direct causal nexus between the damage caused to the environment of the northern part of Isla Portillos, as a result of Nicaragua's unlawful activities, and the overflight missions undertaken by Costa Rica to monitor the effectiveness of the newly constructed dyke. Costa Rica has also discharged its burden of proof in terms of providing evidence of the cost of flight hours incurred in respect of the hired private civilian helicopter used to access the northern part of Isla Portillos. Costa Rica has submitted three invoices, accompanied by flight data which indicated that the flight route took the aircraft over the dyke. In the Court's view, it is evident that the helicopter hired for these missions had to overfly other parts of Costa Rican territory in order to reach the construction site of the dyke. Moreover, the Court observes that there is nothing on the record to show that these overflights were not en route to the dyke area, nor that the helicopter missions were unrelated to the purpose of monitoring the effectiveness of the dyke.

145. For the flight of 9 June 2015, Costa Rica has produced an invoice in the amount of US$11,070.75, for the flight of 8 July 2015 an invoice for US$10,689, and for the flight of 3 October 2015 an invoice for US$11,282. The Court finds that the total expense incurred by Costa Rica under this head of expenses, totalling US$33,041.75, is therefore compensable.

146. In conclusion, the Court finds that Costa Rica is entitled to compensation in the amount of US$185,414.56 for the expenses it incurred in connection with the construction in 2015 of a dyke across the 2013 eastern *caño*. This figure is made up of US$152,372.81 for the costs of the construction of the dyke, and US$33,041.75 for the monitoring overflights made once the dyke was completed.

4. Conclusion

147. It follows from the Court's analysis of the compensable costs and expenses incurred by Costa Rica as a direct consequence of Nicaragua's

unlawful activities in the northern part of Isla Portillos (see paragraphs 106, 131 and 146 above), that Costa Rica is entitled to total compensation in the amount of US$236,032.16.

V. Costa Rica's Claim for Pre-Judgment and Post-Judgment Interest

148. Costa Rica maintains that in view of the extent of damage Costa Rica has suffered, full reparation cannot be achieved without payment of interest. It claims both pre-judgment and post-judgment interest. With regard to pre-judgment interest, Costa Rica states that such interest should cover its entire compensation for losses it incurred as a direct consequence of Nicaragua's unlawful activities. However, it makes what it considers to be a "conservative claim", whereby pre-judgment interest would accrue from the date of the Court's Judgment on the merits of 16 December 2015 until the date of the Judgment on compensation. As for post-judgment interest, Costa Rica argues that, should Nicaragua fail to pay the compensation immediately after the delivery of the Judgment, interest on the principal sum of compensation as determined by the Court should be added. It proposes that the annual rate of interest be set at 6 per cent for both pre-judgment and post-judgment interest.

149. Nicaragua maintains that an injured State has no automatic entitlement to the payment of interest and specifies that the awarding of interest depends on the circumstances of each case and, in particular, on whether an award of interest is necessary in order to ensure full reparation. Nicaragua observes that Costa Rica has not explained why the circumstances of the present case warrant the award of interest, nor has it attempted to justify the 6 per cent interest rate it requests.

* *

150. With regard to Costa Rica's claim for pre-judgment interest, the Court recalls that, in its 2015 Judgment, the actual amount of compensation due to Costa Rica was not determined; instead, the Court decided that the Parties were first required to seek a settlement of the question through negotiations. Only in the event that the question was not settled within 12 months could a Party refer it back to the Court for resolution (*Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica* v. *Nicaragua)* and *Construction of a Road in Costa Rica along the San Juan River (Nicaragua* v. *Costa Rica), Judgment, I.C.J. Reports 2015 (II)*, p. 741, para. 229 (5) *(b)*). The Court notes, not without regret, that no agreement was reached between the Parties on the question of compensation within the time-limit fixed by the Court. Consequently, at the request of Costa Rica, the matter is now before the Court for decision.

151. The Court recalls that in the practice of international courts and tribunals, pre-judgment interest may be awarded if full reparation for injury caused by an internationally wrongful act so requires. Nevertheless, interest is not an autonomous form of reparation, nor is it a necessary part of compensation in every case (see Commentary to Article 38, Draft Articles on Responsibility of States for Internationally Wrongful Acts, *Yearbook of the International Law Commission*, 2001, Vol. II (Part Two), p. 107).

152. The Court observes that, in the present case, the compensation to be awarded to Costa Rica is divided into two parts: compensation for environmental damage and compensation for costs and expenses incurred by Costa Rica in connection with Nicaragua's unlawful activities. The Court considers that Costa Rica is not entitled to pre-judgment interest on the amount of compensation for environmental damage; in determining the overall valuation of environmental damage, the Court has taken full account of the impairment or loss of environmental goods and services in the period prior to recovery.

153. With regard to the costs and expenses incurred by Costa Rica as a result of Nicaragua's unlawful activities, the Court notes that most of such costs and expenses were incurred in order to take measures for preventing further harm. The Court awards Costa Rica pre-judgment interest on the costs and expenses found compensable, accruing, as requested by Costa Rica, from 16 December 2015, the date on which the Judgment on the merits was delivered, until 2 February 2018, the date of delivery of the present Judgment. The annual interest rate is fixed at 4 per cent. The amount of interest is US$20,150.04.

154. With regard to Costa Rica's claim for post-judgment interest, the Court recalls that in the case concerning *Ahmadou Sadio Diallo (Republic of Guinea* v. *Democratic Republic of the Congo)*, the Court awarded post-judgment interest, observing that "the award of post-judgment interest is consistent with the practice of other international courts and tribunals" (*Compensation, Judgment, I.C.J. Reports 2012 (I)*, p. 343, para. 56). The Court sees no reason in the current case to adopt a different approach.

155. Thus, although it has every reason to expect timely payment by Nicaragua, the Court decides that, in the event of any delay in payment, post-judgment interest shall accrue on the total amount of compensation. This interest shall be paid at an annual rate of 6 per cent.

VI. Total Sum Awarded

156. The total amount of compensation awarded to Costa Rica is US$378,890.59 to be paid by Nicaragua by 2 April 2018. This amount includes the principal sum of US$358,740.55 and pre-judgment interest on the compensable costs and expenses in the amount of US$20,150.04.

Should payment be delayed, post-judgment interest on the total amount will accrue as from 3 April 2018.

* * *

157. For these reasons,

THE COURT,

(1) *Fixes* the following amounts for the compensation due from the Republic of Nicaragua to the Republic of Costa Rica for environmental damage caused by the Republic of Nicaragua's unlawful activities on Costa Rican territory:

(a) By fifteen votes to one,

US$120,000 for the impairment or loss of environmental goods and services;

IN FAVOUR: *President* Abraham; *Vice-President* Yusuf; *Judges* Owada, Tomka, Bennouna, Cançado Trindade, Greenwood, Xue, Donoghue, Gaja, Sebutinde, Bhandari, Robinson, Gevorgian; *Judge* ad hoc Guillaume;

AGAINST: *Judge* ad hoc Dugard;

(b) By fifteen votes to one,

US$2,708.39 for the restoration costs claimed by the Republic of Costa Rica in respect of the internationally protected wetland;

IN FAVOUR: *President* Abraham; *Vice-President* Yusuf; *Judges* Owada, Tomka, Bennouna, Cançado Trindade, Greenwood, Xue, Gaja, Sebutinde, Bhandari, Robinson, Gevorgian; *Judges* ad hoc Guillaume, Dugard;

AGAINST: *Judge* Donoghue;

(2) Unanimously,

Fixes the amount of compensation due from the Republic of Nicaragua to the Republic of Costa Rica for costs and expenses incurred by Costa Rica as a direct consequence of the Republic of Nicaragua's unlawful activities on Costa Rican territory at US$236,032.16;

(3) Unanimously,

Decides that, for the period from 16 December 2015 to 2 February 2018, the Republic of Nicaragua shall pay interest at an annual rate of 4 per cent on the amount of compensation due to the Republic of Costa Rica under point 2 above, in the sum of US$20,150.04;

(4) Unanimously,

Decides that the total amount due under points 1, 2 and 3 above shall be paid by 2 April 2018 and that, in case it has not been paid by that date, interest on the total amount due from the Republic of Nicaragua to the Republic of Costa Rica will accrue as from 3 April 2018 at an annual rate of 6 per cent.

Done in French and in English, the French text being authoritative, at the Peace Palace, The Hague, this second day of February, two thousand and eighteen, in three copies, one of which will be placed in the archives of the Court and the others transmitted to the Government of the Republic of Costa Rica and the Government of the Republic of Nicaragua, respectively.

(Signed) Ronny ABRAHAM,
President.

(Signed) Philippe COUVREUR,
Registrar.

Judges CANÇADO TRINDADE, DONOGHUE and BHANDARI append separate opinions to the Judgment of the Court; Judge GEVORGIAN appends a declaration to the Judgment of the Court; Judge *ad hoc* GUILLAUME appends a declaration to the Judgment of the Court; Judge *ad hoc* DUGARD appends a dissenting opinion to the Judgment of the Court.

(Initialled) R.A.
(Initialled) Ph.C.

Annex 33

NEWS | October 9, 2019

The Atmosphere: Getting a Handle on Carbon Dioxide

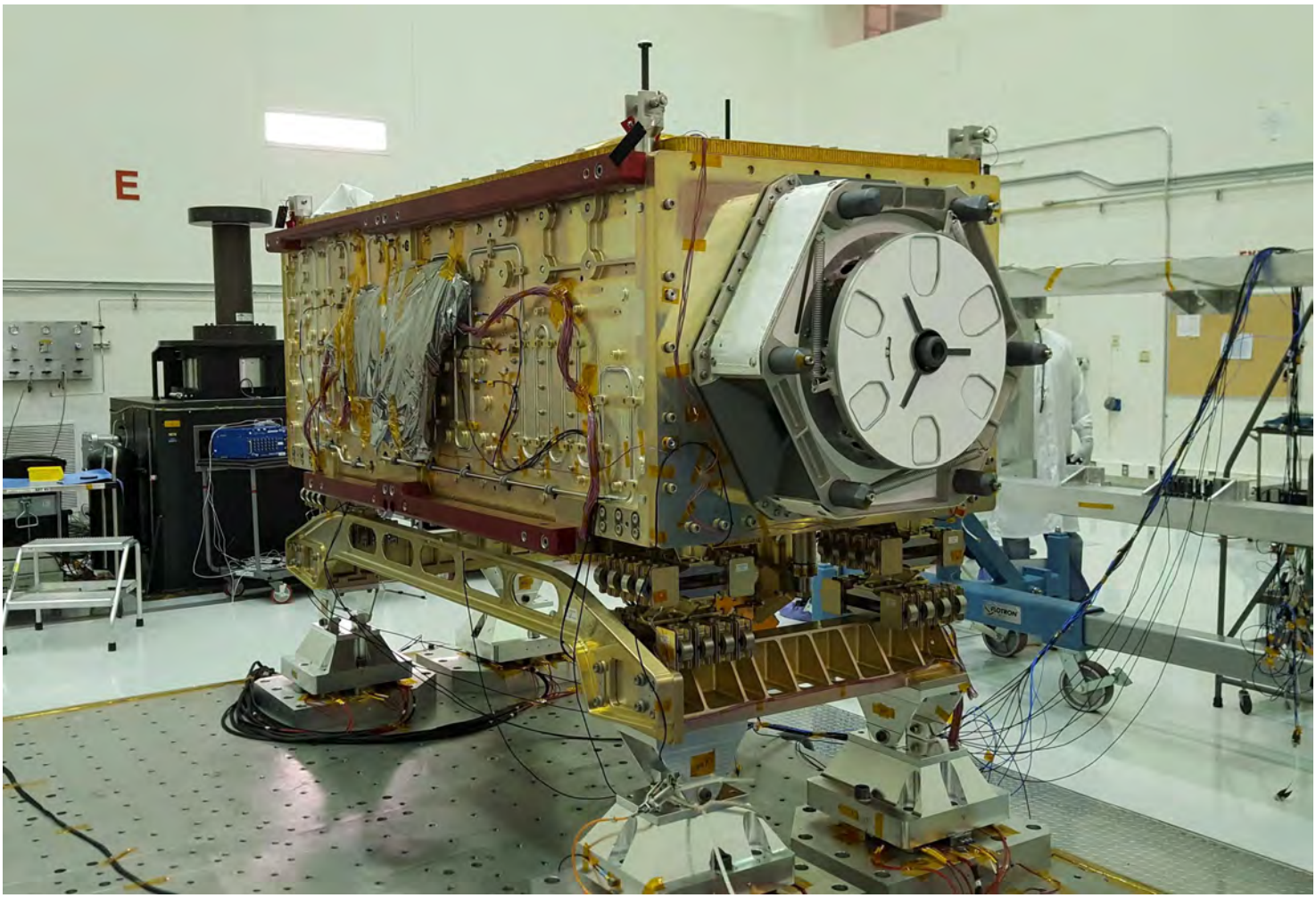
Sizing Up Humanity's Impacts on Earth's Changing Atmosphere: A Five-Part Series

By Alan Buis,
NASA's Jet Propulsion Laboratory

Part Two

Earth’s atmosphere is resilient to many of the changes humans have imposed on it. But, says atmospheric scientist David Crisp of NASA’s Jet Propulsion Laboratory in Pasadena, California, that doesn’t necessarily mean that our society is.

“The resilience of Earth’s atmosphere has been proven throughout our planet’s climate history,” said Crisp, science team lead for NASA’s Orbiting Carbon Observatory-2 (OCO-2) satellite and its successor instrument, OCO-3, which launched to the International Space Station on May 4. “Humans have increased the abundance of carbon dioxide by 45 percent since the beginning of the Industrial Age. That’s making big changes in our environment, but at the same time, it’s not going to lead to a runaway greenhouse effect or something like that. So, our atmosphere will survive, but, as suggested by UCLA professor and Pulitzer-Prize-winning author Jared Diamond, even the most advanced societies can be more fragile than the atmosphere is.”



NASA's OCO-3 instrument sits on the large vibration table (known as the "shaker") in the Environmental Test Lab at NASA's Jet Propulsion Laboratory. Thermal blankets were later added to the instrument at NASA's Kennedy Space Center, where a Space-X Dragon capsule carrying OCO-3 launched on a Falcon 9 rocket to the space station on May 4, 2019. Credit: NASA/JPL-Caltech

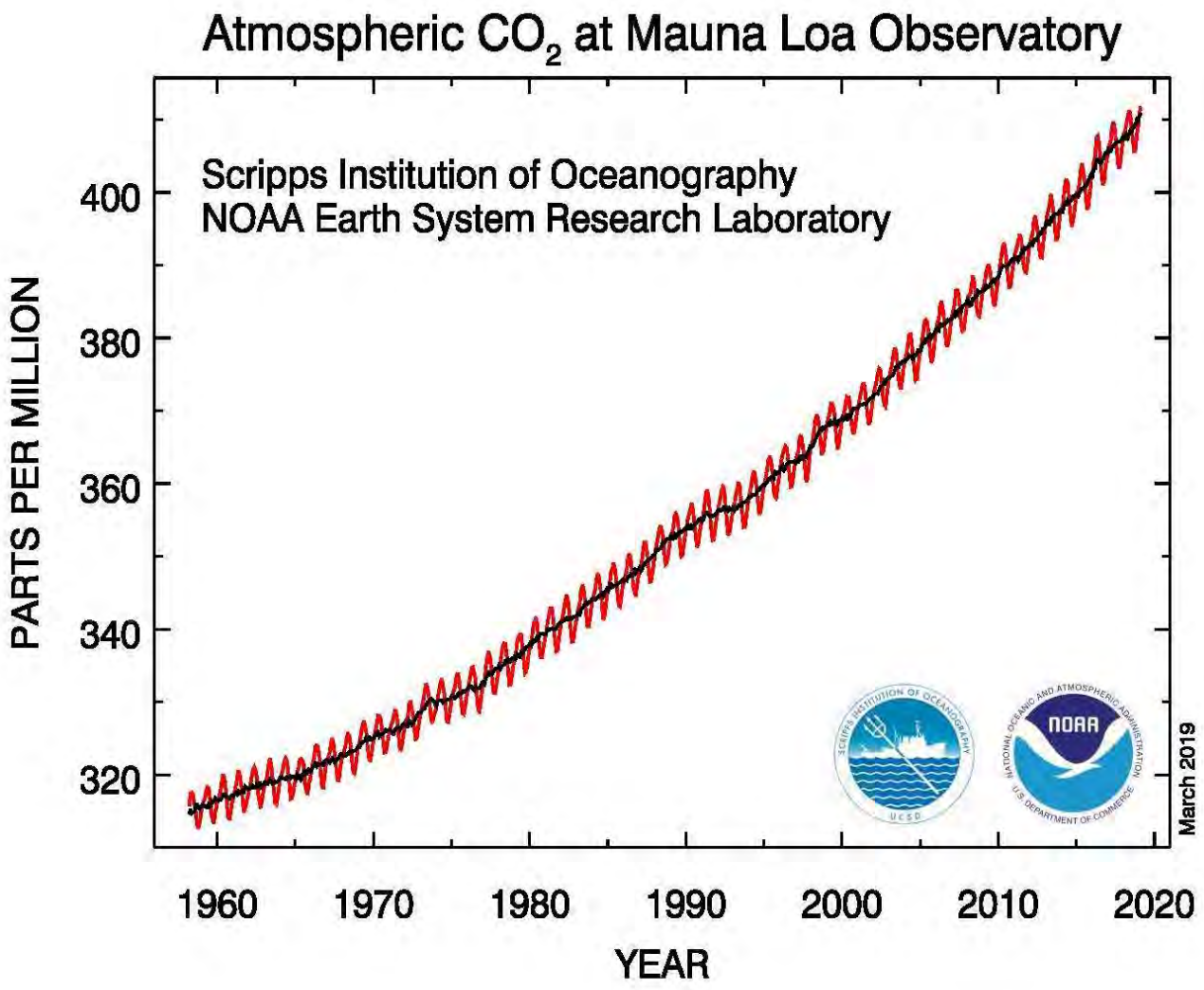
Changes to our atmosphere associated with reactive gases (gases that undergo chemical reactions) like ozone and ozone-forming chemicals like nitrous oxides, are relatively short-lived. Carbon dioxide is a different animal, however. Once it's added to the atmosphere, it hangs around, for a *long* time: between 300 to 1,000 years. Thus, as humans change the atmosphere by emitting carbon dioxide, those changes will endure on the timescale of many human lives.

Earth's atmosphere is associated with many types of cycles, such as the carbon cycle and the water cycle. Crisp says that while our atmosphere is very stable, those cycles aren't.

"Humanity's ability to thrive depends on these other planetary cycles and processes working the way they now do," he said. "Thanks to detailed observations of our planet from space, we've seen some changes over the last 30 years that are quite alarming: changes in precipitation patterns, in where and how plants grow, in sea and land ice, in entire ecosystems like tropical rain forests. These changes should attract our attention.

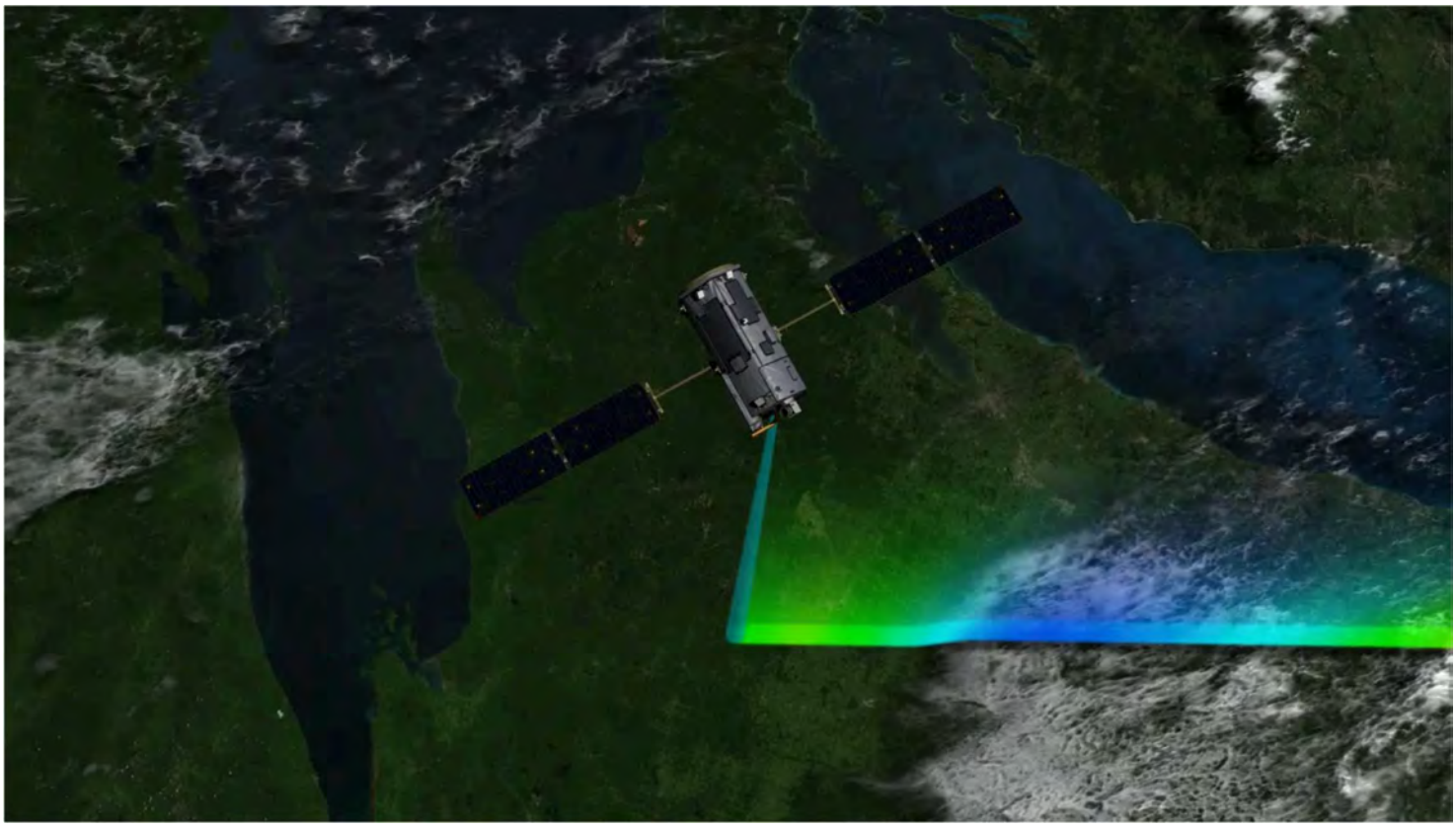
“One could say that because the atmosphere is so thin, the activity of 7.7 billion humans can actually make significant changes to the entire system,” he added. “The composition of Earth’s atmosphere has most certainly been altered. Half of the increase in atmospheric carbon dioxide concentrations in the last 300 years has occurred since 1980, and one quarter of it since 2000. Methane concentrations have increased 2.5 times since the start of the Industrial Age, with almost all of that occurring since 1980. So changes are coming faster, and they’re becoming more significant.”

The concentration of carbon dioxide in Earth’s atmosphere is currently at nearly 412 parts per million (ppm) and rising. This represents a 47 percent increase since the beginning of the Industrial Age, when the concentration was near 280 ppm, and an 11 percent increase since 2000, when it was near 370 ppm. Crisp points out that scientists know the increases in carbon dioxide are caused primarily by human activities because carbon produced by burning fossil fuels has a different ratio of heavy-to-light carbon atoms, so it leaves a distinct “fingerprint” that instruments can measure. A relative decline in the amount of heavy carbon-13 isotopes in the atmosphere points to fossil fuel sources. Burning fossil fuels also depletes oxygen and lowers the ratio of oxygen to nitrogen in the atmosphere.



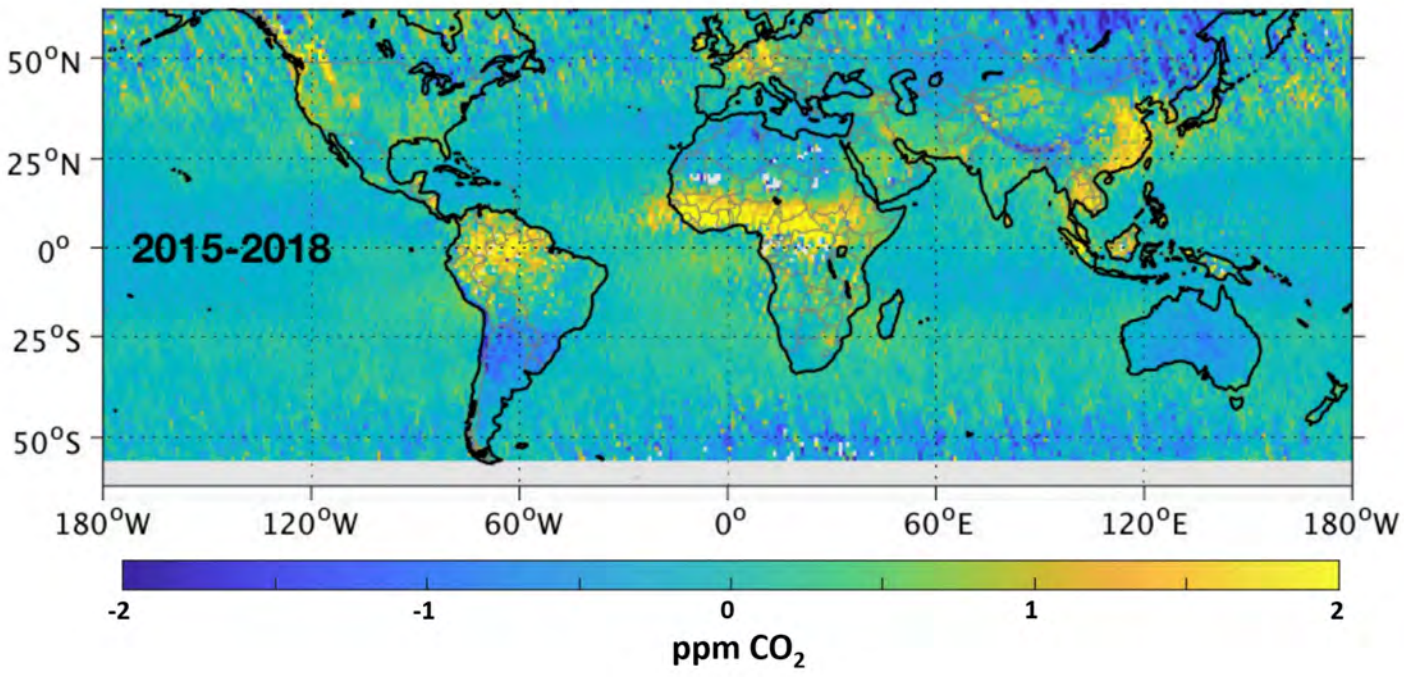
A chart showing the steadily increasing concentrations of carbon dioxide in the atmosphere (in parts per million) observed at NOAA's Mauna Loa Observatory in Hawaii over the course of 60 years. Measurements of the greenhouse gas began in 1959. Credit: NOAA

OCO-2, launched in July 2014, gathers global measurements of atmospheric carbon dioxide with the resolution, precision and coverage needed to understand how this important greenhouse gas — the principal human-produced driver of climate change — moves through the Earth system at regional scales, and how it changes over time. From its vantage point in space, OCO-2 makes roughly 100,000 measurements of atmospheric carbon dioxide every day.



Artist's rendering of NASA's Orbiting Carbon Observatory (OCO)-2 in orbit above the U.S. upper Great Plains. Credit: NASA-JPL/Caltech

Crisp says OCO-2 has already provided new insights into the processes emitting carbon dioxide to the atmosphere and those that are absorbing it.

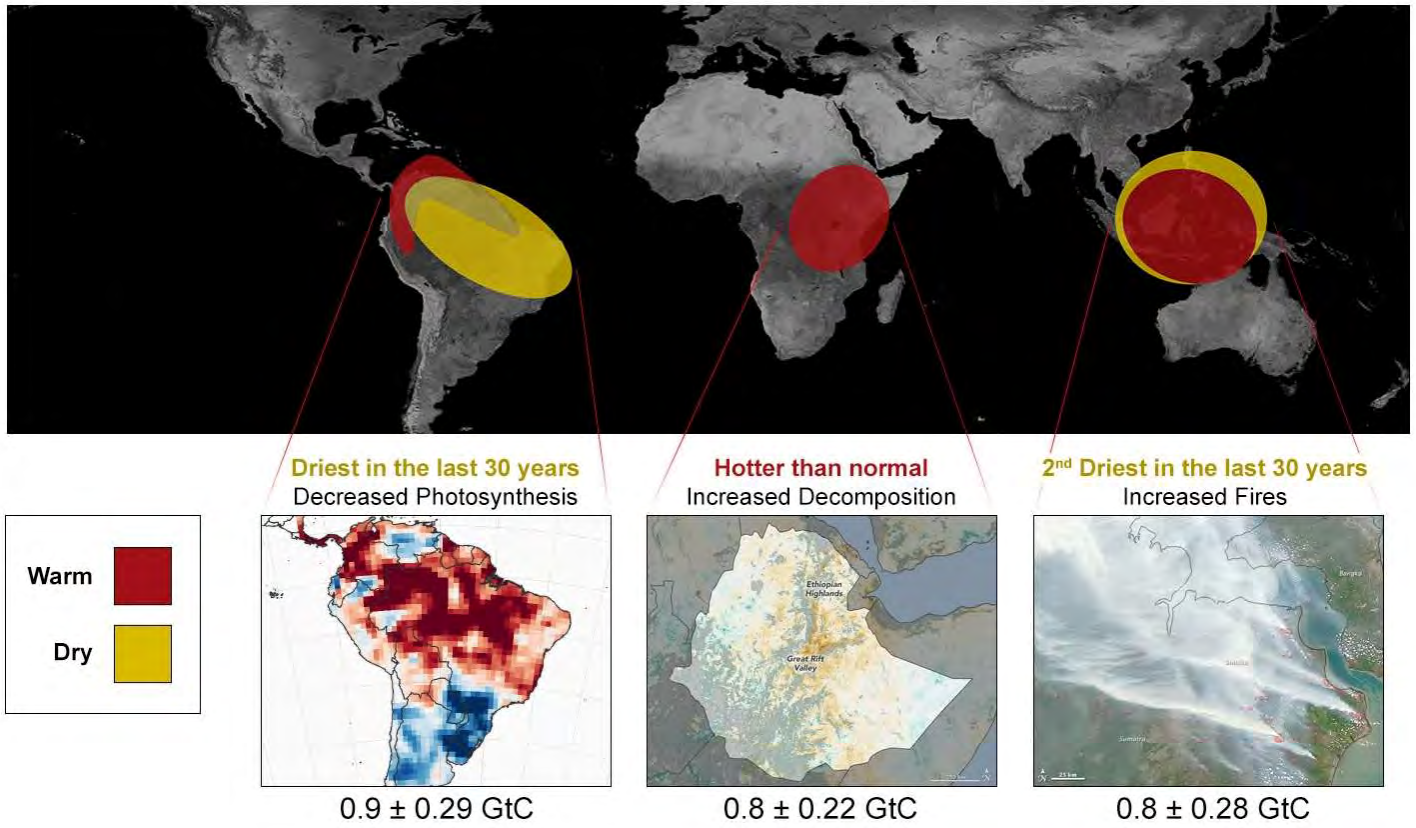


Map of the most persistent carbon dioxide “anomalies” seen by OCO-2 (i.e. where the carbon dioxide is always systematically higher or lower than in the surrounding areas). Positive anomalies are most likely sources of carbon dioxide, while negative anomalies are most likely to be sinks, or reservoirs, of carbon dioxide. Credit: NASA/JPL-Caltech

“For as long as we can remember, we’ve talked about Earth’s tropical rainforests as the ‘lungs’ of our planet,” he said. “Most scientists considered them to be the principal absorber and storage place of carbon dioxide in the Earth system, with Earth’s northern boreal forests playing a secondary role. But that’s not what’s being borne out by our data. We’re seeing that Earth’s tropical regions are a net *source* of carbon dioxide to the atmosphere, at least since 2009. This changes our understanding of things.”

Measurements of atmospheric carbon dioxide in the tropics are consistently higher than anything around them, and scientists don’t know why, Crisp said. OCO-2 and the Japan Aerospace Exploration Agency’s Greenhouse gases Observing SATellite (GOSAT) are tracking plant growth in the tropics by observing solar-induced fluorescence (SIF) from chlorophyll in plants. SIF is an indicator of the rate at which plants convert light from the Sun and carbon dioxide from the atmosphere into chemical energy.

“We’re finding that plant respiration is outstripping their ability to absorb carbon dioxide,” he said. “This is happening throughout the tropics, and almost all of the time. When we first launched OCO-2, our first two years of on-orbit operations occurred during a strong El Niño event, which had a strong impact on global carbon dioxide emissions. Now we have more than five years of data, and we see that the tropics are always a source (of carbon dioxide), in every season. In fact, the only time we see significant absorption of carbon dioxide in the tropics is in Africa during June, July and August. So that’s half the story.



The last El Niño in 2015-16 impacted the amount of carbon dioxide that Earth's tropical regions released into the atmosphere, , leading to Earth's recent record spike in atmospheric carbon dioxide. The effects of the El Nino were different in each region. Credit: NASA-JPL/Caltech

“The other half is also quite interesting,” he added. “We’re seeing northern mid- and high-latitude rainforests becoming better and better absorbers for carbon dioxide over time. One possible explanation for this is that the growing season is getting longer. Things that didn’t used to grow well at high latitudes are growing better and things that were growing well there before are growing longer. We’re seeing that in our data set. We see that South America’s high southern latitudes — the so-called cone of South America — are also strong absorbers for carbon. We don’t know if it was always this way and our previous understandings were incomplete or wrong, or if climate change has increased the intensity of the growing season. So we’ve established a new baseline, and it appears to be somewhat of a paradigm shift. Our space-based measurements are beginning to change our understanding of how the carbon cycle works and are providing new tools to allow us to monitor changes in the future in response to climate change.”

Crisp says OCO-2, OCO-3 and other new satellites are giving us new tools to understand how, where and how much carbon dioxide human activities are emitting into the atmosphere and how those emissions are interacting with Earth’s natural cycles. “We’re getting a sharper picture of those processes,” he said.

Impacts from agricultural activities also seem to be changing, he says. During summer in the U.S. upper Midwest, scientists are seeing an intense absorption of carbon dioxide associated with agricultural activities. The same thing is being observed in Eastern and Southern Asia. The strong absorption of carbon dioxide across China is erasing all but a thin strip of fossil fuel emissions along the coast, with Central China now functioning as a net absorber of carbon dioxide during the growing season. Thanks to the development of big, sophisticated computer models combined with wind and other measurements, we're able to quantify these changes for the first time.

In response to the rapid changes observed in carbon dioxide concentrations and their potential impact on our climate, 33 of the world's space agencies, including participants from the United States, Europe, Japan and China, are now working together to develop a global greenhouse gas monitoring system that could be implemented as soon as the late 2020s, Crisp added. The system would include a series of spacecraft making coordinated measurements to monitor these changes. Key components of the system would include the OCO-2 and OCO-3 missions, Japan's GOSAT and GOSAT-2, and Europe's Copernicus missions. The system would be complemented by ground-based and aerial research.

Crisp said he and his fellow team members are eagerly poring over the first science data from OCO-3. The new instrument, installed on the exterior of the space station, will extend and enhance the OCO-2 data set by collecting the first dawn-to-dusk observations of variations in carbon dioxide from space over tropical and mid-latitude regions, giving scientists a better view of emission and absorption processes. This is made possible by the space station's unique orbit, which carries OCO-3 over locations on the ground at slightly different times each orbit.

NASA's OCO-3 mission launched to the International Space Station on May 4, 2019. This follow-on to OCO-2 brings new techniques and new technologies to carbon dioxide observations of Earth from space. Credit: NASA-JPL/Caltech

The Copernicus CO2 Mission, scheduled for launch around 2025, will be the first operational carbon dioxide monitoring satellite constellation. Crisp, who's a member of its Mission Advisory Group, said the constellation will include multiple satellites with wide viewing swaths that will be able to map Earth's entire surface at weekly intervals. While its basic measurement technique evolved from the GOSAT and OCO-2 missions, there's a key difference: the earlier satellites are sampling systems focused on improving understanding of Earth's natural carbon cycle, while Copernicus will be an imaging system focused on monitoring human-produced emissions. In fact, it will have the ability to estimate the emissions of every large power plant in every city around the world.

Crisp says as time goes on the objective is to build an operational system that will monitor all aspects of Earth's environment. Pioneering satellites like OCO-2, OCO-3, GOSAT and GOSAT-2 are adding greenhouse gas measurements to the data on temperature, water vapor, cloud cover, air quality and other atmospheric properties that have been collected for decades.

"We know our atmosphere is changing and that these changes may affect our civilization," he said. "We now have the tools to monitor our atmosphere very carefully so that we can give policymakers the best information available. If you've invested in a carbon reduction strategy, such as converting from

coal to natural gas or transitioning from fossil fuels to renewables, wouldn’t you like to know that it worked? You can only manage what you can measure.”

Annex 34

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Maximum warming occurs about one decade after a carbon dioxide emission

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Maximum warming occurs about one decade after a carbon dioxide emission

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Abstract

It is known that carbon dioxide emissions cause the Earth to warm, but no previous study has focused on examining how long it takes to reach maximum warming following a particular CO_2 emission. Using conjoined results of carbon-cycle and physical-climate model intercomparison projects (Taylor *et al* 2012, Joos *et al* 2013), we find the median time between an emission and maximum warming is 10.1 years, with a 90% probability range of 6.6–30.7 years. We evaluate uncertainties in timing and amount of warming, partitioning them into three contributing factors: carbon cycle, climate sensitivity and ocean thermal inertia. If uncertainty in any one factor is reduced to zero without reducing uncertainty in the other factors, the majority of overall uncertainty remains. Thus, narrowing uncertainty in century-scale warming depends on narrowing uncertainty in all contributing factors. Our results indicate that benefit from avoided climate damage from avoided CO_2 emissions will be manifested within the lifetimes of people who acted to avoid that emission. While such avoidance could be expected to benefit future generations, there is potential for emissions avoidance to provide substantial benefit to current generations.

S Online supplementary data available from stacks.iop.org/ERL/9/124002/mmedia

Keywords: anthropogenic climate change, model intercomparisons, carbon dioxide emission

1. Introduction

It is a widely held misconception that the main effects of a CO_2 emission will not be felt for several decades. For example, in a non-peer reviewed setting, Alan Marshall estimated a 40 year lag between greenhouse emissions and elevated temperature[1]. Indeed, a co-author on this paper has previously said that 'it takes several decades for the climate system to fully respond to reductions in emissions'[2]. Such misconceptions extend beyond the scientific community and have played roles in policy discussions. For example, former US Energy Secretary Steven Chu has been quoted as saying, 'It may take 100 years to heat up this huge thermal mass so it reaches a uniform temperature … The damage we have done today will not be seen for at least 50 years'[3]. On the other hand, Matthews and Solomon (2013) asserted 'Climate warming tomorrow, this year, this decade, or this century is not predetermined by past CO_2 emissions; it is yet to be determined by future emissions'. Our results support their assertion that warming that might occur decades from now would be a consequence of future emissions. However, our findings show that past emissions very much influence rates of warming on the time scale of a year or decade following the emission.

[1] www.skepticalscience.com/Climate-Change-The-40-Year-Delay-Between-Cause-and-Effect.html.

[2] https://carnegiescience.edu/news/only_lowest_co2_emitting_technologies_can_ avoid_hot_endofcentury.

[3] www.oakridger.com/article/20140221/News/140229919.

In this study, we focus on the amount and timing of global warming associated with a present-day emission of carbon dioxide to the atmosphere—information that is relevant to the projection of the future amount and present value of climate damage expected to occur from the emissions made today. There has been a long tradition of estimating the amount of climate change that would result from various carbon dioxide emission or concentration scenarios (Leggett *et al* 1992, Ackerman *et al* 2009, Moss *et al* 2010) but there has been relatively little quantitative analysis of how long it takes to feel the consequences of an individual carbon dioxide emission.

Uncertainties in the timing and amount of projected additional global temperature increase resulting from an incremental emission of carbon dioxide (CO_2) derive from several factors (Huntingford *et al* 2009). There are *carbon-cycle* uncertainties associated with the magnitude and timescales of changes in uptake and release of CO_2 by the ocean and biosphere (Falkowski *et al* 2000). There are uncertainties of *climate sensitivity* associated with the radiative forcing of the emission and feedbacks of the climate system to that forcing that determine the resulting equilibrium global mean temperature change (Knutti and Hegerl 2008). Finally, there are uncertainties of *thermal inertia* in the climate system associated with the exchange of heat between the atmosphere and the surface and deep oceans which influences the timing of climate change (Winton *et al* 2010). Two such recent intercomparison projects together contain estimates of our three uncertainty factors from suites of state-of the-art models.

2. Methods

In this analysis, we combine modeling data from a carbon-cycle modeling project (Joos *et al* 2013) with data from the Coupled Model Intercomparison Project phase 5 (CMIP5) (Taylor *et al* 2012) to evaluate the climate response to a pulse input of CO_2 and its associated uncertainty. Fits to a collection of CO_2 responses to pulse releases, performed by Joos *et al* (2013), are used here to provide an uncertainty range for our understanding of the carbon cycle. Simple models of global temperature response, tuned using CMIP5 simulations of an abrupt quadrupling of CO_2, are used to represent and parse the uncertainty ranges for climate sensitivity and ocean thermal inertia.

2.1. Carbon-cycle response characterization

As a part of a carbon-cycle model intercomparison project (Joos *et al* 2013; a CO_2-impulse response function model intercomparison project, IRF-MIP), carbon-cycle models, including complex earth system models, earth system models of intermediate complexity and simple box models, were used to project future changes in CO_2 concentration resulting from a CO_2 emission. Responses of the atmospheric carbon dioxide concentration to a pulse release of carbon dioxide are well-approximated using a three exponential fit. To characterize the carbon cycle uncertainty associated with the global temperature response to a carbon dioxide emission today, we use fits to the time series of carbon dioxide concentrations from the IRF-MIP experiment's 15 ensemble members (Joos *et al* 2013) (see supplementary table S1).

For the simulations analyzed here, a 100 GtC pulse of carbon dioxide was released into a system in equilibrium with an atmosphere with a background concentration of 389 ppm CO_2. (Annual average atmospheric CO_2 content averaged 389 ppm between 2010 and 2011; when we use 'today' in this work, we are referring to this time (Dlugokencky and Tans n. d).) The size of this release was well suited to characterizing carbon-cycle response in these models, but because the release amount was relatively small, the internal model variability dominated the forced response to the carbon dioxide pulse release in all of the coupled climate models included in the ensemble, resulting in a multi-model mean time series for global mean temperature with several local maxima (Joos *et al* 2013). Therefore, IRF-MIP was ill suited to characterize with confidence the time to maximum warming following an individual carbon dioxide emission. However, this signal-to-noise issue can be resolved by combining the IRF-MIP data with the CMIP5 results.

2.2. Climate system response characterization

Using standard protocols as part of CMIP5, coupled atmosphere–ocean modeling groups projected future changes in global mean temperature resulting from changes in atmospheric CO_2 concentration. While the CMIP5 protocol did not include simulations in which a single pulse of CO_2 was emitted into the atmosphere, it did include an *abrupt*4*xCO*$_2$ simulation. Modeling groups projected the climate change that would occur in response to a step function change in atmospheric CO_2 concentrations (Taylor *et al* 2012).

To characterize both the uncertainty in climate sensitivity and in the thermal inertia of the climate system, we use fits to the time series of global temperature change from the CMIP5 *abrupt*4*xCO*$_2$ experiment's 20 ensemble's members (see supplementary table S2). To characterize the climate sensitivity uncertainty range, we use an approach devised by Gregory *et al* (2004). At least two studies (Andrews *et al* 2012, Caldeira and Myhrvold 2013), have applied this approach to the CMIP5 multi-model ensemble, and here we use estimates of equilibrium climate sensitivity from a quadrupling of atmospheric CO_2 from Caldeira and Myhrvold (2013). These estimates are numerically similar to those provided by Andrews *et al* (2012) but are accompanied by consistent functions representing the pace of warming for each model.

Unlike climate sensitivity, the thermal inertia of the ocean cannot be described by a single number, but requires some representation of an underlying physical model. Both two-box (Held *et al* 2010, Geoffroy *et al* 2012) and one-dimensional heat-diffusion (Hansen *et al* 1984, MacMynowski *et al* 2011) have been widely used to characterize the thermal response of more complex climate models. In this study, we characterize the thermal response uncertainty range using whichever of the two underlying physical models better

fits the approach to equilibrium for each atmosphere–ocean model used in the CMIP5 *abrupt*4xCO_2 simulations (Andrews *et al* 2012). For details see the supplementary information. Relevant parameters for the temperature models tuned to each CMIP5 model are documented in table 1. while we assume in our analysis that the climate sensitivity and ocean thermal inertia are independent, there could be correlations introduced by the process of constraining the model behavior to match historical data, though in our analysis this correlation is very weak ($R^2 = 0.0537$).

2.3. Coupled carbon-climate approximation

A combined approximation of the climate system's response to a present-day CO_2 pulse emission can be obtained by using a standard convolution integral approach similar to that of Shine *et al* (2005), convoluting the carbon cycle and climate system responses:

$$T(t) = \alpha \int_0^t R'_{\Delta T}(\tau) \times R_{CO_2}(t - \tau)\mathrm{d}\tau, \qquad (1)$$

where $R_{\Delta T}$ is the global temperature response to a step-change in atmospheric CO_2, as defined by one of the two models described above and in the supplementary methods; R_{CO_2} is the 3-exponential atmospheric carbon dioxide response to a present-day pulse release. This yields 15 estimates of the carbon cycle response to a unit emission, 20 estimates of climate sensitivity, and 20 simplified models of the thermal inertia of the climate system, giving us 6000 possible combinations of these three factors. We limit our analysis to the first century of warming in order to remain within the scope of any simulation in either ensemble.

While the response of the carbon cycle to pulse releases of CO_2 may vary with the size of the emission pulse as they grow far beyond 100 GtC (Eby *et al* 2009), we here assume a linear scaling factor, α, to account for the difference in the magnitude of the forcing response for the pulse release simulated as opposed to the step change in CO_2 concentration (i.e., 100 GtC from 389 ppm versus *abrupt*4xCO_2). We assume that the global temperature response of the climate system is linear enough that $R_{\Delta T}$ as derived from the *abrupt*4xCO_2 simulations is representative of the response to more complex forcing perturbations. This assumption is supported by contemporary analyses (Andrews *et al* 2012, Good *et al* 2013). Our results are relevant to CO_2 releases of less than 100 GtC where these linear approximations are most likely to be valid.

The range of model results in model intercomparison projects is often taken as indicative of scientific uncertainty in scenario-based projections (Tebaldi and Knutti 2007). When we say 'very likely' (Mastrandrea *et al* 2010) in presenting our results, our statements related directly to the distribution of model results. It is possible that all models are biased in a similar fashion and thus the probability that real values will lie outside of our stated uncertainty ranges may be underestimated. In addition, the approach does not account for the fact that models with highest rates of ocean carbon uptake are likely to also have high rates of heat uptake—these properties of the Earth system are independent according to our method. Nevertheless, because these models represent the scientific community's best effort to quantitatively represent known physics and biogeochemistry, these model results are at least indicative of current scientific uncertainty.

3. Results and discussion

Across the 6000 combined projections, there is a high degree of concordance on the overall magnitude and general shape of global warming resulting from a CO_2 emission (figure 1). A pulse emission of CO_2 results in a stepwise increase in atmospheric CO_2 content, followed by a slow decrease as the CO_2 is taken up by the oceans and terrestrial biosphere. Global temperature rises in response to the CO_2 forcing, but with a lag of about a decade due to the thermal inertia of the upper layers of the ocean. The maximum temperature is reached when the ever-decreasing rate of warming in response to the increase in radiative forcing is balanced by the slowly decreasing magnitude of radiative forcing of atmospheric CO_2.

Figure 2 shows, for all 6000 projections, the distributions of the amount of time after the emission that it takes to reach the maximum temperature anomaly caused by a CO_2 emission (ΔT_{max}), the magnitude of ΔT_{max}, and ΔT as a fraction ΔT_{max} at 100 years after the emission. The median estimate of the time until maximum warming occurs is 10.1 years after the CO_2 emission, with a very likely (90% probability) range of 6.6–30.7 years (figure 2(a)). We find a median estimate of the maximum amount of warming caused by a CO_2 emission during the first century after the emission (ΔT_{max}) is 2.2 mK GtC^{-1}, with a very likely range of between 1.6 and 2.9 mK GtC^{-1} (figure 2(b); supplementary table S3). This range is in keeping with contemporary estimates of transient climate response to cumulative carbon emission obtained in a number of studies (Collins *et al* 2013), though our metric is time-dependent so the values are not directly comparable.

Consistent with a long list of previous work (e.g., Archer 2005, Matthews and Caldeira 2008, Solomon *et al* 2009), figures 1 and 2 show that while the temperature consequences of CO_2 emission materialize more quickly than commonly assumed, they are long lasting. The fraction of maximum warming still remaining one century after an emission has a median value of 0.82, with a very likely range of 0.65–0.97 (figure 2(c)). (Note that after one century, temperatures are still increasing in 119 of the 6000 simulated time series (i.e., have not reached ΔT_{max}) and therefore, if the simulation datasets available and analysis were extended for a longer time period, 2% of simulations would have fractional values greater than one.) In addition, even if the globally averaged maximum effect of an emission may be manifested after one decade, the results may vary spatially. For example, continued polar amplification may result in later a maximum warming effect at high latitudes.

We partition uncertainty in the temperature increase following an emission into three independent factors: uncertainty in the carbon cycle, equilibrium climate sensitivity and

Table 1. Best-fit ocean model parameters for CMIP5 models based on two-box and 1D diffusion models. The 'better fit' model was used in our study. The climate sensitivity parameter, effective vertical diffusivity and better fit model were first presented in Caldeira and Myhrvold (2013).

		Two-box model (2-exp)			One-dimensional model (1D)	
Model	Climate sensitivity parameter (λ) (W m^{-2} K^{-1})	Land/ocean-mixed layer effective heat capacity (C) (10^8 J m^{-2} s^{-1} K^{-1})	Thermocline/deep-ocean effective heat capacity (C0) (10^8 J m^{-2} s^{-1} K^{-1})	Effective exchange rate (γ) (W m^{-2} K^{-1})	Effective vertical diffusivity (κ) (10^4 m^2 s^{-1})	Better fit model
BCC-CSM1.1	1.15	1.97	19.1	0.806	0.355	2-exp
BCC-CSM1.1(m)	1.23	1.94	16.2	0.785	0.295	1D
CanESM2	1.03	1.95	20.8	0.699	0.338	1D
CSIRO-Mk3.6.0	0.63	1.69	22.0	0.917	0.444	2-exp
FGOALS-g2	0.73	2.12	27.7	0.726	0.43	1D
FGOALS-s2	0.90	1.90	37.6	0.781	0.59	2-exp
GFDL-CM3	0.76	1.93	21.4	0.854	0.417	2-exp
GFDL-ESM2G	1.00	1.34	39.7	0.766	0.591	2-exp
GFDL-ESM2M	1.06	1.75	40.6	0.864	0.689	2-exp
INM-CM4	1.47	2.42	69.9	0.714	0.713	2-exp
IPSL-CM5A-LR	0.78	3.16	36.6	0.554	0.464	1D
IPSL-CM5A-Mr	0.81	2.54	26.7	0.662	0.418	2-exp
IPSL-CM5B-LR	1.04	1.74	20.1	0.739	0.332	1D
MIROC5	1.55	1.98	40.5	0.872	0.692	2-exp
MIROC-ESM	0.92	2.59	36.7	0.731	0.571	2-exp
MPI-ESM-LR	1.12	1.87	22.2	0.790	0.395	2-exp
MPI-ESM-Mr	1.18	1.92	21.9	0.768	0.382	2-exp
MPI-ESM-P	1.24	1.75	21.7	0.816	0.391	2-exp
MRI-CGCM3	1.26	2.38	19.4	0.761	0.362	1D
NorESM1-M	1.10	2.13	33.4	1.035	0.747	2-exp

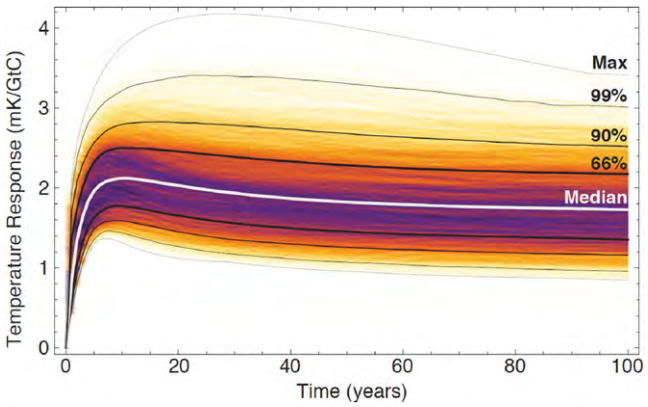

Figure 1. Temperature increase from an individual emission of carbon dioxide (CO_2). Time series of the marginal warming in mK (=milliKelvin = 0.001 K) per GtC (=10^{15} g carbon) as projected by 6000 convolution-function simulations for the first 100 years after the emission. Maximum warming occurs a median of 10.1 years after the CO_2 emission event and has a median value of 2.2 mK GtC^{-1}. The colors represent the relative density of simulations in a given region of the plot.

thermal inertia (figure 3). As our central case for our sensitivity study, we choose the one convolution simulation out of the 6000 available that minimizes the least-squares difference with the numerically-determined median warming trajectory shown in figure 1. Climate sensitivity is the largest individual contributing factor to temperature response uncertainty, but the combined effect of all three uncertainty sources is a considerably larger range. There has been considerable focus on the 'high tail' on equilibrium climate sensitivity estimates (Roe and Baker 2007), but this analysis suggests that carbon cycle uncertainty contributes nearly as much to the high tail of warming as climate sensitivity does. We find that carbon cycle uncertainty increases steadily relative to other factors over time, and that the ratio of carbon cycle uncertainty to that associated with climate sensitivity and thermal inertia together is about 0.42 after a decade, but 0.72 after a century (figure 3(a)). This suggests that the relative magnitude of carbon cycle uncertainty to uncertainty associated with physical uncertainties is larger than previous similar analyses have found (Huntingford *et al* 2009).

Substantially reducing the uncertainty about the effect of an emission will require more than just constraining climate sensitivity. While climate sensitivity is the largest contributor to total uncertainty, even if climate sensitivity uncertainty were reduced to zero, more than 70% of total uncertainty about the magnitude of warming remains 100 years after the emission (figure 3(b)). Removing uncertainty for any one factor will only decrease total uncertainty about the magnitude of warming by 20–30%. This is also true for reducing uncertainty about the timing of warming; even eliminating all uncertainty about thermal inertia—the largest contributor to uncertainty about the time until ΔT_{max}—only reduces the total uncertainty range about timing by 44%.

Our analysis provides an estimate of the timing and amount of incremental warming that would be caused by CO_2 emitted today. These estimates span the uncertainty range of

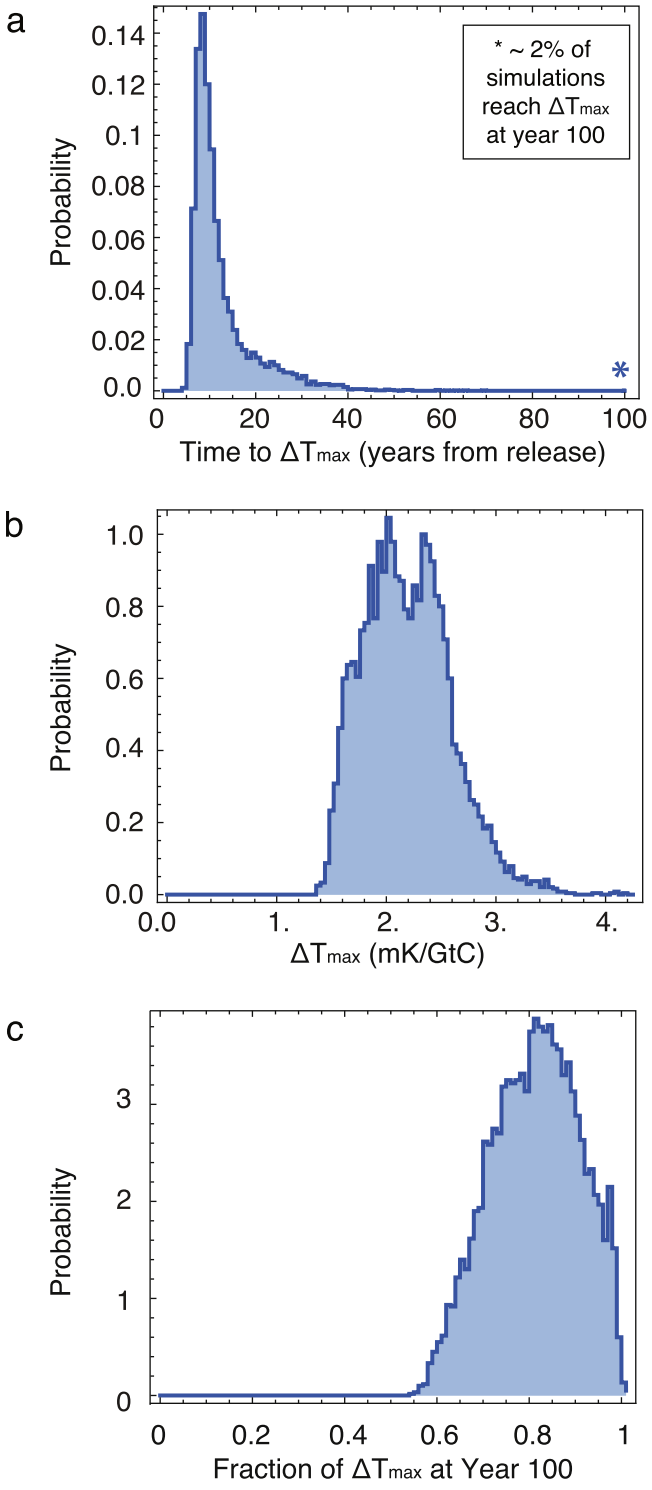

Figure 2. Frequency distributions of time to ΔT_{max}, magnitude of ΔT_{max}, and ΔT at year 100 relative to ΔT_{max}. The frequency distribution functions, based on all 6000 simulations, for: (a) the time until the maximum temperature increase achieved in the first 100 years after a CO_2 emission (ΔT_{max}) is reached (in years), (b) the magnitude of ΔT_{max} (in milliKelvins per gigatonne carbon), and (c) the fraction of that warming remaining 100 years after the emission. Vertical axis units are the multiplicative inverse of the horizontal axis units.

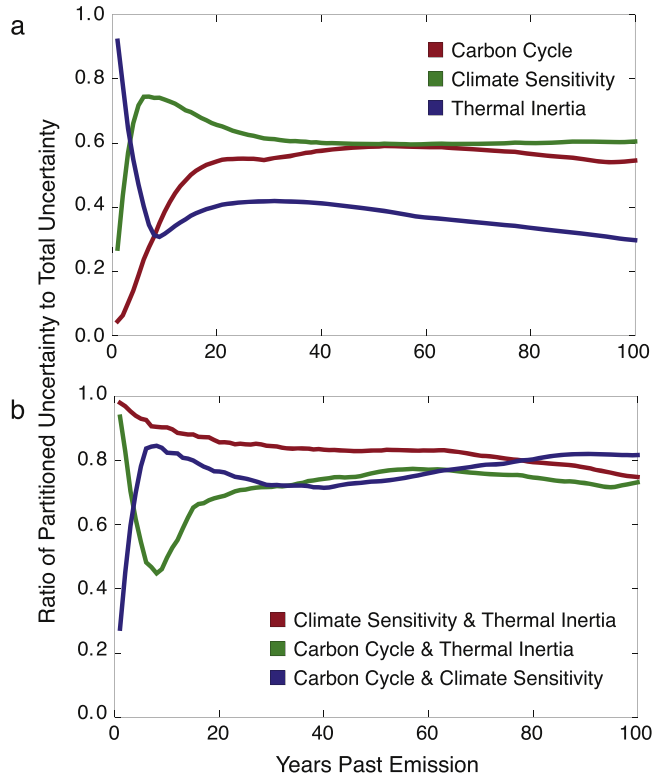

Figure 3. Partitioned uncertainty over time. The fraction of 90% (very likely) uncertainty range remaining if different contributors to overall uncertainty were reduced to zero: (a) uncertainty of two factors is reduced to zero, with no reduction in uncertainty in the third (labeled) factor, (b) uncertainty of one factor is reduced to zero, with no reduction in uncertainty in the other two factors.

model results, yet are simple enough to be employed in a broad range of climate change assessment applications. In supplementary methods we describe the development of simple 3-exponential fits to the solid lines shown in figure 1, and provide relevant coefficients in table 2. These curve fits could be useful for approximating the temperature increase resulting from CO_2 emissions in alternative scenario analyses, economic modeling, or other exercises that require a simplified but physically robust representation climate system's response to CO_2 emissions. However, care should be used when applying these representations under conditions far from the current state, because carbon-cycle dynamics and physical climate system response both vary with background atmospheric CO_2 concentration. At higher CO_2 concentrations, the ocean takes up CO_2 more slowly, leaving more CO_2 in the atmosphere. However, at higher CO_2 concentrations, that additional CO_2 also produces less radiative forcing. These two effects are opposite in sign and of approximately the same magnitude, so there is first-order cancellation (Caldeira and Kasting 1992), but detailed results will differ. In addition, these results are only appropriate for the representation of the temperature response in the first century after a CO_2 emission. The multi-century scale warming effects have not been extensively explored in fully coupled AOGCMs that include a carbon cycle (Pierrehumbert 2014), but some preliminary work suggests that some warming effects of an emission may extend well beyond the first century (Frölicher *et al* 2014).

While the maximum warming effect of a CO_2 emission may manifest itself in only one decade, other impact-relevant effects, such as sea level rise, will quite clearly not reach their maximum until after the first century (see, e.g., figure 2(c) of Joos *et al* (2013)). For many impacts, such as changes to natural ecosystems, degradation is the result of the cumulative effects of consecutive years of warming or precipitation change (Parmesan and Yohe 2003). Ice sheet melting can persist for thousands of years following a warming (Huybrechts *et al* 2011). As such, even if maximum warming occurs within a decade, maximum impact may not be reached until much later. From this perspective, Steven Chu's statement that today's damage 'will not be seen for at least 50 years' may well be accurate.

4. Conclusions

Our analysis implies warming from an individual carbon dioxide emission can be expected to reach its peak value within about a decade and, for the most part, persist for longer than a century. There is substantial uncertainty in both the amount and timing of this warming, and while the largest contributor to this uncertainty is equilibrium climate sensitivity, there are substantial contributions from the carbon-cycle and climate system thermal inertia. Carbon-cycle uncertainties make a contribution to the 'high tail' of the temperature response distribution that is comparable to climate sensitivity's contribution.

Carbon dioxide emissions are long-lasting and generate multi-century and multi-millennial commitments (Archer *et al* 2009). On the multi-century scale, some authors have suggested that the climate response to a CO_2 emission can be regarded as a nearly immediate step function change followed by relatively constant warming that persists for centuries (Matthews and Caldeira 2008, Solomon *et al* 2009, Matthews and Solomon 2013). Our results provide additional evidence that on time scales substantially longer than a decade, the warming from a CO_2 emission can be approximated by a step function increase in temperature that then remains approximately constant for an extended period of time. Under this framing, the amount of climate change is critical to estimating climate damage stemming from an emission, and delays in warming may be regarded as relatively unimportant. Extreme forms of this perspective even suggest that the timing of emission is unimportant, and cumulative emissions are most relevant to the policy process (Zickfeld *et al* 2009).

On the other hand, economic evaluations of costs and benefits typically take timing into consideration, discounting gains and losses in the future relative to those of the present day (Nordhaus 1992) and thereby placing much greater significance on the warming experienced in the first decades after an emission. Some have suggested that the benefits of emissions avoidance will be felt nearly immediately (Matthews and Solomon 2013), whereas others have emphasized that benefits of emissions avoidance will accrue primarily to

Table 2. Fit coefficients for a three-exponential function representing the marginal temperature response to a present day emission[a].

		a_1[b]	a_2[b]	a_3[b]	τ[c]	τ_2[c]	τ_3[c]	rms[b]
Median		−2.308	0.743	−0.191	2.241	35.750	97.180	0.005
Likely	Lo	−2.121	0.535	0.318	2.663	14.960	78.316	0.002
(>66%)	Hi	−0.777	−1.884	0.539	0.048	2.659	41.581	0.003
Very likely	Lo	−2.327	0.812	0.410	3.084	8.384	50.173	0.004
(>90%)	Hi	−1.507	−1.447	0.727	0.432	3.628	105.899	0.006
Virtually certain	Lo	−2.314	1.066	0.498	3.255	8.849	112.671	0.009
(>99%)	Hi	−2.264	−1.367	6.830	0.689	7.458	1000.000	0.016
Minimum	Lo	−2.147	1.011	0.463	3.012	8.186	101.242	0.016
Maximum	Hi	−2.278	−2.405	13.811	0.630	9.106	1000.000	0.018

[a] The functional form is: $\Delta T(t) = -(a_1 + a_2 + a_3) + a_1 e^{-t/\tau_1} + a_2 e^{-t/\tau_2} + a_3 e^{-t/\tau_3}$.
[b] Units of mK GtC^{-1}.
[c] Units of years.

the next generation and beyond (Myhrvold and Caldeira 2012).

The primary time lag limiting efforts to diminish future climate change may be the time scales associated with political consensus (Victor 2011) and with energy system transitions (Smil 2010), and not time lags in the physical climate system. While the relevant time lags imposed by the climate system are substantially shorter than a human lifetime, they are substantially longer than the typical political election cycle, making these delays and their associated uncertainties important, both economically and politically. Nonetheless, our study indicates that people alive today are very likely to benefit from emissions avoided today.

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Annex 35

Summary for Policymakers

SPM

Summary for Policymakers

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Introduction

This Summary for Policymakers (SPM) presents key findings of the Working Group I (WGI) contribution to the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6)[1] on the physical science basis of climate change. The report builds upon the 2013 Working Group I contribution to the IPCC's Fifth Assessment Report (AR5) and the 2018–2019 IPCC Special Reports[2] of the AR6 cycle and incorporates subsequent new evidence from climate science.[3]

This SPM provides a high-level summary of the understanding of the current state of the climate, including how it is changing and the role of human influence, the state of knowledge about possible climate futures, climate information relevant to regions and sectors, and limiting human-induced climate change.

Based on scientific understanding, key findings can be formulated as statements of fact or associated with an assessed level of confidence indicated using the IPCC calibrated language.[4]

The scientific basis for each key finding is found in chapter sections of the main Report and in the integrated synthesis presented in the Technical Summary (hereafter TS), and is indicated in curly brackets. The AR6 WGI Interactive Atlas facilitates exploration of these key synthesis findings, and supporting climate change information, across the WGI reference regions.[5]

A. The Current State of the Climate

Since AR5, improvements in observationally based estimates and information from paleoclimate archives provide a comprehensive view of each component of the climate system and its changes to date. New climate model simulations, new analyses, and methods combining multiple lines of evidence lead to improved understanding of human influence on a wider range of climate variables, including weather and climate extremes. The time periods considered throughout this section depend upon the availability of observational products, paleoclimate archives and peer-reviewed studies.

A.1 It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred. {2.2, 2.3, Cross-Chapter Box 2.3, 3.3, 3.4, 3.5, 3.6, 3.8, 5.2, 5.3, 6.4, 7.3, 8.3, 9.2, 9.3, 9.5, 9.6, Cross-Chapter Box 9.1} (Figure SPM.1, Figure SPM.2)

A.1.1 Observed increases in well-mixed greenhouse gas (GHG) concentrations since around 1750 are unequivocally caused by human activities. Since 2011 (measurements reported in AR5), concentrations have continued to increase in the atmosphere, reaching annual averages of 410 parts per million (ppm) for carbon dioxide (CO_2), 1866 parts per billion (ppb) for methane (CH_4), and 332 ppb for nitrous oxide (N_2O) in 2019.[6] Land and ocean have taken up a near-constant proportion (globally about 56% per year) of CO_2 emissions from human activities over the past six decades, with regional differences (*high confidence*).[7]
{2.2, 5.2, 7.3, TS.2.2, Box TS.5}

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1 Decision IPCC/XLVI-2.

2 The three Special Reports are: Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (SR1.5); Climate Change and Land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems (SRCCL); IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC).

3 The assessment covers scientific literature accepted for publication by 31 January 2021.

4 Each finding is grounded in an evaluation of underlying evidence and agreement. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and typeset in italics, for example, *medium confidence*. The following terms have been used to indicate the assessed likelihood of an outcome or result: virtually certain 99–100% probability; very likely 90–100%; likely 66–100%; about as likely as not 33–66%; unlikely 0–33%; very unlikely 0–10%; and exceptionally unlikely 0–1%. Additional terms (extremely likely 95–100%; more likely than not >50–100%; and extremely unlikely 0–5%) are also used when appropriate. Assessed likelihood is typeset in italics, for example, *very likely*. This is consistent with AR5. In this Report, unless stated otherwise, square brackets [x to y] are used to provide the assessed *very likely* range, or 90% interval.

5 The Interactive Atlas is available at https://interactive-atlas.ipcc.ch

6 Other GHG concentrations in 2019 were: perfluorocarbons (PFCs) – 109 parts per trillion (ppt) CF_4 equivalent; sulphur hexafluoride (SF_6) – 10 ppt; nitrogen trifluoride (NF_3) – 2 ppt; hydrofluorocarbons (HFCs) – 237 ppt HFC-134a equivalent; other Montreal Protocol gases (mainly chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs)) – 1032 ppt CFC-12 equivalent). Increases from 2011 are 19 ppm for CO_2, 63 ppb for CH_4 and 8 ppb for N_2O.

7 Land and ocean are not substantial sinks for other GHGs.

A.1.2 Each of the last four decades has been successively warmer than any decade that preceded it since 1850. Global surface temperature[8] in the first two decades of the 21st century (2001–2020) was 0.99 [0.84 to 1.10] °C higher than 1850–1900.[9] Global surface temperature was 1.09 [0.95 to 1.20] °C higher in 2011–2020 than 1850–1900, with larger increases over land (1.59 [1.34 to 1.83] °C) than over the ocean (0.88 [0.68 to 1.01] °C). The estimated increase in global surface temperature since AR5 is principally due to further warming since 2003–2012 (+0.19 [0.16 to 0.22] °C). Additionally, methodological advances and new datasets contributed approximately 0.1°C to the updated estimate of warming in AR6.[10]
{2.3, Cross-Chapter Box 2.3} (Figure SPM.1)

A.1.3 The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019[11] is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver[12] of tropospheric warming since 1979 and *extremely likely* that human-caused stratospheric ozone depletion was the main driver of cooling of the lower stratosphere between 1979 and the mid-1990s.
{3.3, 6.4, 7.3, TS.2.3, Cross-Section Box TS.1} (Figure SPM.2)

A.1.4 Globally averaged precipitation over land has *likely* increased since 1950, with a faster rate of increase since the 1980s (*medium confidence*). It is *likely* that human influence contributed to the pattern of observed precipitation changes since the mid-20th century and *extremely likely* that human influence contributed to the pattern of observed changes in near-surface ocean salinity. Mid-latitude storm tracks have *likely* shifted poleward in both hemispheres since the 1980s, with marked seasonality in trends (*medium confidence*). For the Southern Hemisphere, human influence *very likely* contributed to the poleward shift of the closely related extratropical jet in austral summer.
{2.3, 3.3, 8.3, 9.2, TS.2.3, TS.2.4, Box TS.6}

A.1.5 Human influence is *very likely* the main driver of the global retreat of glaciers since the 1990s and the decrease in Arctic sea ice area between 1979–1988 and 2010–2019 (decreases of about 40% in September and about 10% in March). There has been no significant trend in Antarctic sea ice area from 1979 to 2020 due to regionally opposing trends and large internal variability. Human influence *very likely* contributed to the decrease in Northern Hemisphere spring snow cover since 1950. It is *very likely* that human influence has contributed to the observed surface melting of the Greenland Ice Sheet over the past two decades, but there is only *limited evidence*, with *medium agreement*, of human influence on the Antarctic Ice Sheet mass loss.
{2.3, 3.4, 8.3, 9.3, 9.5, TS.2.5}

A.1.6 It is *virtually certain* that the global upper ocean (0–700 m) has warmed since the 1970s and *extremely likely* that human influence is the main driver. It is *virtually certain* that human-caused CO_2 emissions are the main driver of current global acidification of the surface open ocean. There is *high confidence* that oxygen levels have dropped in many upper ocean regions since the mid-20th century and *medium confidence* that human influence contributed to this drop.
{2.3, 3.5, 3.6, 5.3, 9.2, TS.2.4}

A.1.7 Global mean sea level increased by 0.20 [0.15 to 0.25] m between 1901 and 2018. The average rate of sea level rise was 1.3 [0.6 to 2.1] mm yr^{-1} between 1901 and 1971, increasing to 1.9 [0.8 to 2.9] mm yr^{-1} between 1971 and 2006, and further increasing to 3.7 [3.2 to 4.2] mm yr^{-1} between 2006 and 2018 (*high confidence*). Human influence was *very likely* the main driver of these increases since at least 1971.
{2.3, 3.5, 9.6, Cross-Chapter Box 9.1, Box TS.4}

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8 The term 'global surface temperature' is used in reference to both global mean surface temperature and global surface air temperature throughout this SPM. Changes in these quantities are assessed with *high confidence* to differ by at most 10% from one another, but conflicting lines of evidence lead to *low confidence* in the sign (direction) of any difference in long-term trend. {Cross-Section Box TS.1}

9 The period 1850–1900 represents the earliest period of sufficiently globally complete observations to estimate global surface temperature and, consistent with AR5 and SR1.5, is used as an approximation for pre-industrial conditions.

10 Since AR5, methodological advances and new datasets have provided a more complete spatial representation of changes in surface temperature, including in the Arctic. These and other improvements have also increased the estimate of global surface temperature change by approximately 0.1°C, but this increase does not represent additional physical warming since AR5.

11 The period distinction with A.1.2 arises because the attribution studies consider this slightly earlier period. The observed warming to 2010–2019 is 1.06 [0.88 to 1.21] °C.

12 Throughout this SPM, 'main driver' means responsible for more than 50% of the change.

A.1.8 Changes in the land biosphere since 1970 are consistent with global warming: climate zones have shifted poleward in both hemispheres, and the growing season has on average lengthened by up to two days per decade since the 1950s in the Northern Hemisphere extratropics (*high confidence*). {2.3, TS.2.6}

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Changes in global surface temperature relative to 1850–1900

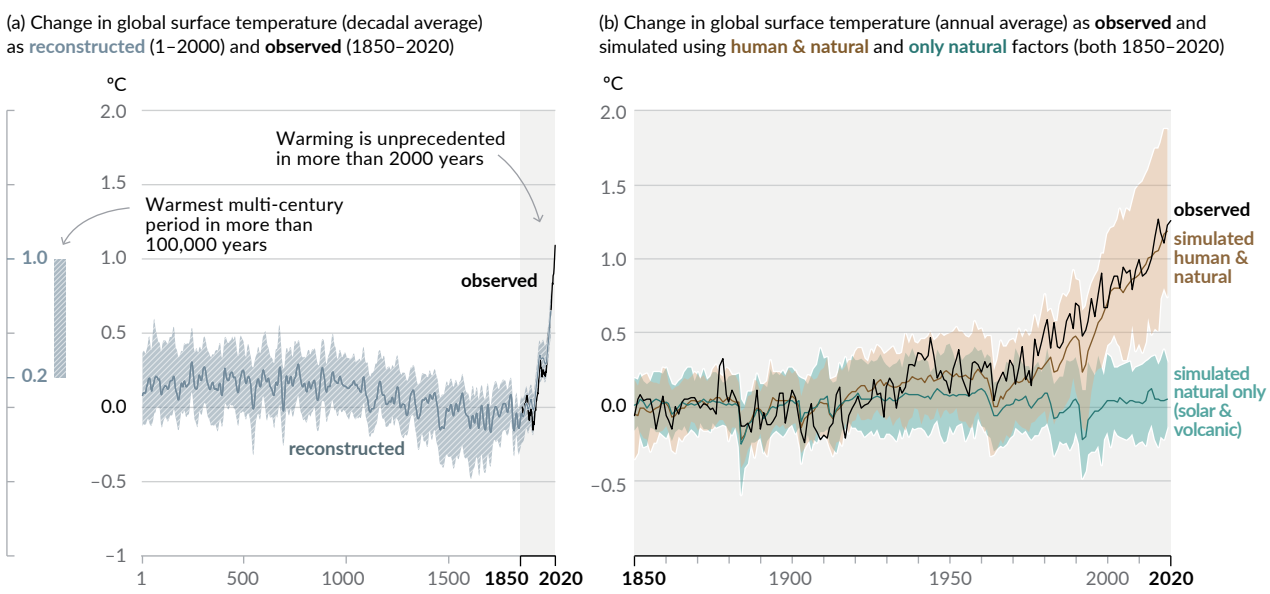

Figure SPM.1 | History of global temperature change and causes of recent warming

Panel (a) Changes in global surface temperature reconstructed from paleoclimate archives (solid grey line, years 1–2000) **and from direct observations** (solid black line, 1850–2020), both relative to 1850–1900 and decadally averaged. The vertical bar on the left shows the estimated temperature (*very likely* range) during the warmest multi-century period in at least the last 100,000 years, which occurred around 6500 years ago during the current interglacial period (Holocene). The Last Interglacial, around 125,000 years ago, is the next most recent candidate for a period of higher temperature. These past warm periods were caused by slow (multi-millennial) orbital variations. The grey shading with white diagonal lines shows the *very likely* ranges for the temperature reconstructions.

Panel (b) Changes in global surface temperature over the past 170 years (black line) relative to 1850–1900 and annually averaged, compared to Coupled Model Intercomparison Project Phase 6 (CMIP6) climate model simulations (see Box SPM.1) of the temperature response to both human and natural drivers (brown) and to only natural drivers (solar and volcanic activity, green). Solid coloured lines show the multi-model average, and coloured shades show the *very likely* range of simulations. (See Figure SPM.2 for the assessed contributions to warming).

{2.3.1; Cross-Chapter Box 2.3; 3.3; TS.2.2; Cross-Section Box TS.1, Figure 1a}

Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling

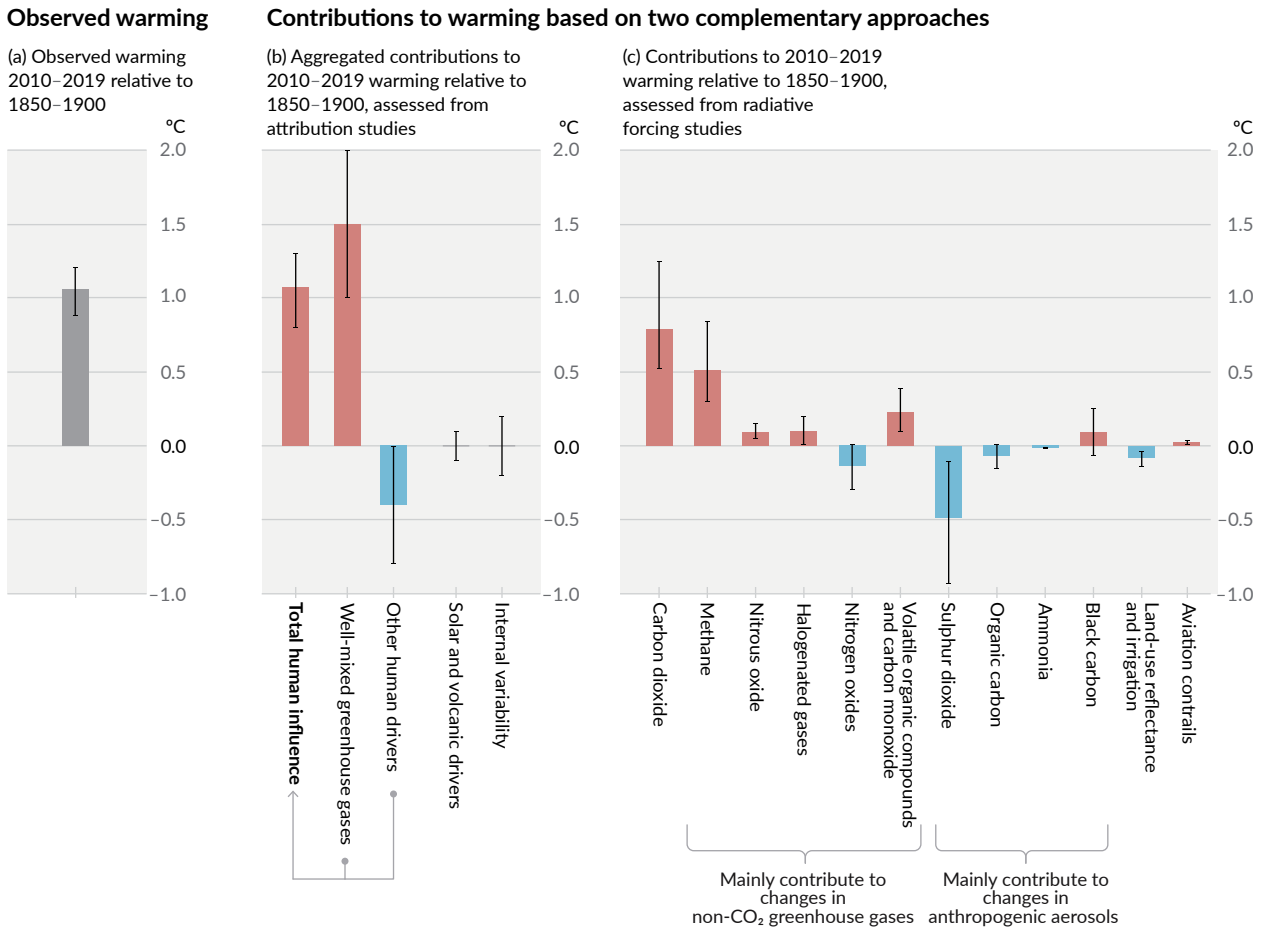

Figure SPM.2 | Assessed contributions to observed warming in 2010–2019 relative to 1850–1900

Panel (a) Observed global warming (increase in global surface temperature). Whiskers show the *very likely* range.

Panel (b) Evidence from attribution studies, which synthesize information from climate models and observations. The panel shows temperature change attributed to: total human influence; changes in well-mixed greenhouse gas concentrations; other human drivers due to aerosols, ozone and land-use change (land-use reflectance); solar and volcanic drivers; and internal climate variability. Whiskers show *likely* ranges.

Panel (c) Evidence from the assessment of radiative forcing and climate sensitivity. The panel shows temperature changes from individual components of human influence: emissions of greenhouse gases, aerosols and their precursors; land-use changes (land-use reflectance and irrigation); and aviation contrails. Whiskers show *very likely* ranges. Estimates account for both direct emissions into the atmosphere and their effect, if any, on other climate drivers. For aerosols, both direct effects (through radiation) and indirect effects (through interactions with clouds) are considered.

{Cross-Chapter Box 2.3, 3.3.1, 6.4.2, 7.3}

A.2 The scale of recent changes across the climate system as a whole – and the present state of many aspects of the climate system – are unprecedented over many centuries to many thousands of years. {2.2, 2.3, Cross-Chapter Box 2.1, 5.1} (Figure SPM.1)

A.2.1 In 2019, atmospheric CO_2 concentrations were higher than at any time in at least 2 million years (*high confidence*), and concentrations of CH_4 and N_2O were higher than at any time in at least 800,000 years (*very high confidence*). Since 1750, increases in CO_2 (47%) and CH_4 (156%) concentrations far exceed – and increases in N_2O (23%) are similar to – the natural multi-millennial changes between glacial and interglacial periods over at least the past 800,000 years (*very high confidence*). {2.2, 5.1, TS.2.2}

A.2.2 Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2000 years (*high confidence*). Temperatures during the most recent decade (2011–2020) exceed those of the most recent multi-century warm period, around 6500 years ago[13] [0.2°C to 1°C relative to 1850–1900] (*medium confidence*). Prior to that, the next most recent warm period was about 125,000 years ago, when the multi-century temperature [0.5°C to 1.5°C relative to 1850–1900] overlaps the observations of the most recent decade (*medium confidence*). {2.3, Cross-Chapter Box 2.1, Cross-Section Box TS.1} (Figure SPM.1)

A.2.3 In 2011–2020, annual average Arctic sea ice area reached its lowest level since at least 1850 (*high confidence*). Late summer Arctic sea ice area was smaller than at any time in at least the past 1000 years (*medium confidence*). The global nature of glacier retreat since the 1950s, with almost all of the world's glaciers retreating synchronously, is unprecedented in at least the last 2000 years (*medium confidence*). {2.3, TS.2.5}

A.2.4 Global mean sea level has risen faster since 1900 than over any preceding century in at least the last 3000 years (*high confidence*). The global ocean has warmed faster over the past century than since the end of the last deglacial transition (around 11,000 years ago) (*medium confidence*). A long-term increase in surface open ocean pH occurred over the past 50 million years (*high confidence*). However, surface open ocean pH as low as recent decades is unusual in the last 2 million years (*medium confidence*). {2.3, TS.2.4, Box TS.4}

A.3 Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5. {2.3, 3.3, 8.2, 8.3, 8.4, 8.5, 8.6, Box 8.1, Box 8.2, Box 9.2, 10.6, 11.2, 11.3, 11.4, 11.6, 11.7, 11.8, 11.9, 12.3} (Figure SPM.3)

A.3.1 It is *virtually certain* that hot extremes (including heatwaves) have become more frequent and more intense across most land regions since the 1950s, while cold extremes (including cold waves) have become less frequent and less severe, with *high confidence* that human-induced climate change is the main driver[14] of these changes. Some recent hot extremes observed over the past decade would have been *extremely unlikely* to occur without human influence on the climate system. Marine heatwaves have approximately doubled in frequency since the 1980s (*high confidence*), and human influence has *very likely* contributed to most of them since at least 2006. {Box 9.2, 11.2, 11.3, 11.9, TS.2.4, TS.2.6, Box TS.10} (Figure SPM.3)

A.3.2 The frequency and intensity of heavy precipitation events have increased since the 1950s over most land area for which observational data are sufficient for trend analysis (*high confidence*), and human-induced climate change is *likely* the main driver. Human-induced climate change has contributed to increases in agricultural and ecological droughts[15] in some regions due to increased land evapotranspiration[16] (*medium confidence*). {8.2, 8.3, 11.4, 11.6, 11.9, TS.2.6, Box TS.10} (Figure SPM.3)

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13 As stated in section B.1, even under the very low emissions scenario SSP1-1.9, temperatures are assessed to remain elevated above those of the most recent decade until at least 2100 and therefore warmer than the century-scale period 6500 years ago.

14 As indicated in footnote 12, throughout this SPM, 'main driver' means responsible for more than 50% of the change.

15 Agricultural and ecological drought (depending on the affected biome): a period with abnormal soil moisture deficit, which results from combined shortage of precipitation and excess evapotranspiration, and during the growing season impinges on crop production or ecosystem function in general (see Annex VII: Glossary). Observed changes in meteorological droughts (precipitation deficits) and hydrological droughts (streamflow deficits) are distinct from those in agricultural and ecological droughts and are addressed in the underlying AR6 material (Chapter 11).

16 The combined processes through which water is transferred to the atmosphere from open water and ice surfaces, bare soils and vegetation that make up the Earth's surface (Glossary).

A.3.3 Decreases in global land monsoon precipitation[17] from the 1950s to the 1980s are partly attributed to human-caused Northern Hemisphere aerosol emissions, but increases since then have resulted from rising GHG concentrations and decadal to multi-decadal internal variability (*medium confidence*). Over South Asia, East Asia and West Africa, increases in monsoon precipitation due to warming from GHG emissions were counteracted by decreases in monsoon precipitation due to cooling from human-caused aerosol emissions over the 20th century (*high confidence*). Increases in West African monsoon precipitation since the 1980s are partly due to the growing influence of GHGs and reductions in the cooling effect of human-caused aerosol emissions over Europe and North America (*medium confidence*).
{2.3, 3.3, 8.2, 8.3, 8.4, 8.5, 8.6, Box 8.1, Box 8.2, 10.6, Box TS.13}

A.3.4 It is *likely* that the global proportion of major (Category 3–5) tropical cyclone occurrence has increased over the last four decades, and it is *very likely* that the latitude where tropical cyclones in the western North Pacific reach their peak intensity has shifted northward; these changes cannot be explained by internal variability alone (*medium confidence*). There is *low confidence* in long-term (multi-decadal to centennial) trends in the frequency of all-category tropical cyclones. Event attribution studies and physical understanding indicate that human-induced climate change increases heavy precipitation associated with tropical cyclones (*high confidence*), but data limitations inhibit clear detection of past trends on the global scale.
{8.2, 11.7, Box TS.10}

A.3.5 Human influence has *likely* increased the chance of compound extreme events[18] since the 1950s. This includes increases in the frequency of concurrent heatwaves and droughts on the global scale (*high confidence*), fire weather in some regions of all inhabited continents (*medium confidence*), and compound flooding in some locations (*medium confidence*).
{11.6, 11.7, 11.8, 12.3, 12.4, TS.2.6, Table TS.5, Box TS.10}

17 The global monsoon is defined as the area in which the annual range (local summer minus local winter) of precipitation is greater than 2.5 mm day^{-1} (Glossary). Global land monsoon precipitation refers to the mean precipitation over land areas within the global monsoon.

18 Compound extreme events are the combination of multiple drivers and/or hazards that contribute to societal or environmental risk (Glossary). Examples are concurrent heatwaves and droughts, compound flooding (e.g., a storm surge in combination with extreme rainfall and/or river flow), compound fire weather conditions (i.e., a combination of hot, dry and windy conditions), or concurrent extremes at different locations.

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

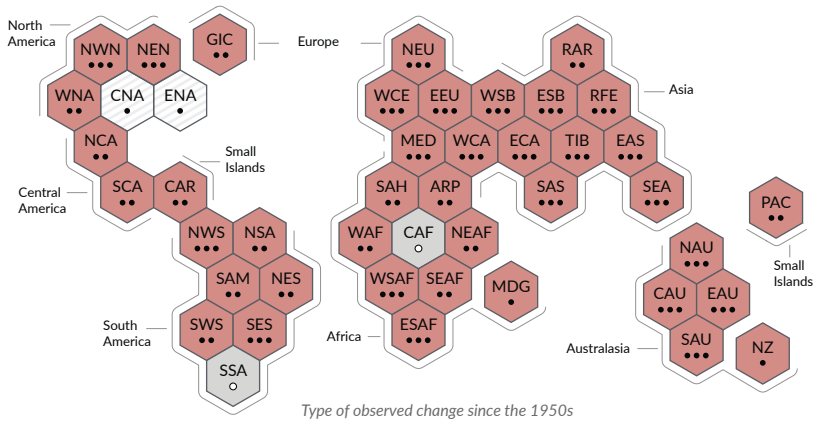
(a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in hot extremes

- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

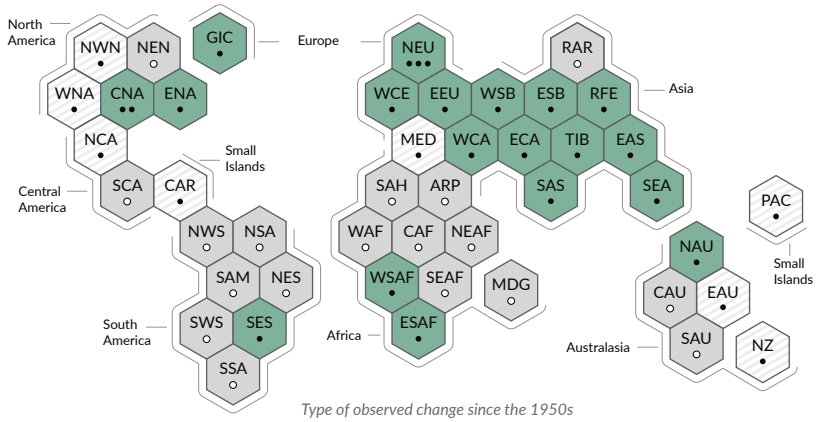
(b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in heavy precipitation

- Increase (19)
- Decrease (0)
- Low agreement in the type of change (8)
- Limited data and/or literature (18)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

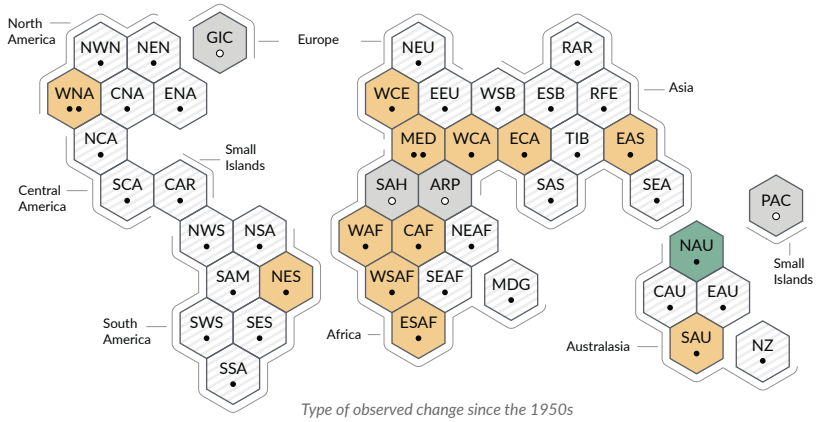
(c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in agricultural and ecological drought

- Increase (12)
- Decrease (1)
- Low agreement in the type of change (28)
- Limited data and/or literature (4)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

Each hexagon corresponds to one of the IPCC AR6 WGI reference regions

NWN *North-Western North America*

IPCC AR6 WGI reference regions: **North America:** ***NWN*** *(North-Western North America),* ***NEN*** *(North-Eastern North America),* ***WNA*** *(Western North America),* ***CNA*** *(Central North America),* ***ENA*** *(Eastern North America),* **Central America:** ***NCA*** *(Northern Central America),* ***SCA*** *(Southern Central America),* ***CAR*** *(Caribbean),* **South America:** ***NWS*** *(North-Western South America),* ***NSA*** *(Northern South America),* ***NES*** *(North-Eastern South America),* ***SAM*** *(South American Monsoon),* ***SWS*** *(South-Western South America),* ***SES*** *(South-Eastern South America),* ***SSA*** *(Southern South America),* **Europe:** ***GIC*** *(Greenland/Iceland),* ***NEU*** *(Northern Europe),* ***WCE*** *(Western and Central Europe),* ***EEU*** *(Eastern Europe),* ***MED*** *(Mediterranean),* **Africa:** ***MED*** *(Mediterranean),* ***SAH*** *(Sahara),* ***WAF*** *(Western Africa),* ***CAF*** *(Central Africa),* ***NEAF*** *(North Eastern Africa),* ***SEAF*** *(South Eastern Africa),* ***WSAF*** *(West Southern Africa),* ***ESAF*** *(East Southern Africa),* ***MDG*** *(Madagascar),* **Asia:** ***RAR*** *(Russian Arctic),* ***WSB*** *(West Siberia),* ***ESB*** *(East Siberia),* ***RFE*** *(Russian Far East),* ***WCA*** *(West Central Asia),* ***ECA*** *(East Central Asia),* ***TIB*** *(Tibetan Plateau),* ***EAS*** *(East Asia),* ***ARP*** *(Arabian Peninsula),* ***SAS*** *(South Asia),* ***SEA*** *(South East Asia),* **Australasia:** ***NAU*** *(Northern Australia),* ***CAU*** *(Central Australia),* ***EAU*** *(Eastern Australia),* ***SAU*** *(Southern Australia),* ***NZ*** *(New Zealand),* **Small Islands:** ***CAR*** *(Caribbean),* ***PAC*** *(Pacific Small Islands)*

Figure SPM.3 | Synthesis of assessed observed and attributable regional changes

The IPCC AR6 WGI inhabited regions are displayed as **hexagons** with identical size in their approximate geographical location (see legend for regional acronyms). All assessments are made for each region as a whole and for the 1950s to the present. Assessments made on different time scales or more local spatial scales might differ from what is shown in the figure. The **colours** in each panel represent the four outcomes of the assessment on observed changes. Striped hexagons (white and light-grey) are used where there is *low agreement* in the type of change for the region as a whole, and grey hexagons are used when there is limited data and/or literature that prevents an assessment of the region as a whole. Other colours indicate at least *medium confidence* in the observed change. The **confidence level** for the human influence on these observed changes is based on assessing trend detection and attribution and event attribution literature, and it is indicated by the number of dots: three dots for *high confidence*, two dots for *medium confidence* and one dot for *low confidence* (single, filled dot: limited agreement; single, empty dot: limited evidence).

Panel (a) For hot extremes, the evidence is mostly drawn from changes in metrics based on daily maximum temperatures; regional studies using other indices (heatwave duration, frequency and intensity) are used in addition. Red hexagons indicate regions where there is at least *medium confidence* in an observed increase in hot extremes.

Panel (b) For heavy precipitation, the evidence is mostly drawn from changes in indices based on one-day or five-day precipitation amounts using global and regional studies. Green hexagons indicate regions where there is at least *medium confidence* in an observed increase in heavy precipitation.

Panel (c) Agricultural and ecological droughts are assessed based on observed and simulated changes in total column soil moisture, complemented by evidence on changes in surface soil moisture, water balance (precipitation minus evapotranspiration) and indices driven by precipitation and atmospheric evaporative demand. Yellow hexagons indicate regions where there is at least *medium confidence* in an observed increase in this type of drought, and green hexagons indicate regions where there is at least *medium confidence* in an observed decrease in agricultural and ecological drought.

For all regions, Table TS.5 shows a broader range of observed changes besides the ones shown in this figure. Note that Southern South America (SSA) is the only region that does not display observed changes in the metrics shown in this figure, but is affected by observed increases in mean temperature, decreases in frost and increases in marine heatwaves.

{11.9, Atlas 1.3.3, Figure Atlas.2, Table TS.5; Box TS.10, Figure 1}

A.4 Improved knowledge of climate processes, paleoclimate evidence and the response of the climate system to increasing radiative forcing gives a best estimate of equilibrium climate sensitivity of 3°C, with a narrower range compared to AR5. {2.2, 7.3, 7.4, 7.5, Box 7.2, 9.4, 9.5, 9.6, Cross-Chapter Box 9.1}

A.4.1 Human-caused radiative forcing of 2.72 [1.96 to 3.48] W m^{-2} in 2019 relative to 1750 has warmed the climate system. This warming is mainly due to increased GHG concentrations, partly reduced by cooling due to increased aerosol concentrations. The radiative forcing has increased by 0.43 W m^{-2} (19%) relative to AR5, of which 0.34 W m^{-2} is due to the increase in GHG concentrations since 2011. The remainder is due to improved scientific understanding and changes in the assessment of aerosol forcing, which include decreases in concentration and improvement in its calculation (*high confidence*). {2.2, 7.3, TS.2.2, TS.3.1}

A.4.2 Human-caused net positive radiative forcing causes an accumulation of additional energy (heating) in the climate system, partly reduced by increased energy loss to space in response to surface warming. The observed average rate of heating of the climate system increased from 0.50 [0.32 to 0.69] W m^{-2} for the period 1971–2006[19] to 0.79 [0.52 to 1.06] W m^{-2} for the period 2006–2018[20] (*high confidence*). Ocean warming accounted for 91% of the heating in the climate system, with land warming, ice loss and atmospheric warming accounting for about 5%, 3% and 1%, respectively (*high confidence*). {7.2, Box 7.2, TS.3.1}

A.4.3 Heating of the climate system has caused global mean sea level rise through ice loss on land and thermal expansion from ocean warming. Thermal expansion explained 50% of sea level rise during 1971–2018, while ice loss from glaciers contributed 22%, ice sheets 20% and changes in land-water storage 8%. The rate of ice-sheet loss increased by a factor of four between 1992–1999 and 2010–2019. Together, ice-sheet and glacier mass loss were the dominant contributors to global mean sea level rise during 2006–2018 (*high confidence*). {9.4, 9.5, 9.6, Cross-Chapter Box 9.1}

A.4.4 The equilibrium climate sensitivity is an important quantity used to estimate how the climate responds to radiative forcing. Based on multiple lines of evidence,[21] the *very likely* range of equilibrium climate sensitivity is between 2°C (*high confidence*) and 5°C (*medium confidence*). The AR6 assessed best estimate is 3°C with a *likely* range of 2.5°C to 4°C (*high confidence*), compared to 1.5°C to 4.5°C in AR5, which did not provide a best estimate. {7.4, 7.5, TS.3.2}

19 Cumulative energy increase of 282 [177 to 387] ZJ over 1971–2006 (1 ZJ = 10^{21} joules).

20 Cumulative energy increase of 152 [100 to 205] ZJ over 2006–2018.

21 Understanding of climate processes, the instrumental record, paleoclimates and model-based emergent constraints (Glossary).

B. Possible Climate Futures

A set of five new illustrative emissions scenarios is considered consistently across this Report to explore the climate response to a broader range of greenhouse gas (GHG), land-use and air pollutant futures than assessed in AR5. This set of scenarios drives climate model projections of changes in the climate system. These projections account for solar activity and background forcing from volcanoes. Results over the 21st century are provided for the near term (2021–2040), mid-term (2041–2060) and long term (2081–2100) relative to 1850–1900, unless otherwise stated.

Box SPM.1 | Scenarios, Climate Models and Projections

Box SPM.1.1: This Report assesses the climate response to five illustrative scenarios that cover the range of possible future development of anthropogenic drivers of climate change found in the literature. They start in 2015, and include scenarios[22] with high and very high GHG emissions (SSP3-7.0 and SSP5-8.5) and CO_2 emissions that roughly double from current levels by 2100 and 2050, respectively, scenarios with intermediate GHG emissions (SSP2-4.5) and CO_2 emissions remaining around current levels until the middle of the century, and scenarios with very low and low GHG emissions and CO_2 emissions declining to net zero around or after 2050, followed by varying levels of net negative CO_2 emissions[23] (SSP1-1.9 and SSP1-2.6), as illustrated in Figure SPM.4. Emissions vary between scenarios depending on socio-economic assumptions, levels of climate change mitigation and, for aerosols and non-methane ozone precursors, air pollution controls. Alternative assumptions may result in similar emissions and climate responses, but the socio-economic assumptions and the feasibility or likelihood of individual scenarios are not part of the assessment.
{1.6, Cross-Chapter Box 1.4, TS.1.3} (Figure SPM.4)

Box SPM.1.2: This Report assesses results from climate models participating in the Coupled Model Intercomparison Project Phase 6 (CMIP6) of the World Climate Research Programme. These models include new and better representations of physical, chemical and biological processes, as well as higher resolution, compared to climate models considered in previous IPCC assessment reports. This has improved the simulation of the recent mean state of most large-scale indicators of climate change and many other aspects across the climate system. Some differences from observations remain, for example in regional precipitation patterns. The CMIP6 historical simulations assessed in this Report have an ensemble mean global surface temperature change within 0.2°C of the observations over most of the historical period, and observed warming is within the *very likely* range of the CMIP6 ensemble. However, some CMIP6 models simulate a warming that is either above or below the assessed *very likely* range of observed warming.
{1.5, Cross-Chapter Box 2.2, 3.3, 3.8, TS.1.2, Cross-Section Box TS.1} (Figure SPM.1b, Figure SPM.2)

Box SPM.1.3: The CMIP6 models considered in this Report have a wider range of climate sensitivity than in CMIP5 models and the AR6 assessed *very likely* range, which is based on multiple lines of evidence. These CMIP6 models also show a higher average climate sensitivity than CMIP5 and the AR6 assessed best estimate. The higher CMIP6 climate sensitivity values compared to CMIP5 can be traced to an amplifying cloud feedback that is larger in CMIP6 by about 20%.
{Box 7.1, 7.3, 7.4, 7.5, TS.3.2}

Box SPM.1.4: For the first time in an IPCC report, assessed future changes in global surface temperature, ocean warming and sea level are constructed by combining multi-model projections with observational constraints based on past simulated warming, as well as the AR6 assessment of climate sensitivity. For other quantities, such robust methods do not yet exist to constrain the projections. Nevertheless, robust projected geographical patterns of many variables can be identified at a given level of global warming, common to all scenarios considered and independent of timing when the global warming level is reached.
{1.6, 4.3, 4.6, Box 4.1, 7.5, 9.2, 9.6, Cross-Chapter Box 11.1, Cross-Section Box TS.1}

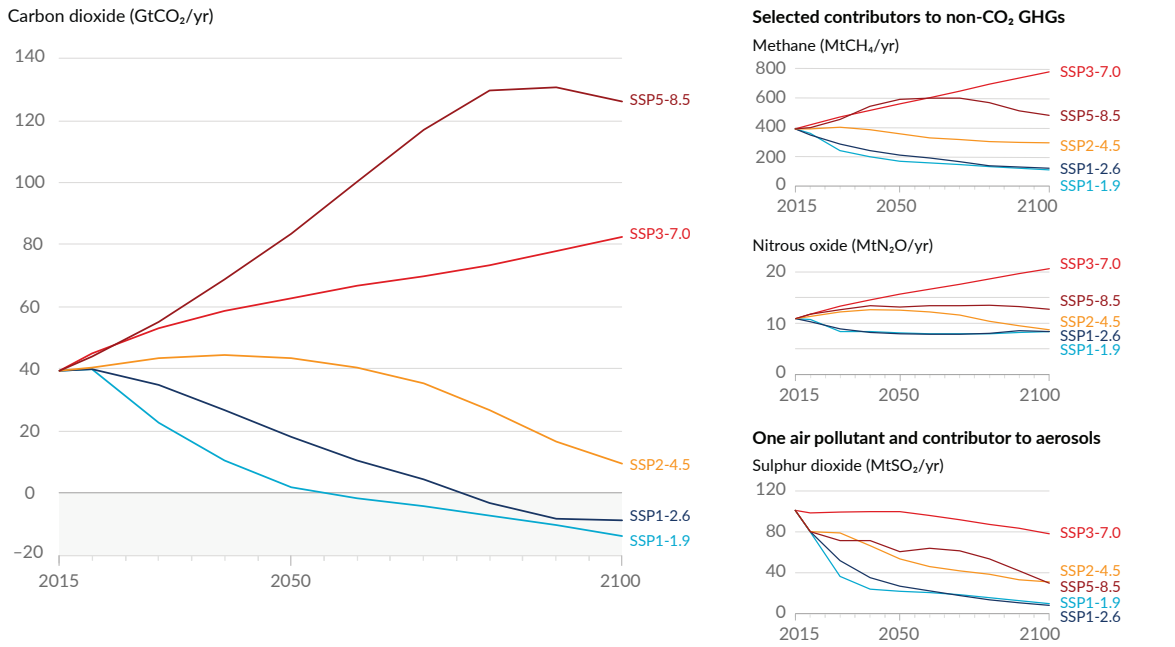
22 Throughout this Report, the five illustrative scenarios are referred to as SSPx-y, where 'SSPx' refers to the Shared Socio-economic Pathway or 'SSP' describing the socio-economic trends underlying the scenario, and 'y' refers to the approximate level of radiative forcing (in watts per square metre, or W m^{-2}) resulting from the scenario in the year 2100. A detailed comparison to scenarios used in earlier IPCC reports is provided in Section TS.1.3, and Sections 1.6 and 4.6. The SSPs that underlie the specific forcing scenarios used to drive climate models are not assessed by WGI. Rather, the SSPx-y labelling ensures traceability to the underlying literature in which specific forcing pathways are used as input to the climate models. IPCC is neutral with regard to the assumptions underlying the SSPs, which do not cover all possible scenarios. Alternative scenarios may be considered or developed.

23 Net negative CO_2 emissions are reached when anthropogenic removals of CO_2 exceed anthropogenic emissions (Glossary).

Box SPM.1 (continued)

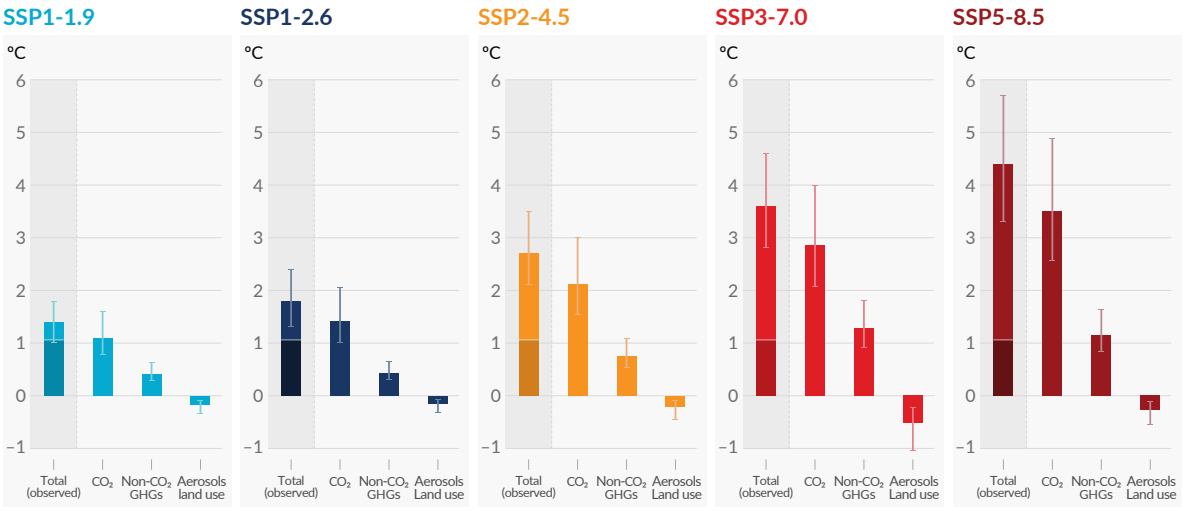
Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

(a) Future annual emissions of CO_2 (left) and of a subset of key non-CO_2 drivers (right), across five illustrative scenarios



(b) Contribution to global surface temperature increase from different emissions, with a dominant role of CO_2 emissions

Change in global surface temperature in 2081–2100 relative to 1850–1900 (°C)



Total warming (observed warming to date in darker shade), warming from CO_2, warming from non-CO_2 GHGs and cooling from changes in aerosols and land use

Figure SPM.4 | Future anthropogenic emissions of key drivers of climate change and warming contributions by groups of drivers for the five illustrative scenarios used in this report

The five scenarios are SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5.

Panel (a) Annual anthropogenic (human-caused) emissions over the 2015–2100 period. Shown are emissions trajectories for carbon dioxide (CO_2) from all sectors ($GtCO_2$/yr) (left graph) and for a subset of three key non-CO_2 drivers considered in the scenarios: methane (CH_4, $MtCH_4$/yr, top-right graph); nitrous oxide (N_2O, MtN_2O/yr, middle-right graph); and sulphur dioxide (SO_2, $MtSO_2$/yr, bottom-right graph, contributing to anthropogenic aerosols in panel (b).

Panel (b) Warming contributions by groups of anthropogenic drivers and by scenario are shown as the change in global surface temperature (°C) in 2081–2100 relative to 1850–1900, with indication of the observed warming to date. Bars and whiskers represent median values and the *very likely* range, respectively. Within each scenario bar plot, the bars represent: total global warming (°C; 'total' bar) (see Table SPM.1); warming contributions (°C) from changes in CO_2 ('CO_2' bar) and from non-CO_2 greenhouse gases (GHGs; 'non-CO_2 GHGs' bar: comprising well-mixed greenhouse gases and ozone); and net cooling from other anthropogenic drivers ('aerosols and land use' bar: anthropogenic aerosols, changes in reflectance due to land-use and irrigation changes, and contrails from aviation) (see Figure SPM.2, panel c, for the warming contributions to date for individual drivers). The best estimate for observed warming in 2010–2019 relative to 1850–1900 (see Figure SPM.2, panel a) is indicated in the darker column in the 'total' bar. Warming contributions in panel (b) are calculated as explained in Table SPM.1 for the total bar. For the other bars, the contribution by groups of drivers is calculated with a physical climate emulator of global surface temperature that relies on climate sensitivity and radiative forcing assessments.

{Cross-Chapter Box 1.4; 4.6; Figure 4.35; 6.7; Figures 6.18, 6.22 and 6.24; 7.3; Cross-Chapter Box 7.1; Figure 7.7; Box TS.7; Figures TS.4 and TS.15}

B.1 Global surface temperature will continue to increase until at least mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO_2 and other greenhouse gas emissions occur in the coming decades. {2.3, Cross-Chapter Box 2.3, Cross-Chapter Box 2.4, 4.3, 4.4, 4.5} (Figure SPM.1, Figure SPM.4, Figure SPM.8, Table SPM.1, Box SPM.1)

B.1.1 Compared to 1850–1900, global surface temperature averaged over 2081–2100 is *very likely* to be higher by 1.0°C to 1.8°C under the very low GHG emissions scenario considered (SSP1-1.9), by 2.1°C to 3.5°C in the intermediate GHG emissions scenario (SSP2-4.5) and by 3.3°C to 5.7°C under the very high GHG emissions scenario (SSP5-8.5).[24] The last time global surface temperature was sustained at or above 2.5°C higher than 1850–1900 was over 3 million years ago (*medium confidence*).
{2.3, Cross-Chapter Box 2.4, 4.3, 4.5, Box TS.2, Box TS.4, Cross-Section Box TS.1} (Table SPM.1)

Table SPM.1 | Changes in global surface temperature, which are assessed based on multiple lines of evidence, for selected 20-year time periods and the five illustrative emissions scenarios considered. Temperature differences relative to the average global surface temperature of the period 1850–1900 are reported in °C. This includes the revised assessment of observed historical warming for the AR5 reference period 1986–2005, which in AR6 is higher by 0.08 [–0.01 to +0.12] °C than in AR5 (see footnote 10). Changes relative to the recent reference period 1995–2014 may be calculated approximately by subtracting 0.85°C, the best estimate of the observed warming from 1850–1900 to 1995–2014.
{Cross-Chapter Box 2.3, 4.3, 4.4, Cross-Section Box TS.1}

	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

B.1.2 Based on the assessment of multiple lines of evidence, global warming of 2°C, relative to 1850–1900, would be exceeded during the 21st century under the high and very high GHG emissions scenarios considered in this report (SSP3-7.0 and SSP5-8.5, respectively). Global warming of 2°C would *extremely likely* be exceeded in the intermediate GHG emissions scenario (SSP2-4.5). Under the very low and low GHG emissions scenarios, global warming of 2°C is *extremely unlikely* to be exceeded (SSP1-1.9) or *unlikely* to be exceeded (SSP1-2.6).[25] Crossing the 2°C global warming level in the mid-term period (2041–2060) is *very likely* to occur under the very high GHG emissions scenario (SSP5-8.5), *likely* to occur under the high GHG emissions scenario (SSP3-7.0), and *more likely than not* to occur in the intermediate GHG emissions scenario (SSP2-4.5).[26]
{4.3, Cross-Section Box TS.1} (Table SPM.1, Figure SPM.4, Box SPM.1)

24 Changes in global surface temperature are reported as running 20-year averages, unless stated otherwise.

25 SSP1-1.9 and SSP1-2.6 are scenarios that start in 2015 and have very low and low GHG emissions, respectively, and CO_2 emissions declining to net zero around or after 2050, followed by varying levels of net negative CO_2 emissions.

26 Crossing is defined here as having the assessed global surface temperature change, averaged over a 20-year period, exceed a particular global warming level.

B.1.3 Global warming of 1.5°C relative to 1850–1900 would be exceeded during the 21st century under the intermediate, high and very high GHG emissions scenarios considered in this report (SSP2-4.5, SSP3-7.0 and SSP5-8.5, respectively). Under the five illustrative scenarios, in the near term (2021–2040), the 1.5°C global warming level is *very likely* to be exceeded under the very high GHG emissions scenario (SSP5-8.5), *likely* to be exceeded under the intermediate and high GHG emissions scenarios (SSP2-4.5 and SSP3-7.0), *more likely than not* to be exceeded under the low GHG emissions scenario (SSP1-2.6) and *more likely than not* to be reached under the very low GHG emissions scenario (SSP1-1.9).[27] Furthermore, for the very low GHG emissions scenario (SSP1-1.9), it is *more likely than not* that global surface temperature would decline back to below 1.5°C toward the end of the 21st century, with a temporary overshoot of no more than 0.1°C above 1.5°C global warming.
{4.3, Cross-Section Box TS.1} (Table SPM.1, Figure SPM.4)

B.1.4 Global surface temperature in any single year can vary above or below the long-term human-induced trend, due to substantial natural variability.[28] The occurrence of individual years with global surface temperature change above a certain level, for example 1.5°C or 2°C, relative to 1850–1900 does not imply that this global warming level has been reached.[29]
{Cross-Chapter Box 2.3, 4.3, 4.4, Box 4.1, Cross-Section Box TS.1} (Table SPM.1, Figure SPM.1, Figure SPM.8)

B.2 Many changes in the climate system become larger in direct relation to increasing global warming. They include increases in the frequency and intensity of hot extremes, marine heatwaves, heavy precipitation, and, in some regions, agricultural and ecological droughts; an increase in the proportion of intense tropical cyclones; and reductions in Arctic sea ice, snow cover and permafrost.
{4.3, 4.5, 4.6, 7.4, 8.2, 8.4, Box 8.2, 9.3, 9.5, Box 9.2, 11.1, 11.2, 11.3, 11.4, 11.6, 11.7, 11.9, Cross-Chapter Box 11.1, 12.4, 12.5, Cross-Chapter Box 12.1, Atlas.4, Atlas.5, Atlas.6, Atlas.7, Atlas.8, Atlas.9, Atlas.10, Atlas.11} (Figure SPM.5, Figure SPM.6, Figure SPM.8)

B.2.1 It is *virtually certain* that the land surface will continue to warm more than the ocean surface (*likely* 1.4 to 1.7 times more). It is *virtually certain* that the Arctic will continue to warm more than global surface temperature, with *high confidence* above two times the rate of global warming.
{2.3, 4.3, 4.5, 4.6, 7.4, 11.1, 11.3, 11.9, 12.4, 12.5, Cross-Chapter Box 12.1, Atlas.4, Atlas.5, Atlas.6, Atlas.7, Atlas.8, Atlas.9, Atlas.10, Atlas.11, Cross-Section Box TS.1, TS.2.6} (Figure SPM.5)

B.2.2 With every additional increment of global warming, changes in extremes continue to become larger. For example, every additional 0.5°C of global warming causes clearly discernible increases in the intensity and frequency of hot extremes, including heatwaves (*very likely*), and heavy precipitation (*high confidence*), as well as agricultural and ecological droughts[30] in some regions (*high confidence*). Discernible changes in intensity and frequency of meteorological droughts, with more regions showing increases than decreases, are seen in some regions for every additional 0.5°C of global warming (*medium confidence*). Increases in frequency and intensity of hydrological droughts become larger with increasing global warming in some regions (*medium confidence*). There will be an increasing occurrence of some extreme events unprecedented in the observational record with additional global warming, even at 1.5°C of global warming. Projected percentage changes in frequency are larger for rarer events (*high confidence*).
{8.2, 11.2, 11.3, 11.4, 11.6, 11.9, Cross-Chapter Box 11.1, Cross-Chapter Box 12.1, TS.2.6} (Figure SPM.5, Figure SPM.6)

B.2.3 Some mid-latitude and semi-arid regions, and the South American Monsoon region, are projected to see the highest increase in the temperature of the hottest days, at about 1.5 to 2 times the rate of global warming (*high confidence*). The Arctic is projected to experience the highest increase in the temperature of the coldest days, at about three times the rate of global warming (*high confidence*). With additional global warming, the frequency of marine heatwaves will continue to increase (*high confidence*), particularly in the tropical ocean and the Arctic (*medium confidence*).
{Box 9.2, 11.1, 11.3, 11.9, Cross-Chapter Box 11.1, Cross-Chapter Box 12.1, 12.4, TS.2.4, TS.2.6} (Figure SPM.6)

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27 The AR6 assessment of when a given global warming level is first exceeded benefits from the consideration of the illustrative scenarios, the multiple lines of evidence entering the assessment of future global surface temperature response to radiative forcing, and the improved estimate of historical warming. The AR6 assessment is thus not directly comparable to the SR1.5 SPM, which reported *likely* reaching 1.5°C global warming between 2030 and 2052, from a simple linear extrapolation of warming rates of the recent past. When considering scenarios similar to SSP1-1.9 instead of linear extrapolation, the SR1.5 estimate of when 1.5°C global warming is first exceeded is close to the best estimate reported here.

28 Natural variability refers to climatic fluctuations that occur without any human influence, that is, internal variability combined with the response to external natural factors such as volcanic eruptions, changes in solar activity and, on longer time scales, orbital effects and plate tectonics (Glossary).

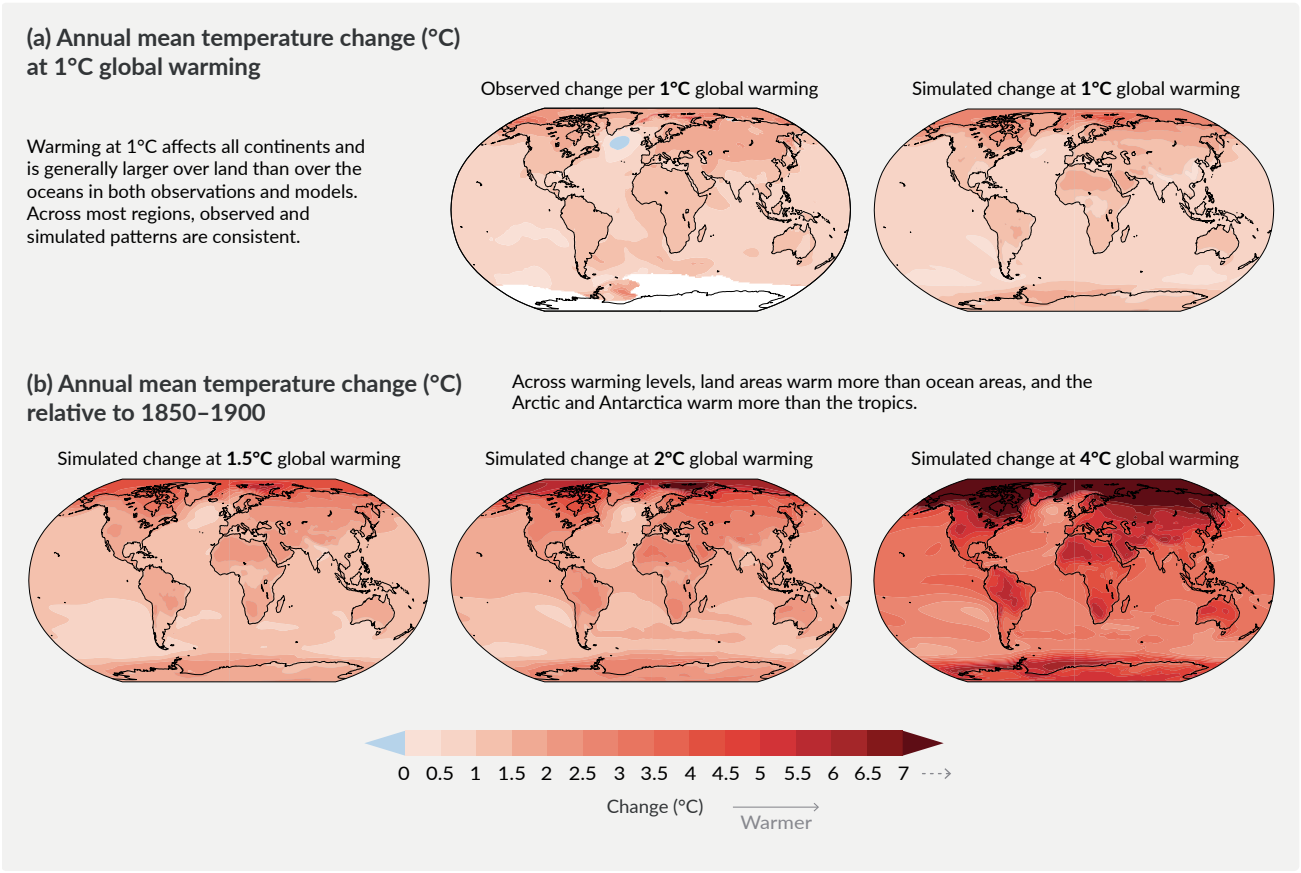
29 The internal variability in any single year is estimated to be about ±0.25°C (5–95% range, *high confidence*).

30 Projected changes in agricultural and ecological droughts are primarily assessed based on total column soil moisture. See footnote 15 for definition and relation to precipitation and evapotranspiration.

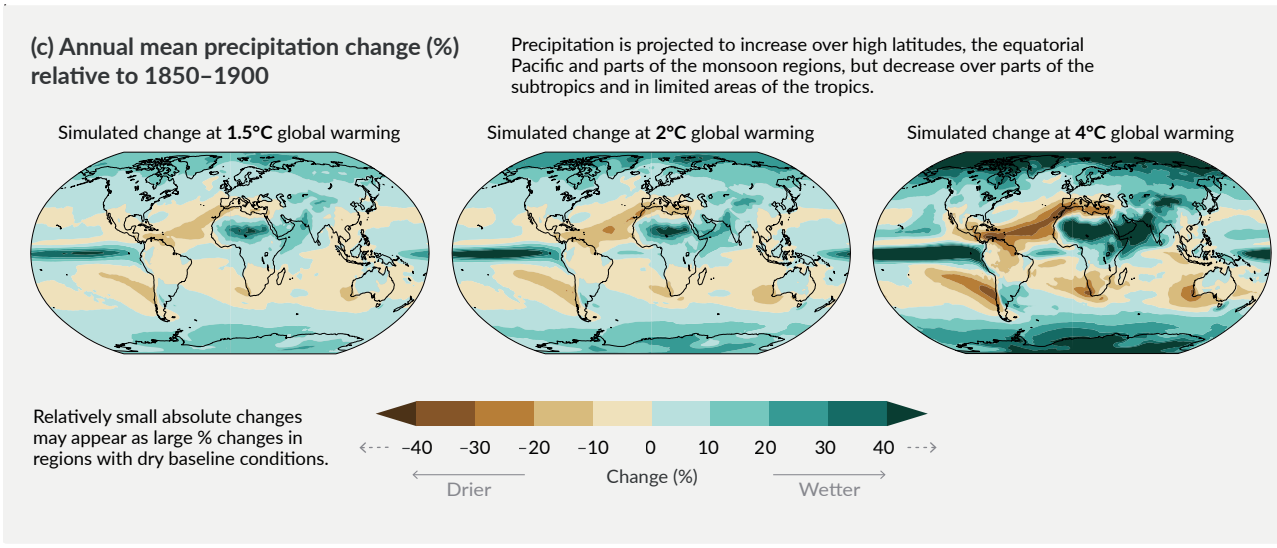
B.2.4 It is *very likely* that heavy precipitation events will intensify and become more frequent in most regions with additional global warming. At the global scale, extreme daily precipitation events are projected to intensify by about 7% for each 1°C of global warming (*high confidence*). The proportion of intense tropical cyclones (Category 4–5) and peak wind speeds of the most intense tropical cyclones are projected to increase at the global scale with increasing global warming (*high confidence*). {8.2, 11.4, 11.7, 11.9, Cross-Chapter Box 11.1, Box TS.6, TS.4.3.1} (Figure SPM.5, Figure SPM.6)

B.2.5 Additional warming is projected to further amplify permafrost thawing and loss of seasonal snow cover, of land ice and of Arctic sea ice (*high confidence*). The Arctic is *likely* to be practically sea ice-free in September[31] at least once before 2050 under the five illustrative scenarios considered in this report, with more frequent occurrences for higher warming levels. There is *low confidence* in the projected decrease of Antarctic sea ice. {4.3, 4.5, 7.4, 8.2, 8.4, Box 8.2, 9.3, 9.5, 12.4, Cross-Chapter Box 12.1, Atlas.5, Atlas.6, Atlas.8, Atlas.9, Atlas.11, TS.2.5} (Figure SPM.8)

With every increment of global warming, changes get larger in regional mean temperature, precipitation and soil moisture



31 Monthly average sea ice area of less than 1 million km², which is about 15% of the average September sea ice area observed in 1979–1988.



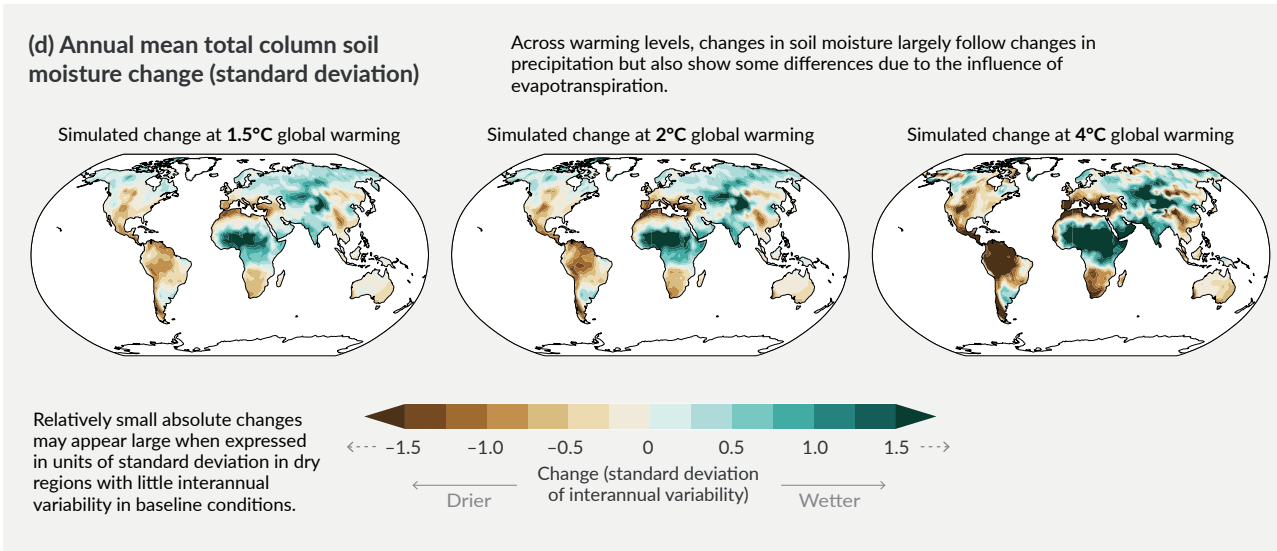


Figure SPM.5 | Changes in annual mean surface temperature, precipitation, and soil moisture

Panel (a) Comparison of observed and simulated annual mean surface temperature change. The **left map** shows the observed changes in annual mean surface temperature in the period 1850–2020 per °C of global warming (°C). The local (i.e., grid point) observed annual mean surface temperature changes are linearly regressed against the global surface temperature in the period 1850–2020. Observed temperature data are from Berkeley Earth, the dataset with the largest coverage and highest horizontal resolution. Linear regression is applied to all years for which data at the corresponding grid point is available. The regression method was used to take into account the complete observational time series and thereby reduce the role of internal variability at the grid point level. White indicates areas where time coverage was 100 years or less and thereby too short to calculate a reliable linear regression. The **right map** is based on model simulations and shows change in annual multi-model mean simulated temperatures at a global warming level of 1°C (20-year mean global surface temperature change relative to 1850–1900). The triangles at each end of the colour bar indicate out-of-bound values, that is, values above or below the given limits.

Panel (b) Simulated annual mean temperature change (°C), panel (c) precipitation change (%), and panel (d) total column soil moisture change (standard deviation of interannual variability) at global warming levels of 1.5°C, 2°C and 4°C (20-year mean global surface temperature change relative to 1850–1900). Simulated changes correspond to Coupled Model Intercomparison Project Phase 6 (CMIP6) multi-model mean change (median change for soil moisture) at the corresponding global warming level, that is, the same method as for the right map in panel (a).

In **panel (c)**, high positive percentage changes in dry regions may correspond to small absolute changes. In **panel (d)**, the unit is the standard deviation of interannual variability in soil moisture during 1850–1900. Standard deviation is a widely used metric in characterizing drought severity. A projected reduction in mean soil moisture by one standard deviation corresponds to soil moisture conditions typical of droughts that occurred about once every six years during 1850–1900. In panel (d), large changes in dry regions with little interannual variability in the baseline conditions can correspond to small absolute change. The triangles at each end of the colour bars indicate out-of-bound values, that is, values above or below the given limits. Results from all models reaching the corresponding warming level in any of the five illustrative scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5) are averaged. Maps of annual mean temperature and precipitation changes at a global warming level of 3°C are available in Figure 4.31 and Figure 4.32 in Section 4.6. Corresponding maps of panels (b), (c) and (d), including hatching to indicate the level of model agreement at grid-cell level, are found in Figures 4.31, 4.32 and 11.19, respectively; as highlighted in Cross-Chapter Box Atlas.1, grid-cell level hatching is not informative for larger spatial scales (e.g., over AR6 reference regions) where the aggregated signals are less affected by small-scale variability, leading to an increase in robustness.

{Figure 1.14, 4.6.1, Cross-Chapter Box 11.1, Cross-Chapter Box Atlas.1, TS.1.3.2, Figures TS.3 and TS.5}

Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

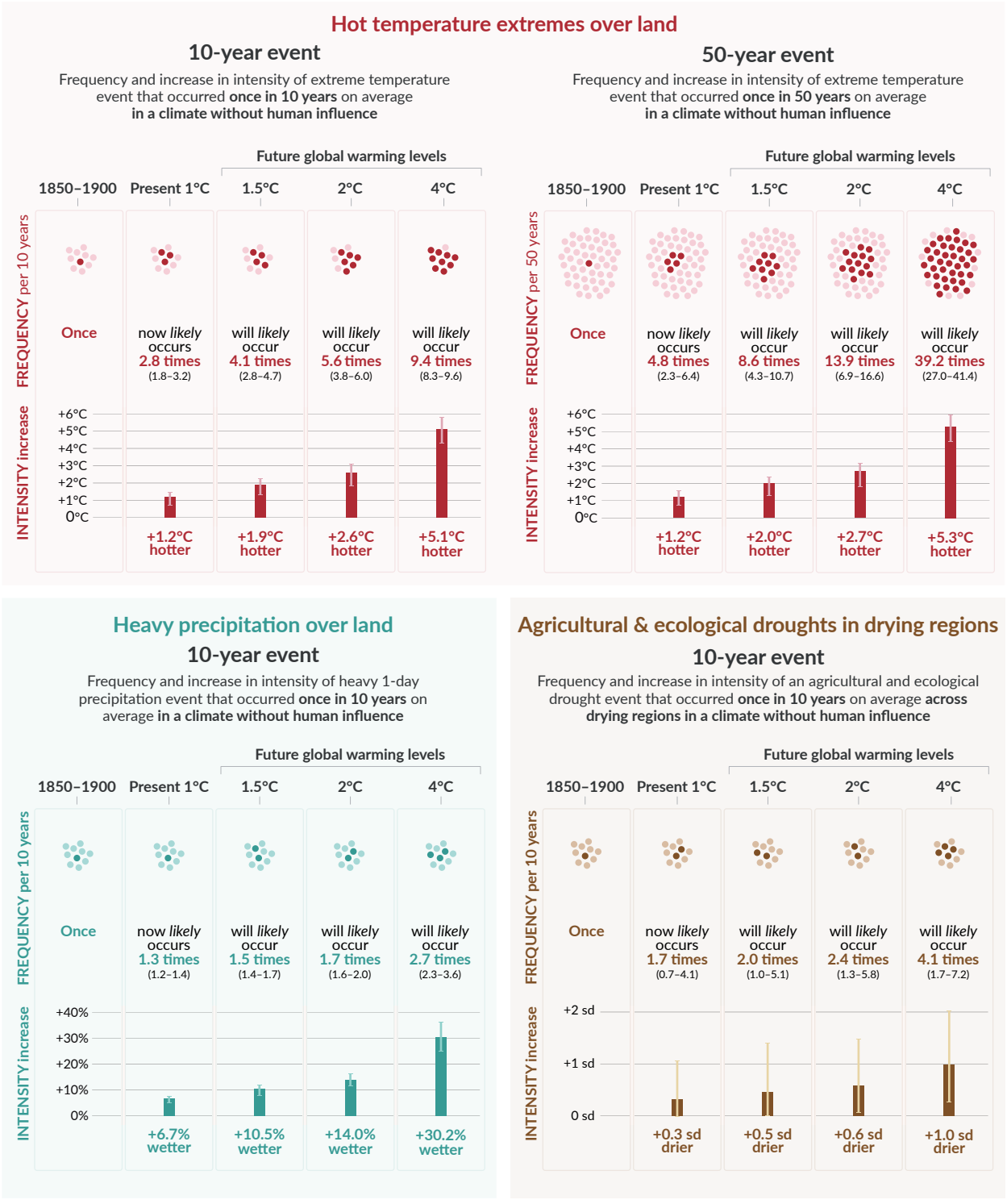


Figure SPM.6 | Projected changes in the intensity and frequency of hot temperature extremes over land, extreme precipitation over land, and agricultural and ecological droughts in drying regions

Projected changes are shown at global warming levels of 1°C, 1.5°C, 2°C, and 4°C and are relative to 1850–1900,[9] representing a climate without human influence. The figure depicts frequencies and increases in intensity of 10- or 50-year extreme events from the base period (1850–1900) under different global warming levels.

Hot temperature extremes are defined as the daily maximum temperatures over land that were exceeded on average once in a decade (10-year event) or once in 50 years (50-year event) during the 1850–1900 reference period. **Extreme precipitation events** are defined as the daily precipitation amount over land that

was exceeded on average once in a decade during the 1850–1900 reference period. **Agricultural and ecological drought events** are defined as the annual average of total column soil moisture below the 10th percentile of the 1850–1900 base period. These extremes are defined on model grid box scale. For hot temperature extremes and extreme precipitation, results are shown for the global land. For agricultural and ecological drought, results are shown for drying regions only, which correspond to the AR6 regions in which there is at least *medium confidence* in a projected increase in agricultural and ecological droughts at the 2°C warming level compared to the 1850–1900 base period in the Coupled Model Intercomparison Project Phase 6 (CMIP6). These regions include Western North America, Central North America, Northern Central America, Southern Central America, Caribbean, Northern South America, North-Eastern South America, South American Monsoon, South-Western South America, Southern South America, Western and Central Europe, Mediterranean, West Southern Africa, East Southern Africa, Madagascar, Eastern Australia, and Southern Australia (Caribbean is not included in the calculation of the figure because of the too-small number of full land grid cells). The non-drying regions do not show an overall increase or decrease in drought severity. Projections of changes in agricultural and ecological droughts in the CMIP Phase 5 (CMIP5) multi-model ensemble differ from those in CMIP6 in some regions, including in parts of Africa and Asia. Assessments of projected changes in meteorological and hydrological droughts are provided in Chapter 11.

In the **'frequency' section**, each year is represented by a dot. The dark dots indicate years in which the extreme threshold is exceeded, while light dots are years when the threshold is not exceeded. Values correspond to the medians (in bold) and their respective 5–95% range based on the multi-model ensemble from simulations of CMIP6 under different Shared Socio-economic Pathway scenarios. For consistency, the number of dark dots is based on the rounded-up median. In the **'intensity' section**, medians and their 5–95% range, also based on the multi-model ensemble from simulations of CMIP6, are displayed as dark and light bars, respectively. Changes in the intensity of hot temperature extremes and extreme precipitation are expressed as degree Celsius and percentage. As for agricultural and ecological drought, intensity changes are expressed as fractions of standard deviation of annual soil moisture.

{11.1; 11.3; 11.4; 11.6; 11.9; Figures 11.12, 11.15, 11.6, 11.7, and 11.18}

B.3 Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events. {4.3, 4.4, 4.5, 4.6, 8.2, 8.3, 8.4, 8.5, Box 8.2, 11.4, 11.6, 11.9, 12.4, Atlas.3} (Figure SPM.5, Figure SPM.6)

B.3.1 There is strengthened evidence since AR5 that the global water cycle will continue to intensify as global temperatures rise (*high confidence*), with precipitation and surface water flows projected to become more variable over most land regions within seasons (*high confidence*) and from year to year (*medium confidence*). The average annual global land precipitation is projected to increase by 0–5% under the very low GHG emissions scenario (SSP1-1.9), 1.5–8% for the intermediate GHG emissions scenario (SSP2-4.5) and 1–13% under the very high GHG emissions scenario (SSP5-8.5) by 2081–2100 relative to 1995–2014 (*likely* ranges). Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and limited areas in the tropics in SSP2-4.5, SSP3-7.0 and SSP5-8.5 (*very likely*). The portion of the global land experiencing detectable increases or decreases in seasonal mean precipitation is projected to increase (*medium confidence*). There is *high confidence* in an earlier onset of spring snowmelt, with higher peak flows at the expense of summer flows in snow-dominated regions globally.
{4.3, 4.5, 4.6, 8.2, 8.4, Atlas.3, TS.2.6, TS.4.3, Box TS.6} (Figure SPM.5)

B.3.2 A warmer climate will intensify very wet and very dry weather and climate events and seasons, with implications for flooding or drought (*high confidence*), but the location and frequency of these events depend on projected changes in regional atmospheric circulation, including monsoons and mid-latitude storm tracks. It is *very likely* that rainfall variability related to the El Niño–Southern Oscillation is projected to be amplified by the second half of the 21st century in the SSP2-4.5, SSP3-7.0 and SSP5-8.5 scenarios.
{4.3, 4.5, 4.6, 8.2, 8.4, 8.5, 11.4, 11.6, 11.9, 12.4, TS.2.6, TS.4.2, Box TS.6} (Figure SPM.5, Figure SPM.6)

B.3.3 Monsoon precipitation is projected to increase in the mid- to long term at the global scale, particularly over South and South East Asia, East Asia and West Africa apart from the far west Sahel (*high confidence*). The monsoon season is projected to have a delayed onset over North and South America and West Africa (*high confidence*) and a delayed retreat over West Africa (*medium confidence*).
{4.4, 4.5, 8.2, 8.3, 8.4, Box 8.2, Box TS.13}

B.3.4 A projected southward shift and intensification of Southern Hemisphere summer mid-latitude storm tracks and associated precipitation is *likely* in the long term under high GHG emissions scenarios (SSP3-7.0, SSP5-8.5), but in the near term the effect of stratospheric ozone recovery counteracts these changes (*high confidence*). There is *medium confidence* in a continued poleward shift of storms and their precipitation in the North Pacific, while there is *low confidence* in projected changes in the North Atlantic storm tracks.
{4.4, 4.5, 8.4, TS.2.3, TS.4.2}

B.4 Under scenarios with increasing CO_2 emissions, the ocean and land carbon sinks are projected to be less effective at slowing the accumulation of CO_2 in the atmosphere. {4.3, 5.2, 5.4, 5.5, 5.6} (Figure SPM.7)

B.4.1 While natural land and ocean carbon sinks are projected to take up, in absolute terms, a progressively larger amount of CO_2 under higher compared to lower CO_2 emissions scenarios, they become less effective, that is, the proportion of emissions taken up by land and ocean decrease with increasing cumulative CO_2 emissions. This is projected to result in a higher proportion of emitted CO_2 remaining in the atmosphere (*high confidence*).
{5.2, 5.4, Box TS.5} (Figure SPM.7)

B.4.2 Based on model projections, under the intermediate GHG emissions scenario that stabilizes atmospheric CO_2 concentrations this century (SSP2-4.5), the rates of CO_2 taken up by the land and ocean are projected to decrease in the second half of the 21st century (*high confidence*). Under the very low and low GHG emissions scenarios (SSP1-1.9, SSP1-2.6), where CO_2 concentrations peak and decline during the 21st century, the land and ocean begin to take up less carbon in response to declining atmospheric CO_2 concentrations (*high confidence*) and turn into a weak net source by 2100 under SSP1-1.9 (*medium confidence*). It is *very unlikely* that the combined global land and ocean sink will turn into a source by 2100 under scenarios without net negative emissions (SSP2-4.5, SSP3-7.0, SSP5-8.5).[32]
{4.3, 5.4, 5.5, 5.6, Box TS.5, TS.3.3}

B.4.3 The magnitude of feedbacks between climate change and the carbon cycle becomes larger but also more uncertain in high CO_2 emissions scenarios (*very high confidence*). However, climate model projections show that the uncertainties in atmospheric CO_2 concentrations by 2100 are dominated by the differences between emissions scenarios (*high confidence*). Additional ecosystem responses to warming not yet fully included in climate models, such as CO_2 and CH_4 fluxes from wetlands, permafrost thaw and wildfires, would further increase concentrations of these gases in the atmosphere (*high confidence*).
{5.4, Box TS.5, TS.3.2}

The proportion of CO_2 emissions taken up by land and ocean carbon sinks is smaller in scenarios with higher cumulative CO_2 emissions

Total cumulative CO_2 emissions **taken up by land and ocean** (colours) and remaining in the atmosphere (grey) under the five illustrative scenarios from 1850 to 2100

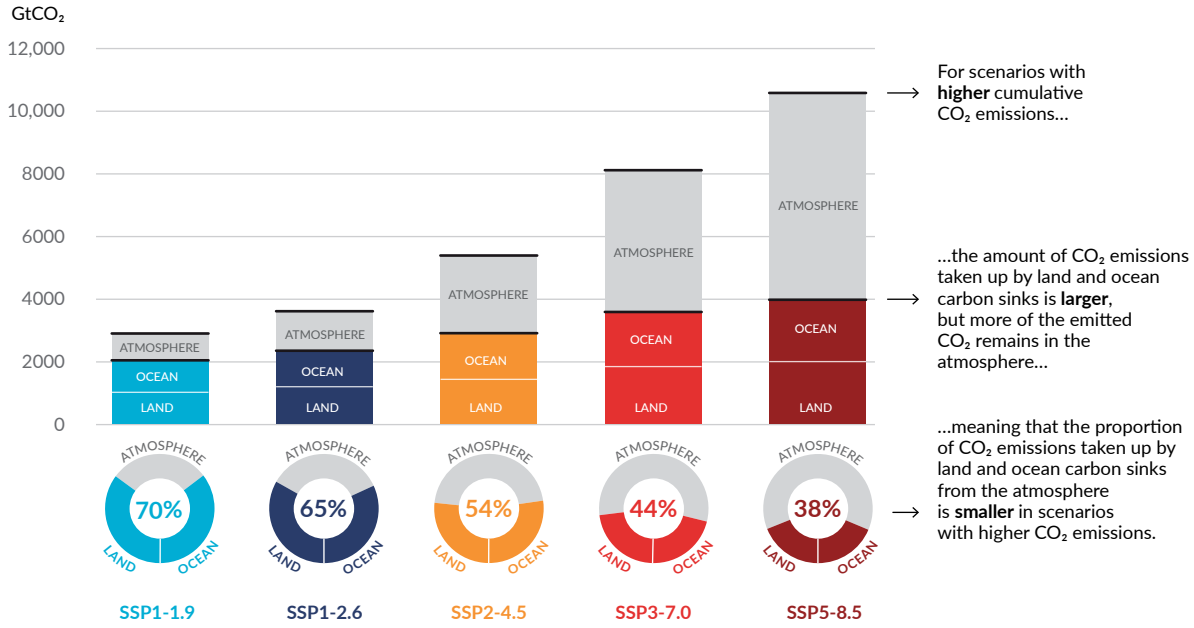


Figure SPM.7 | Cumulative anthropogenic CO_2 emissions taken up by land and ocean sinks by 2100 under the five illustrative scenarios

The cumulative anthropogenic (human-caused) carbon dioxide (CO_2) emissions taken up by the land and ocean sinks under the five illustrative scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5) are simulated from 1850 to 2100 by Coupled Model Intercomparison Project Phase 6 (CMIP6) climate models in the concentration-driven simulations. Land and ocean carbon sinks respond to past, current and future emissions; therefore, cumulative sinks from 1850 to 2100 are presented here. During the historical period (1850–2019) the observed land and ocean sink took up 1430 $GtCO_2$ (59% of the emissions).

32 These projected adjustments of carbon sinks to stabilization or decline of atmospheric CO_2 are accounted for in calculations of remaining carbon budgets.

The bar chart illustrates the projected amount of cumulative anthropogenic CO_2 emissions ($GtCO_2$) between 1850 and 2100 remaining in the atmosphere (grey part) and taken up by the land and ocean (coloured part) in the year 2100. **The doughnut chart** illustrates the proportion of the cumulative anthropogenic CO_2 emissions taken up by the land and ocean sinks and remaining in the atmosphere in the year 2100. Values in % indicate the proportion of the cumulative anthropogenic CO_2 emissions taken up by the combined land and ocean sinks in the year 2100. The overall anthropogenic carbon emissions are calculated by adding the net global land-use emissions from the CMIP6 scenario database to the other sectoral emissions calculated from climate model runs with prescribed CO_2 concentrations.[33] Land and ocean CO_2 uptake since 1850 is calculated from the net biome productivity on land, corrected for CO_2 losses due to land-use change by adding the land-use change emissions, and net ocean CO_2 flux.

{5.2.1; Table 5.1; 5.4.5; Figure 5.25; Box TS.5; Box TS.5, Figure 1}

B.5 Many changes due to past and future greenhouse gas emissions are irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea level. {2.3, Cross-Chapter Box 2.4, 4.3, 4.5, 4.7, 5.3, 9.2, 9.4, 9.5, 9.6, Box 9.4} (Figure SPM.8)

B.5.1 Past GHG emissions since 1750 have committed the global ocean to future warming (*high confidence*). Over the rest of the 21st century, *likely* ocean warming ranges from 2–4 (SSP1-2.6) to 4–8 times (SSP5-8.5) the 1971–2018 change. Based on multiple lines of evidence, upper ocean stratification (*virtually certain*), ocean acidification (*virtually certain*) and ocean deoxygenation (*high confidence*) will continue to increase in the 21st century, at rates dependent on future emissions. Changes are irreversible on centennial to millennial time scales in global ocean temperature (*very high confidence*), deep-ocean acidification (*very high confidence*) and deoxygenation (*medium confidence*).
{4.3, 4.5, 4.7, 5.3, 9.2, TS.2.4} (Figure SPM.8)

B.5.2 Mountain and polar glaciers are committed to continue melting for decades or centuries (*very high confidence*). Loss of permafrost carbon following permafrost thaw is irreversible at centennial time scales (*high confidence*). Continued ice loss over the 21st century is *virtually certain* for the Greenland Ice Sheet and *likely* for the Antarctic Ice Sheet. There is *high confidence* that total ice loss from the Greenland Ice Sheet will increase with cumulative emissions. There is *limited evidence* for low-likelihood, high-impact outcomes (resulting from ice-sheet instability processes characterized by deep uncertainty and in some cases involving tipping points) that would strongly increase ice loss from the Antarctic Ice Sheet for centuries under high GHG emissions scenarios.[34]
{4.3, 4.7, 5.4, 9.4, 9.5, Box 9.4, Box TS.1, TS.2.5}

B.5.3 It is *virtually certain* that global mean sea level will continue to rise over the 21st century. Relative to 1995–2014, the *likely* global mean sea level rise by 2100 is 0.28–0.55 m under the very low GHG emissions scenario (SSP1-1.9); 0.32–0.62 m under the low GHG emissions scenario (SSP1-2.6); 0.44–0.76 m under the intermediate GHG emissions scenario (SSP2-4.5); and 0.63–1.01 m under the very high GHG emissions scenario (SSP5-8.5); and by 2150 is 0.37–0.86 m under the very low scenario (SSP1-1.9); 0.46–0.99 m under the low scenario (SSP1-2.6); 0.66–1.33 m under the intermediate scenario (SSP2-4.5); and 0.98–1.88 m under the very high scenario (SSP5-8.5) (*medium confidence*).[35] Global mean sea level rise above the *likely* range – approaching 2 m by 2100 and 5 m by 2150 under a very high GHG emissions scenario (SSP5-8.5) (*low confidence*) – cannot be ruled out due to deep uncertainty in ice-sheet processes.
{4.3, 9.6, Box 9.4, Box TS.4} (Figure SPM.8)

B.5.4 In the longer term, sea level is committed to rise for centuries to millennia due to continuing deep-ocean warming and ice-sheet melt and will remain elevated for thousands of years (*high confidence*). Over the next 2000 years, global mean sea level will rise by about 2 to 3 m if warming is limited to 1.5°C, 2 to 6 m if limited to 2°C and 19 to 22 m with 5°C of warming, and it will continue to rise over subsequent millennia (*low confidence*). Projections of multi-millennial global mean sea level rise are consistent with reconstructed levels during past warm climate periods: *likely* 5–10 m higher than today around 125,000 years ago, when global temperatures were *very likely* 0.5°C–1.5°C higher than 1850–1900; and *very likely* 5–25 m higher roughly 3 million years ago, when global temperatures were 2.5°C–4°C higher (*medium confidence*).
{2.3, Cross-Chapter Box 2.4, 9.6, Box TS.2, Box TS.4, Box TS.9}

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33 The other sectoral emissions are calculated as the residual of the net land and ocean CO_2 uptake and the prescribed atmospheric CO_2 concentration changes in the CMIP6 simulations. These calculated emissions are net emissions and do not separate gross anthropogenic emissions from removals, which are included implicitly.

34 Low-likelihood, high-impact outcomes are those whose probability of occurrence is low or not well known (as in the context of deep uncertainty) but whose potential impacts on society and ecosystems could be high. A tipping point is a critical threshold beyond which a system reorganizes, often abruptly and/or irreversibly. (Glossary) {1.4, Cross-Chapter Box 1.3, 4.7}

35 To compare to the 1986–2005 baseline period used in AR5 and SROCC, add 0.03 m to the global mean sea level rise estimates. To compare to the 1900 baseline period used in Figure SPM.8, add 0.16 m.

Human activities affect all the major climate system components, with some responding over decades and others over centuries

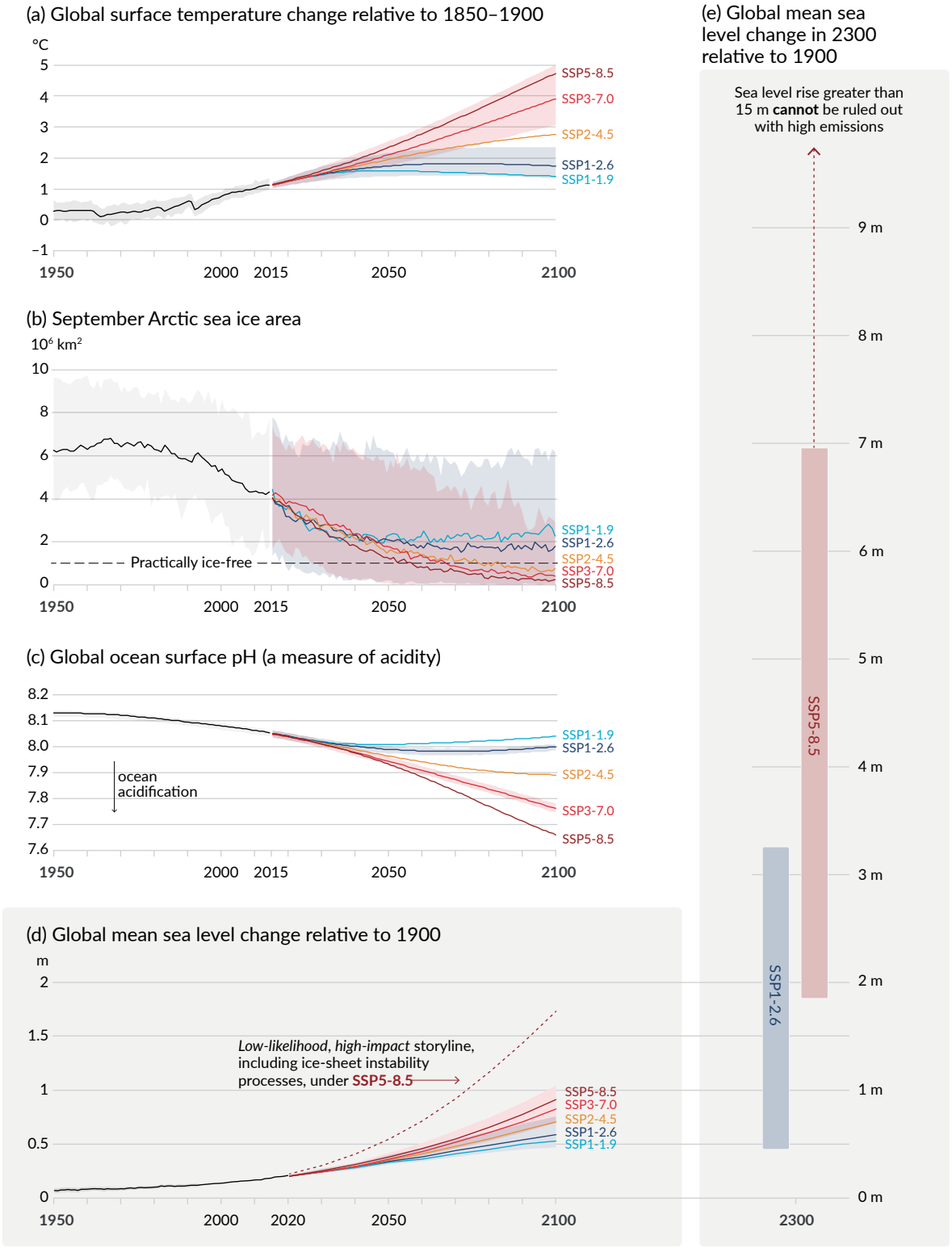

Figure SPM.8 | Selected indicators of global climate change under the five illustrative scenarios used in this Report

The projections for each of the five scenarios are shown in colour. Shades represent uncertainty ranges – more detail is provided for each panel below. The black curves represent the historical simulations (panels a, b, c) or the observations (panel d). Historical values are included in all graphs to provide context for the projected future changes.

Panel (a) Global surface temperature changes in °C relative to 1850–1900. These changes were obtained by combining Coupled Model Intercomparison Project Phase 6 (CMIP6) model simulations with observational constraints based on past simulated warming, as well as an updated assessment of equilibrium climate sensitivity (see Box SPM.1). Changes relative to 1850–1900 based on 20-year averaging periods are calculated by adding 0.85°C (the observed global surface temperature increase from 1850–1900 to 1995–2014) to simulated changes relative to 1995–2014. *Very likely* ranges are shown for SSP1-2.6 and SSP3-7.0.

Panel (b) September Arctic sea ice area in 10^6 km^2 based on CMIP6 model simulations. *Very likely* ranges are shown for SSP1-2.6 and SSP3-7.0. The Arctic is projected to be practically ice-free near mid-century under intermediate and high GHG emissions scenarios.

Panel (c) Global ocean surface pH (a measure of acidity) based on CMIP6 model simulations. *Very likely* ranges are shown for SSP1-2.6 and SSP3-7.0.

Panel (d) Global mean sea level change in metres, relative to 1900. The historical changes are observed (from tide gauges before 1992 and altimeters afterwards), and the future changes are assessed consistently with observational constraints based on emulation of CMIP, ice-sheet, and glacier models. *Likely* ranges are shown for SSP1-2.6 and SSP3-7.0. Only *likely* ranges are assessed for sea level changes due to difficulties in estimating the distribution of deeply uncertain processes. The dashed curve indicates the potential impact of these deeply uncertain processes. It shows the 83rd percentile of SSP5-8.5 projections that include low-likelihood, high-impact ice-sheet processes that cannot be ruled out; because of *low confidence* in projections of these processes, this curve does not constitute part of a *likely* range. Changes relative to 1900 are calculated by adding 0.158 m (observed global mean sea level rise from 1900 to 1995–2014) to simulated and observed changes relative to 1995–2014.

Panel (e) Global mean sea level change at 2300 in metres relative to 1900. Only SSP1-2.6 and SSP5-8.5 are projected at 2300, as simulations that extend beyond 2100 for the other scenarios are too few for robust results. The 17th–83rd percentile ranges are shaded. The dashed arrow illustrates the 83rd percentile of SSP5-8.5 projections that include low-likelihood, high-impact ice-sheet processes that cannot be ruled out.

Panels (b) and (c) are based on single simulations from each model, and so include a component of internal variability. Panels (a), (d) and (e) are based on long-term averages, and hence the contributions from internal variability are small.

{4.3; Figures 4.2, 4.8, and 4.11; 9.6; Figure 9.27; Figures TS.8 and TS.11; Box TS.4, Figure 1}

C. Climate Information for Risk Assessment and Regional Adaptation

Physical climate information addresses how the climate system responds to the interplay between human influence, natural drivers and internal variability. Knowledge of the climate response and the range of possible outcomes, including low-likelihood, high impact outcomes, informs climate services, the assessment of climate-related risks, and adaptation planning. Physical climate information at global, regional and local scales is developed from multiple lines of evidence, including observational products, climate model outputs and tailored diagnostics.

C.1 Natural drivers and internal variability will modulate human-caused changes, especially at regional scales and in the near term, with little effect on centennial global warming. These modulations are important to consider in planning for the full range of possible changes.

{1.4, 2.2, 3.3, Cross-Chapter Box 3.1, 4.4, 4.6, Cross-Chapter Box 4.1, Box 7.2, 8.3, 8.5, 9.2, 10.3, 10.4, 10.6, 11.3, 12.5, Atlas.4, Atlas.5, Atlas.8, Atlas.9, Atlas.10, Atlas.11, Cross-Chapter Box Atlas.2}

C.1.1 The historical global surface temperature record highlights that decadal variability has both enhanced and masked underlying human-caused long-term changes, and this variability will continue into the future (*very high confidence*). For example, internal decadal variability and variations in solar and volcanic drivers partially masked human-caused surface global warming during 1998–2012, with pronounced regional and seasonal signatures (*high confidence*). Nonetheless, the heating of the climate system continued during this period, as reflected in both the continued warming of the global ocean (*very high confidence*) and in the continued rise of hot extremes over land (*medium confidence*).
{1.4, 3.3, Cross-Chapter Box 3.1, 4.4, Box 7.2, 9.2, 11.3, Cross-Section Box TS.1} (Figure SPM.1)

C.1.2 Projected human-caused changes in mean climate and climatic impact-drivers (CIDs),[36] including extremes, will be either amplified or attenuated by internal variability (*high confidence*).[37] Near-term cooling at any particular location with respect to present climate could occur and would be consistent with the global surface temperature increase due to human influence (*high confidence*).
{1.4, 4.4, 4.6, 10.4, 11.3, 12.5, Atlas.5, Atlas.10, Atlas.11, TS.4.2}

36 Climatic impact-drivers (CIDs) are physical climate system conditions (e.g., means, events, extremes) that affect an element of society or ecosystems. Depending on system tolerance, CIDs and their changes can be detrimental, beneficial, neutral, or a mixture of each across interacting system elements and regions (Glossary). CID types include heat and cold, wet and dry, wind, snow and ice, coastal and open ocean.

37 The main internal variability phenomena include El Niño–Southern Oscillation, Pacific Decadal Variability and Atlantic Multi-decadal Variability through their regional influence.

C.1.3 Internal variability has largely been responsible for the amplification and attenuation of the observed human-caused decadal-to-multi-decadal mean precipitation changes in many land regions (*high confidence*). At global and regional scales, near-term changes in monsoons will be dominated by the effects of internal variability (*medium confidence*). In addition to the influence of internal variability, near-term projected changes in precipitation at global and regional scales are uncertain because of model uncertainty and uncertainty in forcings from natural and anthropogenic aerosols (*medium confidence*).
{1.4, 4.4, 8.3, 8.5, 10.3, 10.4, 10.5, 10.6, Atlas.4, Atlas.8, Atlas.9, Atlas.10, Atlas.11, Cross-Chapter Box Atlas.2, TS.4.2, Box TS.6, Box TS.13}

C.1.4 Based on paleoclimate and historical evidence, it is *likely* that at least one large explosive volcanic eruption would occur during the 21st century.[38] Such an eruption would reduce global surface temperature and precipitation, especially over land, for one to three years, alter the global monsoon circulation, modify extreme precipitation and change many CIDs (*medium confidence*). If such an eruption occurs, this would therefore temporarily and partially mask human-caused climate change.
{2.2, 4.4, Cross-Chapter Box 4.1, 8.5, TS.2.1}

C.2 With further global warming, every region is projected to increasingly experience concurrent and multiple changes in climatic impact-drivers. Changes in several climatic impact-drivers would be more widespread at 2°C compared to 1.5°C global warming and even more widespread and/or pronounced for higher warming levels.
{8.2, 9.3, 9.5, 9.6, Box 10.3, 11.3, 11.4, 11.5, 11.6, 11.7, 11.9, Box 11.3, Box 11.4, Cross-Chapter Box 11.1, 12.2, 12.3, 12.4, 12.5, Cross-Chapter Box 12.1, Atlas.4, Atlas.5, Atlas.6, Atlas.7, Atlas.8, Atlas.9, Atlas.10, Atlas.11} (Table SPM.1, Figure SPM.9)

C.2.1 All regions[39] are projected to experience further increases in hot climatic impact-drivers (CIDs) and decreases in cold CIDs (*high confidence*). Further decreases are projected in permafrost; snow, glaciers and ice sheets; and lake and Arctic sea ice (*medium* to *high confidence*).[40] These changes would be larger at 2°C global warming or above than at 1.5°C (*high confidence*). For example, extreme heat thresholds relevant to agriculture and health are projected to be exceeded more frequently at higher global warming levels (*high confidence*).
{9.3, 9.5, 11.3, 11.9, Cross-Chapter Box 11.1, 12.3, 12.4, 12.5, Cross-Chapter Box 12.1, Atlas.4, Atlas.5, Atlas.6, Atlas.7, Atlas.8, Atlas.9, Atlas.10, Atlas.11, TS.4.3} (Table SPM.1, Figure SPM.9)

C.2.2 At 1.5°C global warming, heavy precipitation and associated flooding are projected to intensify and be more frequent in most regions in Africa and Asia (*high confidence*), North America (*medium* to *high confidence*)[40] and Europe (*medium confidence*). Also, more frequent and/or severe agricultural and ecological droughts are projected in a few regions in all inhabited continents except Asia compared to 1850–1900 (*medium confidence*); increases in meteorological droughts are also projected in a few regions (*medium confidence*). A small number of regions are projected to experience increases or decreases in mean precipitation (*medium confidence*).
{11.4, 11.5, 11.6, 11.9, Atlas.4, Atlas.5, Atlas.7, Atlas.8, Atlas.9, Atlas.10, Atlas.11, TS.4.3} (Table SPM.1)

C.2.3 At 2°C global warming and above, the level of confidence in and the magnitude of the change in droughts and heavy and mean precipitation increase compared to those at 1.5°C. Heavy precipitation and associated flooding events are projected to become more intense and frequent in the Pacific Islands and across many regions of North America and Europe (*medium* to *high confidence*).[40] These changes are also seen in some regions in Australasia and Central and South America (*medium confidence*). Several regions in Africa, South America and Europe are projected to experience an increase in frequency and/or severity of agricultural and ecological droughts with *medium* to *high confidence*;[40] increases are also projected in Australasia, Central and North America, and the Caribbean with *medium confidence*. A small number of regions in Africa, Australasia, Europe and North America are also projected to be affected by increases in hydrological droughts, and several regions are projected to be affected by increases or decreases in meteorological droughts, with more regions displaying an increase (*medium confidence*). Mean precipitation is projected to increase in all polar, northern European and northern North American regions, most Asian regions and two regions of South America (*high confidence*).
{11.4, 11.6, 11.9, Cross-Chapter Box 11.1, 12.4, 12.5, Cross-Chapter Box 12.1, Atlas.5, Atlas.7, Atlas.8, Atlas.9, Atlas.11, TS.4.3} (Table SPM.1, Figure SPM.5, Figure SPM.6, Figure SPM.9)

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38 Based on 2500 year reconstructions, eruptions more negative than –1 W m^{-2} occur on average twice per century.

39 Regions here refer to the AR6 WGI reference regions used in this Report to summarize information in sub-continental and oceanic regions. Changes are compared to averages over the last 20–40 years unless otherwise specified. {1.4, 12.4, Atlas.1}.

40 The specific level of confidence or likelihood depends on the region considered. Details can be found in the Technical Summary and the underlying Report.

C.2.4 More CIDs across more regions are projected to change at 2°C and above compared to 1.5°C global warming (*high confidence*). Region-specific changes include intensification of tropical cyclones and/or extratropical storms (*medium confidence*), increases in river floods (*medium* to *high confidence*),[40] reductions in mean precipitation and increases in aridity (*medium* to *high confidence*),[40] and increases in fire weather (*medium* to *high confidence*).[40] There is *low confidence* in most regions in potential future changes in other CIDs, such as hail, ice storms, severe storms, dust storms, heavy snowfall and landslides.
{11.7, 11.9, Cross-Chapter Box 11.1, 12.4, 12.5, Cross-Chapter Box 12.1, Atlas.4, Atlas.6, Atlas.7, Atlas.8, Atlas.10, TS.4.3.1, TS.4.3.2, TS.5} (Table SPM.1, Figure SPM.9)

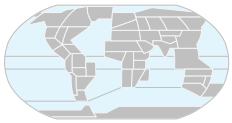
C.2.5 It is *very likely* to *virtually certain*[40] that regional mean relative sea level rise will continue throughout the 21st century, except in a few regions with substantial geologic land uplift rates. Approximately two-thirds of the global coastline has a projected regional relative sea level rise within ±20% of the global mean increase (*medium confidence*). Due to relative sea level rise, extreme sea level events that occurred once per century in the recent past are projected to occur at least annually at more than half of all tide gauge locations by 2100 (*high confidence*). Relative sea level rise contributes to increases in the frequency and severity of coastal flooding in low-lying areas and to coastal erosion along most sandy coasts (*high confidence*).
{9.6, 12.4, 12.5, Cross-Chapter Box 12.1, Box TS.4, TS.4.3} (Figure SPM.9)

C.2.6 Cities intensify human-induced warming locally, and further urbanization together with more frequent hot extremes will increase the severity of heatwaves (*very high confidence*). Urbanization also increases mean and heavy precipitation over and/or downwind of cities (*medium confidence*) and resulting runoff intensity (*high confidence*). In coastal cities, the combination of more frequent extreme sea level events (due to sea level rise and storm surge) and extreme rainfall/riverflow events will make flooding more probable (*high confidence*).
{8.2, Box 10.3, 11.3, 12.4, Box TS.14}

C.2.7 Many regions are projected to experience an increase in the probability of compound events with higher global warming (*high confidence*). In particular, concurrent heatwaves and droughts are *likely* to become more frequent. Concurrent extremes at multiple locations, including in crop-producing areas, become more frequent at 2°C and above compared to 1.5°C global warming (*high confidence*).
{11.8, Box 11.3, Box 11.4, 12.3, 12.4, Cross-Chapter Box 12.1, TS.4.3} (Table SPM.1)

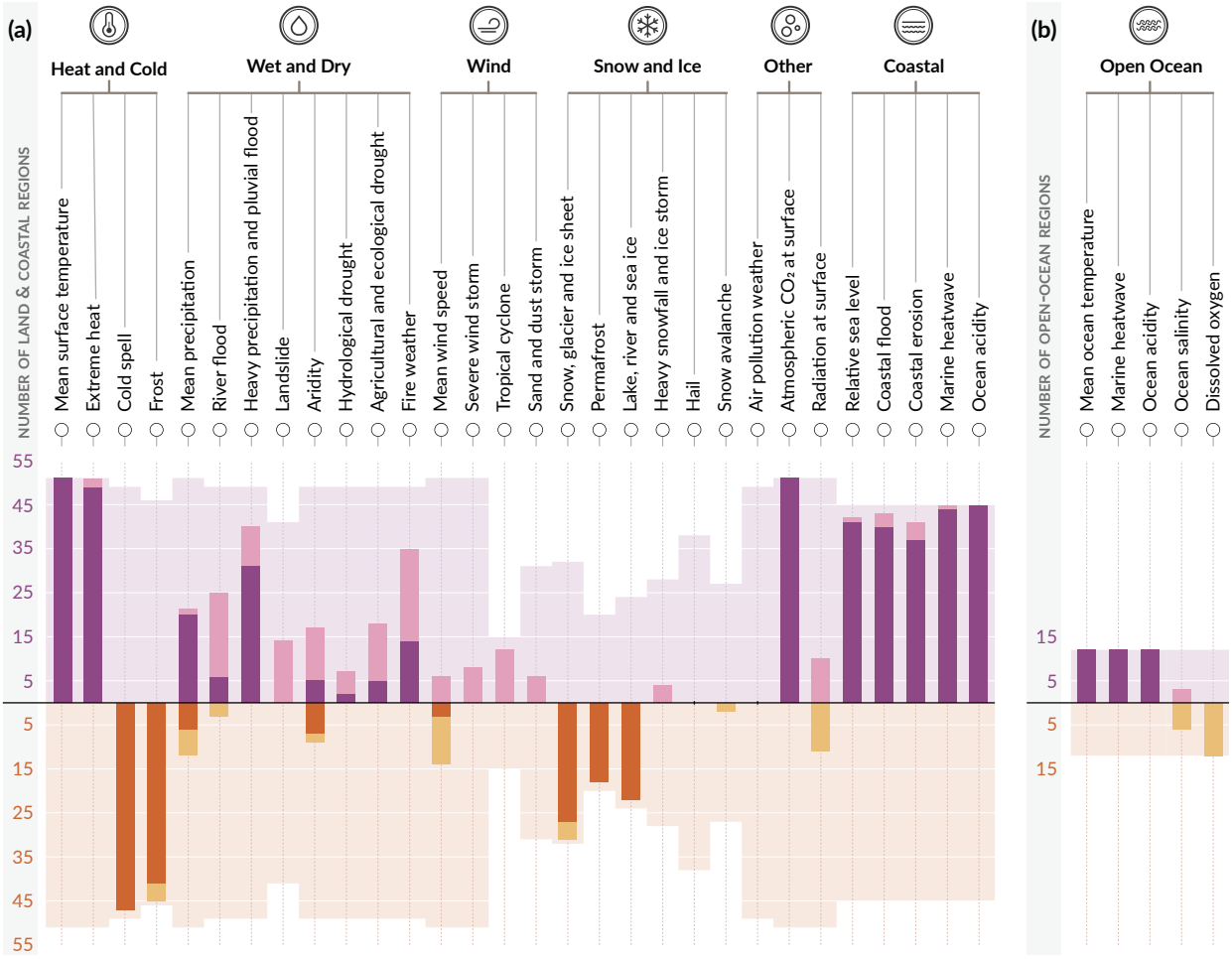
Multiple climatic impact-drivers are projected to change in all regions of the world

Climatic impact-drivers (CIDs) are physical climate system conditions (e.g., means, events, extremes) that affect an element of society or ecosystems. Depending on system tolerance, CIDs and their changes can be detrimental, beneficial, neutral, or a mixture of each across interacting system elements and regions. The CIDs are grouped into seven types, which are summarized under the icons in the figure. All regions are projected to experience changes in at least 5 CIDs. Almost all (96%) are projected to experience changes in at least 10 CIDs and half in at least 15 CIDs. For many CID changes, there is wide geographical variation, and so each region is projected to experience a specific set of CID changes. Each bar in the chart represents a specific geographical set of changes that can be explored in the WGI Interactive Atlas.



interactive-atlas.ipcc.ch

Number of land & coastal regions (a) and **open-ocean regions** (b) where each **climatic impact-driver** (CID) is projected to increase or decrease with ***high*** *confidence* (dark shade) or ***medium*** *confidence* (light shade)



BAR CHART LEGEND

- Regions with ***high*** *confidence* increase
- Regions with ***medium*** *confidence* increase
- Regions with ***high*** *confidence* decrease
- Regions with ***medium*** *confidence* decrease

LIGHTER-SHADED 'ENVELOPE' LEGEND

The height of the lighter shaded 'envelope' behind each bar represents the maximum number of regions for which each CID is relevant. The envelope is symmetrical about the x-axis showing the maximum possible number of relevant regions for CID increase (upper part) or decrease (lower part).

ASSESSED FUTURE CHANGES

Changes refer to a 20–30 year period centred around 2050 and/or consistent with 2°C global warming compared to a similar period within 1960–2014 or 1850–1900.

Figure SPM.9 | Synthesis of the number of AR6 WGI reference regions where climatic impact-drivers are projected to change

A total of 35 climatic impact-drivers (CIDs) grouped into seven types are shown: heat and cold; wet and dry; wind; snow and ice; coastal; open ocean; and other. For each CID, the bar in the graph below displays the number of AR6 WGI reference regions where it is projected to change. The **colours** represent the direction of change and the level of confidence in the change: purple indicates an increase while brown indicates a decrease; darker and lighter shades refer to *high* and *medium confidence*, respectively. Lighter background colours represent the maximum number of regions for which each CID is broadly relevant.

Panel (a) shows the 30 CIDs relevant to the **land and coastal regions**, while **panel (b)** shows the five CIDs relevant to the **open-ocean regions**. Marine heatwaves and ocean acidity are assessed for coastal ocean regions in panel (a) and for open-ocean regions in panel (b). Changes refer to a 20–30-year period centred around 2050 and/or consistent with 2°C global warming compared to a similar period within 1960–2014, except for hydrological drought and agricultural and ecological drought, which is compared to 1850–1900. Definitions of the regions are provided in Sections 12.4 and Atlas.1 and the Interactive Atlas (see https://interactive-atlas.ipcc.ch/).

{11.9, 12.2, 12.4, Atlas.1, Table TS.5, Figures TS.22 and TS.25} (Table SPM.1)

C.3 Low-likelihood outcomes, such as ice-sheet collapse, abrupt ocean circulation changes, some compound extreme events, and warming substantially larger than the assessed *very likely* range of future warming, cannot be ruled out and are part of risk assessment.
{1.4, Cross-Chapter Box 1.3, 4.3, 4.4, 4.8, Cross-Chapter Box 4.1, 8.6, 9.2, Box 9.4, 11.8, Box 11.2, Cross-Chapter Box 12.1} (Table SPM.1)

C.3.1 If global warming exceeds the assessed *very likely* range for a given GHG emissions scenario, including low GHG emissions scenarios, global and regional changes in many aspects of the climate system, such as regional precipitation and other CIDs, would also exceed their assessed *very likely* ranges (*high confidence*). Such low-likelihood, high-warming outcomes are associated with potentially very large impacts, such as through more intense and more frequent heatwaves and heavy precipitation, and high risks for human and ecological systems, particularly for high GHG emissions scenarios.
{Cross-Chapter Box 1.3, 4.3, 4.4, 4.8, Box 9.4, Box 11.2, Cross-Chapter Box 12.1, TS.1.4, Box TS.3, Box TS.4} (Table SPM.1)

C.3.2 Low-likelihood, high-impact outcomes[34] could occur at global and regional scales even for global warming within the *very likely* range for a given GHG emissions scenario. The probability of low-likelihood, high-impact outcomes increases with higher global warming levels (*high confidence*). Abrupt responses and tipping points of the climate system, such as strongly increased Antarctic ice-sheet melt and forest dieback, cannot be ruled out (*high confidence*).
{1.4, 4.3, 4.4, 4.8, 5.4, 8.6, Box 9.4, Cross-Chapter Box 12.1, TS.1.4, TS.2.5, Box TS.3, Box TS.4, Box TS.9} (Table SPM.1)

C.3.3 If global warming increases, some compound extreme events[18] with low likelihood in past and current climate will become more frequent, and there will be a higher likelihood that events with increased intensities, durations and/or spatial extents unprecedented in the observational record will occur (*high confidence*).
{11.8, Box 11.2, Cross-Chapter Box 12.1, Box TS.3, Box TS.9}

C.3.4 The Atlantic Meridional Overturning Circulation is *very likely* to weaken over the 21st century for all emissions scenarios. While there is *high confidence* in the 21st century decline, there is only *low confidence* in the magnitude of the trend. There is *medium confidence* that there will not be an abrupt collapse before 2100. If such a collapse were to occur, it would *very likely* cause abrupt shifts in regional weather patterns and water cycle, such as a southward shift in the tropical rain belt, weakening of the African and Asian monsoons and strengthening of Southern Hemisphere monsoons, and drying in Europe.
{4.3, 8.6, 9.2, TS2.4, Box TS.3}

C.3.5 Unpredictable and rare natural events not related to human influence on climate may lead to low-likelihood, high-impact outcomes. For example, a sequence of large explosive volcanic eruptions within decades has occurred in the past, causing substantial global and regional climate perturbations over several decades. Such events cannot be ruled out in the future, but due to their inherent unpredictability they are not included in the illustrative set of scenarios referred to in this Report
{2.2, Cross-Chapter Box 4.1, Box TS.3} (Box SPM.1)

D. Limiting Future Climate Change

Since AR5, estimates of remaining carbon budgets have been improved by a new methodology first presented in SR1.5, updated evidence, and the integration of results from multiple lines of evidence. A comprehensive range of possible future air pollution controls in scenarios is used to consistently assess the effects of various assumptions on projections of climate and air pollution. A novel development is the ability to ascertain when climate responses to emissions reductions would become discernible above natural climate variability, including internal variability and responses to natural drivers.

D.1 From a physical science perspective, limiting human-induced global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least net zero CO_2 emissions, along with strong reductions in other greenhouse gas emissions. Strong, rapid and sustained reductions in CH_4 emissions would also limit the warming effect resulting from declining aerosol pollution and would improve air quality.
{3.3, 4.6, 5.1, 5.2, 5.4, 5.5, 5.6, Box 5.2, Cross-Chapter Box 5.1, 6.7, 7.6, 9.6} (Figure SPM.10, Table SPM.2)

D.1.1 This Report reaffirms with *high confidence* the AR5 finding that there is a near-linear relationship between cumulative anthropogenic CO_2 emissions and the global warming they cause. Each 1000 $GtCO_2$ of cumulative CO_2 emissions is assessed to *likely* cause a 0.27°C to 0.63°C increase in global surface temperature with a best estimate of 0.45°C.[41] This is a narrower range compared to AR5 and SR1.5. This quantity is referred to as the transient climate response to cumulative CO_2 emissions (TCRE). This relationship implies that reaching net zero anthropogenic CO_2 emissions[42] is a requirement to stabilize human-induced global temperature increase at any level, but that limiting global temperature increase to a specific level would imply limiting cumulative CO_2 emissions to within a carbon budget.[43] {5.4, 5.5, TS.1.3, TS.3.3, Box TS.5} (Figure SPM.10)

Every tonne of CO_2 emissions adds to global warming

Global surface temperature increase since 1850–1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)

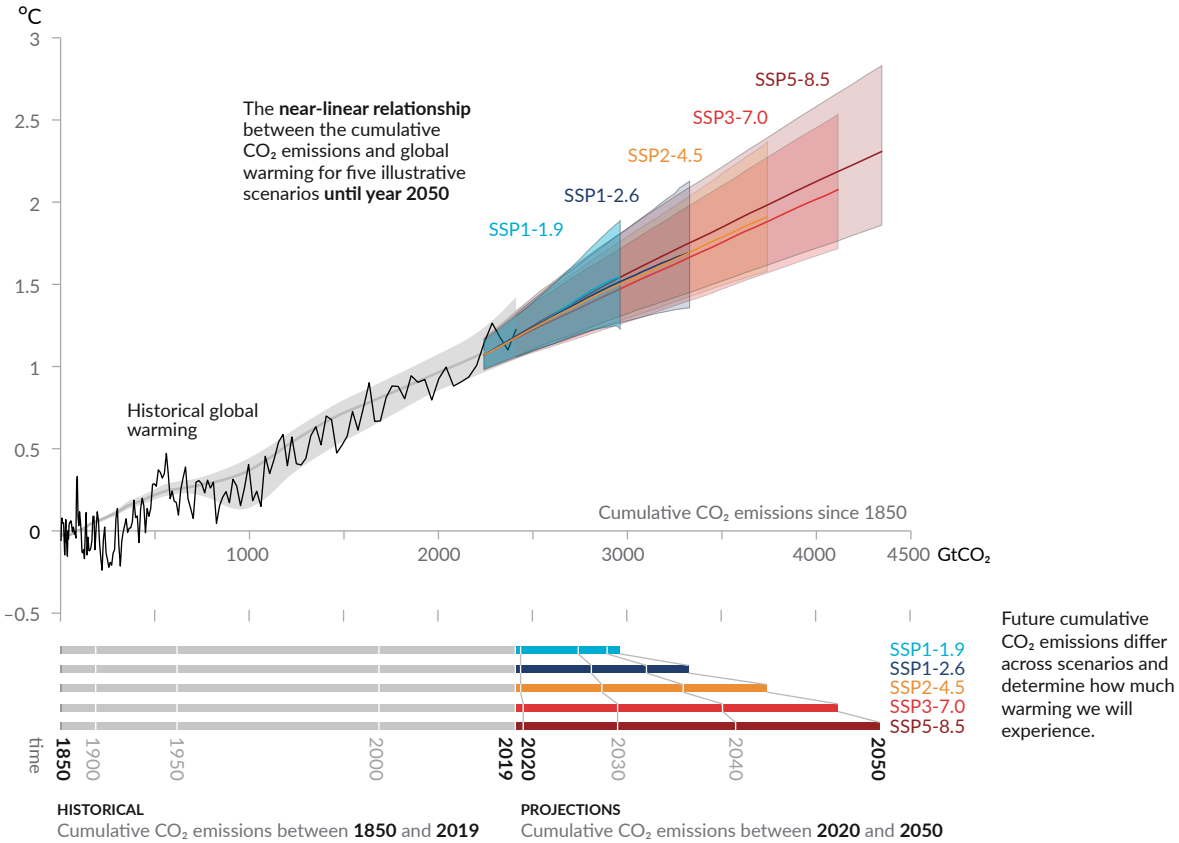


Figure SPM.10 | Near-linear relationship between cumulative CO_2 emissions and the increase in global surface temperature

Top panel: Historical data (thin black line) shows observed global surface temperature increase in °C since 1850–1900 as a function of historical cumulative carbon dioxide (CO_2) emissions in $GtCO_2$ from 1850 to 2019. The grey range with its central line shows a corresponding estimate of the historical human-caused surface warming (see Figure SPM.2). Coloured areas show the assessed *very likely* range of global surface temperature projections, and thick coloured central lines show the median estimate as a function of cumulative CO_2 emissions from 2020 until year 2050 for the set of illustrative scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5; see Figure SPM.4). Projections use the cumulative CO_2 emissions of each respective scenario, and the projected global warming includes the contribution from all anthropogenic forcers. The relationship is illustrated over the domain of cumulative CO_2 emissions for which there is *high confidence* that the transient climate response to cumulative CO_2 emissions (TCRE) remains constant, and for the time period from 1850 to 2050 over which global CO_2 emissions remain net positive under all illustrative scenarios, as there is *limited evidence* supporting the quantitative application of TCRE to estimate temperature evolution under net negative CO_2 emissions.

Bottom panel: Historical and projected cumulative CO_2 emissions in $GtCO_2$ for the respective scenarios.

{Section 5.5, Figure 5.31, Figure TS.18}

41 In the literature, units of °C per 1000 PgC (petagrams of carbon) are used, and the AR6 reports the TCRE ***likely*** range as 1.0°C to 2.3°C per 1000 PgC in the underlying report, with a best estimate of 1.65°C.

42 The condition in which anthropogenic carbon dioxide (CO_2) emissions are balanced by anthropogenic CO_2 removals over a specified period (Glossary).

43 The term 'carbon budget' refers to the maximum amount of cumulative net global anthropogenic CO_2 emissions that would result in limiting global warming to a given level with a given probability, taking into account the effect of other anthropogenic climate forcers. This is referred to as the total carbon budget when expressed starting from the pre-industrial period, and as the remaining carbon budget when expressed from a recent specified date (Glossary). Historical cumulative CO_2 emissions determine to a large degree warming to date, while future emissions cause future additional warming. The remaining carbon budget indicates how much CO_2 could still be emitted while keeping warming below a specific temperature level.

D.1.2 Over the period 1850–2019, a total of 2390 ± 240 (*likely* range) $GtCO_2$ of anthropogenic CO_2 was emitted. Remaining carbon budgets have been estimated for several global temperature limits and various levels of probability, based on the estimated value of TCRE and its uncertainty, estimates of historical warming, variations in projected warming from non-CO_2 emissions, climate system feedbacks such as emissions from thawing permafrost, and the global surface temperature change after global anthropogenic CO_2 emissions reach net zero.
{5.1, 5.5, Box 5.2, TS.3.3} (Table SPM.2)

Table SPM.2 | Estimates of historical carbon dioxide (CO_2) emissions and remaining carbon budgets. Estimated remaining carbon budgets are calculated from the beginning of 2020 and extend until global net zero CO_2 emissions are reached. They refer to CO_2 emissions, while accounting for the global warming effect of non-CO_2 emissions. Global warming in this table refers to human-induced global surface temperature increase, which excludes the impact of natural variability on global temperatures in individual years.
{Table 3.1, 5.5.1, 5.5.2, Box 5.2, Table 5.1, Table 5.7, Table 5.8, Table TS.3}

Global Warming Between 1850–1900 and 2010–2019 (°C)		Historical Cumulative CO_2 Emissions from 1850 to 2019 ($GtCO_2$)					
1.07 (0.8–1.3; likely range)		2390 (± 240; likely range)					
Approximate global warming relative to 1850–1900 until temperature limit (°C)[a]	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 ($GtCO_2$) *Likelihood of limiting global warming to temperature limit*[b]					Variations in reductions in non-CO_2 emissions[c]
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

[a] Values at each 0.1°C increment of warming are available in Tables TS.3 and 5.8.

[b] This likelihood is based on the uncertainty in transient climate response to cumulative CO_2 emissions (TCRE) and additional Earth system feedbacks and provides the probability that global warming will not exceed the temperature levels provided in the two left columns. Uncertainties related to historical warming (±550 $GtCO_2$) and non-CO_2 forcing and response (±220 $GtCO_2$) are partially addressed by the assessed uncertainty in TCRE, but uncertainties in recent emissions since 2015 (±20 $GtCO_2$) and the climate response after net zero CO_2 emissions are reached (±420 $GtCO_2$) are separate.

[c] Remaining carbon budget estimates consider the warming from non-CO_2 drivers as implied by the scenarios assessed in SR1.5. The Working Group III Contribution to AR6 will assess mitigation of non-CO_2 emissions.

D.1.3 Several factors that determine estimates of the remaining carbon budget have been re-assessed, and updates to these factors since SR1.5 are small. When adjusted for emissions since previous reports, estimates of remaining carbon budgets are therefore of similar magnitude compared to SR1.5 but larger compared to AR5 due to methodological improvements.[44]
{5.5, Box 5.2, TS.3.3} (Table SPM.2)

D.1.4 Anthropogenic CO_2 removal (CDR) has the potential to remove CO_2 from the atmosphere and durably store it in reservoirs (*high confidence*). CDR aims to compensate for residual emissions to reach net zero CO_2 or net zero GHG emissions or, if implemented at a scale where anthropogenic removals exceed anthropogenic emissions, to lower surface temperature. CDR methods can have potentially wide-ranging effects on biogeochemical cycles and climate, which can either weaken or strengthen the potential of these methods to remove CO_2 and reduce warming, and can also influence water availability and quality, food production and biodiversity[45] (*high confidence*).
{5.6, Cross-Chapter Box 5.1, TS.3.3}

D.1.5 Anthropogenic CO_2 removal (CDR) leading to global net negative emissions would lower the atmospheric CO_2 concentration and reverse surface ocean acidification (*high confidence*). Anthropogenic CO_2 removals and emissions are partially

44 Compared to AR5, and when taking into account emissions since AR5, estimates in AR6 are about 300–350 $GtCO_2$ larger for the remaining carbon budget consistent with limiting warming to 1.5°C; for 2°C, the difference is about 400–500 $GtCO_2$.

45 Potential negative and positive effects of CDR for biodiversity, water and food production are methods-specific and are often highly dependent on local context, management, prior land use, and scale. IPCC Working Groups II and III assess the CDR potential and ecological and socio-economic effects of CDR methods in their AR6 contributions.

compensated by CO_2 release and uptake respectively, from or to land and ocean carbon pools (*very high confidence*). CDR would lower atmospheric CO_2 by an amount approximately equal to the increase from an anthropogenic emission of the same magnitude (*high confidence*). The atmospheric CO_2 decrease from anthropogenic CO_2 removals could be up to 10% less than the atmospheric CO_2 increase from an equal amount of CO_2 emissions, depending on the total amount of CDR (*medium confidence*).
{5.3, 5.6, TS.3.3}

D.1.6 If global net negative CO_2 emissions were to be achieved and be sustained, the global CO_2-induced surface temperature increase would be gradually reversed but other climate changes would continue in their current direction for decades to millennia (*high confidence*). For instance, it would take several centuries to millennia for global mean sea level to reverse course even under large net negative CO_2 emissions (*high confidence*).
{4.6, 9.6, TS.3.3}

D.1.7 In the five illustrative scenarios, simultaneous changes in CH_4, aerosol and ozone precursor emissions, which also contribute to air pollution, lead to a net global surface warming in the near and long term (*high confidence*). In the long term, this net warming is lower in scenarios assuming air pollution controls combined with strong and sustained CH_4 emissions reductions (*high confidence*). In the low and very low GHG emissions scenarios, assumed reductions in anthropogenic aerosol emissions lead to a net warming, while reductions in CH_4 and other ozone precursor emissions lead to a net cooling. Because of the short lifetime of both CH_4 and aerosols, these climate effects partially counterbalance each other, and reductions in CH_4 emissions also contribute to improved air quality by reducing global surface ozone (*high confidence*).
{6.7, Box TS.7} (Figure SPM.2, Box SPM.1)

D.1.8 Achieving global net zero CO_2 emissions, with anthropogenic CO_2 emissions balanced by anthropogenic removals of CO_2, is a requirement for stabilizing CO_2-induced global surface temperature increase. This is different from achieving net zero GHG emissions, where metric-weighted anthropogenic GHG emissions equal metric-weighted anthropogenic GHG removals. For a given GHG emissions pathway, the pathways of individual GHGs determine the resulting climate response,[46] whereas the choice of emissions metric[47] used to calculate aggregated emissions and removals of different GHGs affects what point in time the aggregated GHGs are calculated to be net zero. Emissions pathways that reach and sustain net zero GHG emissions defined by the 100-year global warming potential are projected to result in a decline in surface temperature after an earlier peak (*high confidence*).
{4.6, 7.6, Box 7.3, TS.3.3}

D.2 Scenarios with very low or low GHG emissions (SSP1-1.9 and SSP1-2.6) lead within years to discernible effects on greenhouse gas and aerosol concentrations and air quality, relative to high and very high GHG emissions scenarios (SSP3-7.0 or SSP5-8.5). Under these contrasting scenarios, discernible differences in trends of global surface temperature would begin to emerge from natural variability within around 20 years, and over longer time periods for many other climatic impact-drivers (*high confidence*).
{4.6, 6.6, 6.7, Cross-Chapter Box 6.1, 9.6, 11.2, 11.4, 11.5, 11.6, Cross-Chapter Box 11.1, 12.4, 12.5} (Figure SPM.8, Figure SPM.10)

D.2.1 Emissions reductions in 2020 associated with measures to reduce the spread of COVID-19 led to temporary but detectable effects on air pollution (*high confidence*) and an associated small, temporary increase in total radiative forcing, primarily due to reductions in cooling caused by aerosols arising from human activities (*medium confidence*). Global and regional climate responses to this temporary forcing are, however, undetectable above natural variability (*high confidence*). Atmospheric CO_2 concentrations continued to rise in 2020, with no detectable decrease in the observed CO_2 growth rate (*medium confidence*).[48]
{Cross-Chapter Box 6.1, TS.3.3}

D.2.2 Reductions in GHG emissions also lead to air quality improvements. However, in the near term,[49] even in scenarios with strong reduction of GHGs, as in the low and very low GHG emissions scenarios (SSP1-2.6 and SSP1-1.9), these improvements

46 A general term for how the climate system responds to a radiative forcing (Glossary).

47 The choice of emissions metric depends on the purposes for which gases or forcing agents are being compared. This Report contains updated emissions metric values and assesses new approaches to aggregating gases.

48 For other GHGs, there was insufficient literature available at the time of the assessment to assess detectable changes in their atmospheric growth rate during 2020.

49 Near term: 2021–2040.

are not sufficient in many polluted regions to achieve air quality guidelines specified by the World Health Organization (*high confidence*). Scenarios with targeted reductions of air pollutant emissions lead to more rapid improvements in air quality within years compared to reductions in GHG emissions only, but from 2040, further improvements are projected in scenarios that combine efforts to reduce air pollutants as well as GHG emissions, with the magnitude of the benefit varying between regions (*high confidence*).
{6.6, 6.7, Box TS.7}.

D.2.3 Scenarios with very low or low GHG emissions (SSP1-1.9 and SSP1-2.6) would have rapid and sustained effects to limit human-caused climate change, compared with scenarios with high or very high GHG emissions (SSP3-7.0 or SSP5-8.5), but early responses of the climate system can be masked by natural variability. For global surface temperature, differences in 20-year trends would *likely* emerge during the near term under a very low GHG emissions scenario (SSP1-1.9), relative to a high or very high GHG emissions scenario (SSP3-7.0 or SSP5-8.5). The response of many other climate variables would emerge from natural variability at different times later in the 21st century (*high confidence*).
{4.6, Cross-Section Box TS.1} (Figure SPM.8, Figure SPM.10)

D.2.4 Scenarios with very low and low GHG emissions (SSP1-1.9 and SSP1-2.6) would lead to substantially smaller changes in a range of CIDs[36] beyond 2040 than under high and very high GHG emissions scenarios (SSP3-7.0 and SSP5-8.5). By the end of the century, scenarios with very low and low GHG emissions would strongly limit the change of several CIDs, such as the increases in the frequency of extreme sea level events, heavy precipitation and pluvial flooding, and exceedance of dangerous heat thresholds, while limiting the number of regions where such exceedances occur, relative to higher GHG emissions scenarios (*high confidence*). Changes would also be smaller in very low compared to low GHG emissions scenarios, as well as for intermediate (SSP2-4.5) compared to high or very high GHG emissions scenarios (*high confidence*).
{9.6, 11.2, 11.3, 11.4, 11.5, 11.6, 11.9, Cross-Chapter Box 11.1, 12.4, 12.5, TS.4.3}

Annex 36

Nationally Determined Contributions

State of Kuwait - October 2021 ((updating the first NDC))

The document index:

The objective:

The State of Kuwait has updated the document of the Nationally Determined Contributions and submitted it to the secretariat of the Convention to share worldwide: the process of combating climate change based on sustainable development plans and programs at the national level for the period from 2015 to 2035.

Based on the principles of the United Nations Framework Convention on Climate Change, the provisions of the Paris Agreement and the Sustainable Development Goals (Agenda 2030 for Sustainable Development), the State of Kuwait seeks to transition to a low-emissions carbon-equivalent economic system based on its future business in the principles of a circular economy of carbon in addition to legislation and laws in the areas of mitigation and adaptation Climate change based on the expectations of its future emissions according to business as usual patterns for the period between 2015-2035. In this period, the State of Kuwait has been seeking to avoid emitting the equivalent of 7.4% of its total emissions in 2035 with unconditional national efforts. Moreover, this percentage of emissions reduction represents the country's maximum ambition which the country of Kuwait had based on national conditions and economic, political, social and health developments during the Corona pandemic during the years 2020 and 2021 and the resulting stagnation of the global economy, and the state's efforts to pandemic the virus on the other.

Introduction:

The State of Kuwait is considered one of the first countries to sign the United Nations Framework Convention on Climate Change; it joined the Convention on 28 Dec.1994 and entered into force on 28 Mar. 1995, and the state of Kuwait ratified Kyoto Protocol under the United Nations Framework Convention on Climate Change on 11 Mar. 2005 and entered into force on 9 Jun. 2005. The State of Kuwait shares the concerns of the international community in limiting the negative impacts of climate change, it recognizes that the global nature of climate change calls for maximum cooperation and participation in an effective international response in implementing the terms of the United Nations Framework Convention on climate change (UNFCCC) from all countries of the world in accordance with common but differentiated responsibilities as stated in Article 4 paragraph 1 , which says: "*All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances*."

The State of Kuwait also signed the Paris Climate Agreement on 4/22/2016 and submitted its first contribution document at the national level after ratification on 4/23/2018 based on the information, results and analyses contained in the first national communication document submitted by the state in 2012. Moreover, based on the latest documents submitted by the State of Kuwait to the Secretariat of the United Nations Framework Convention on Climate Change recently, where the second national communication (SNC) was submitted in July 2019, and the document of the first Biennial update report (BUR) was submitted in September 2019, in addition to the National Adaptation Plan (NAP) in February 2021 Therefore, the State of Kuwait has updated the first national contributions document based on the latest information contained in these documents related to the inventory of emissions and ways to adapt to the negative effects of climate change on the state's sectors.

In this context the standards of sustainable development of the State of Kuwait will be taken into consideration, as it is a developing country with a single source of income as the Convention stated in Article 4 .8, which says: " *In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including*

actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures" and in particular on "*Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products*" as mentioned in paragraph (h).

First: national circumstances of the state of Kuwait:

Kuwait is located in the Northeast of the Middle East and North Africa between latitudes 28° 30" and 30° 5" and longitudes 46° 33" and 48° 30" in the east. The total area of Kuwait is 17,818 km2, including the nine unpopulated islands in the Arabian Gulf region. Kuwait's Government is considered constitutional state, where its Constitution has a democratic appeal which is developing rules that controls legislative, executive, and judicial authorities.

(1) Effects of climate change on the State of Kuwait:

The State of Kuwait is a tropical dry and subtropical desert with an extremely arid climate. Its annual precipitation ranges between 75 and 150 mm, but the actual precipitation is 600 mm per year. There are large and noticeable differences in temperature between summer and winter in Kuwait. In summer, the temperature can reach 48 degrees Celsius and an average of 44 degrees Celsius, and on July 21, 2016, the temperature reached its highest level ever, as the temperature reached 54 degrees Celsius in the north of the State of Kuwait, and it is worth noting that it was the highest temperature recorded throughout history in the Eastern Hemisphere and Asia, according to the World Meteorological Organization report issued in June 2019.

Due to its relatively northern location in the Gulf region, the northern winds blowing from Iran and Iraq ensure that the temperature of Kuwait is lower than that of other Arab Gulf states. Precipitation occurs mostly from October to April.

During the summer, which is much longer than the winter, violent northwest dust storms dominate most weather events during the months of March through April, and in the later months of hot summer, between May and September, sandstorms are more likely, and southeast winds blow during the period From September to October from the Arabian Gulf, hence the humidity during these months (Second National Communication, 2019). By the end of October, the cycle of winter and summer begins again, as the temperature

drops to -6°C during the night. The daytime is usually characterized by higher temperatures ranging from 10 to 17 degrees Celsius.
According to its climate, the State of Kuwait suffers the lack of fresh water, with an annual precipitation ranges between 75 and 150 mm, which is low respectively. **(Figure. 1)**
Kuwait relies entirely on sea water desalination process to obtain fresh water where is 93% from the water supply comes from the desalination of sea water, while the remaining percentage comes from non-generated groundwater due to scarcity of rainfall. However, the seawater desalination process consumes high energy with an adverse impact on marine and coastal ecosystems.
Global sea levels could rise by 1-3 meters during this century according to the Intergovernmental Panel on Climate Change (IPCC). Due to the nature of the low-lying coastal of Kuwait, it is at risk to sea levels rise associated with climate change. With a rise of (0.5 - 2 meters) at sea level. Kuwait could lose 1.4 -3% of its coastal territory, which affects 5% of its GDP.

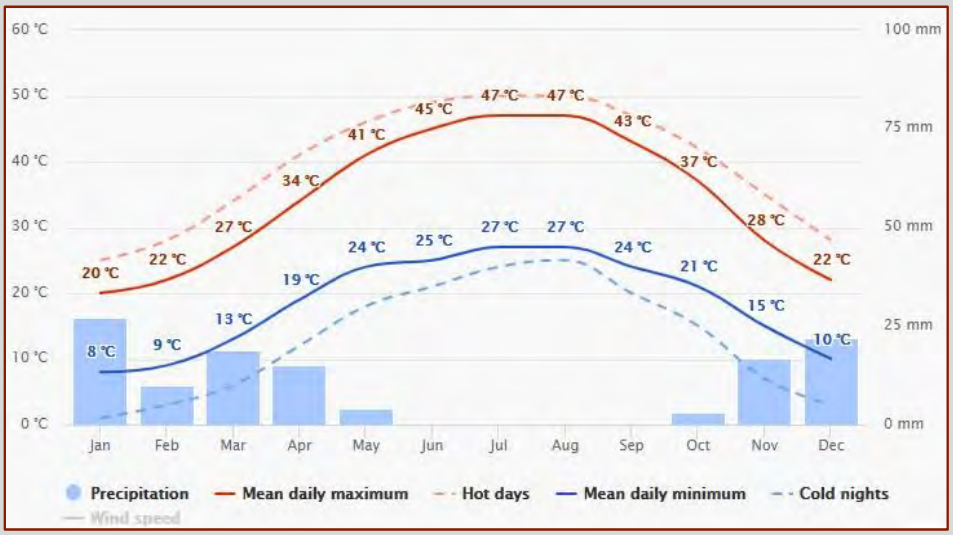


Figure 1: Average annual temperature and precipitation

Kuwait's population reached 4411124 in 2016 with a steady increase over the past two decades by growth rate around 4.1%. The expected increase in population growth rate is combined with urban development and rapid provision of basic services to the population. In the light of the global decline in oil prices and the high cost of subsidies ratio in energy, water and housing prices, the State of Kuwait is facing many developmental challenges, including diversifying, and enhancing work opportunities that provides safe working environments for citizens and residents, urban planning and housing, infrastructure and promoting national capacities to monitor and implement developmental plans.

It is worth mentioning that the state of Kuwait is considered a country with a single source of income, it relies mainly on the extraction and sale of oil in its general budgets. Thus, the state's economy is vulnerable to oil prices fluctuations in supply and demand, and Kuwait's industrial base is based on the extraction, refining, and exporting of oil with an export revenue of more than 90% of the country total revenues, the value of the oil contribution to GDP represents 51-55%. Also, Kuwait is entirely dependent on fossil fuels for energy production by 83.5% of liquid oil and 16.5% of natural gas.

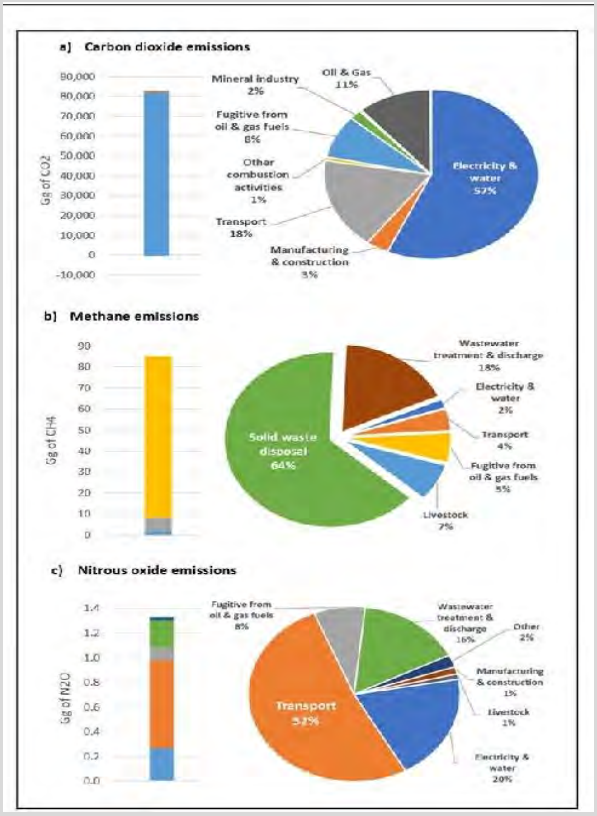


Figure 2: Distribution of greenhouse gas emissions (Gigagrams), 2016

(2) Distribution of greenhouse gas emissions:

The State of Kuwait issued an update of its greenhouse gas emissions inventory for 2016. The total greenhouse gas emissions in 2016 amounted to 86,336,448 gigagrams of carbon dioxide, including 82,556.572 gigagrams of energy; 1,932,156 gigagrams of industrial processes and product use; 154,371 Gg of agriculture, 13,932 Gg of forest and other land use and 1,706,539 Gg of waste. **(Figure.2).**

Emissions of perfluorocarbons, hydrofluorocarbons and Sulphur hexafluoride in Kuwait are very small because products containing these gases are not produced in the country. The (TIER-1) approach of the IPCC Guidelines was used in the calculations for all categories of reports, given that Kuwait does not have national emission factors and does not have detailed data to calculate the list of gases. (Source: BUR- 2019).

The energy sector is one of the largest emitters of greenhouse gases, with energy-related greenhouse gas emissions in 2016 broken down by activity. Emissions from the production of electricity and desalinated water are mainly related to the combustion of natural gas, and petroleum products showed the

highest percentage of greenhouse gas emissions, about 58 percent. The contribution of pre-production and post-production activities in the oil and gas industry to total greenhouse gas emissions is about 11%. Transportation activities are based largely on the use of gasoline and diesel oil and represent about 18% of the total emissions from energy-consuming activities. Fugitive emissions of methane, a gas with a high global warming potential, represent about 9% of all greenhouse gas emissions in the energy industries sector. Other combustion activities in manufacturing and construction accounted for the remaining 4%, **(Figure.3).**

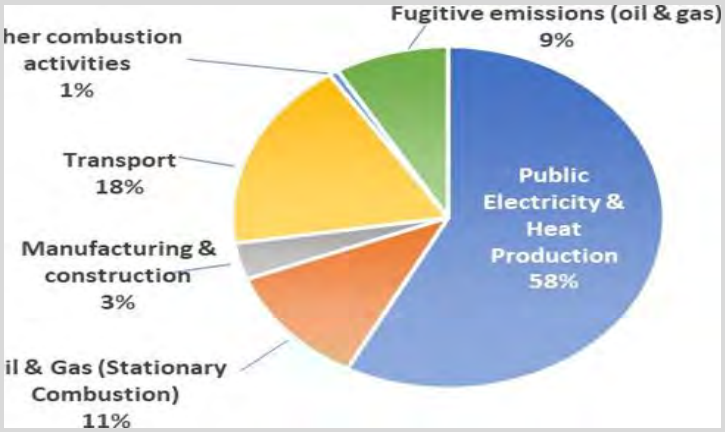


Figure 3: Distribution of greenhouse gas emissions associated with energy activities, 2016

Second: contributions at the national level

(1) avoiding of greenhouse gas emissions:

The State of Kuwait is ambitious to move to a low carbon equivalent economy and to avoid the increase in greenhouse gas emissions compared to business as usual patterns, based on plans and development projects in the country for the period from 2015 to 2035, the state of Kuwait is seeking to achieve this objective on a voluntary basis by implementing some projects and enacting laws and legislation in the areas of mitigation and adapting to the adverse effect of climate change, which are mutually beneficial to mitigation. According to their national economic circumstances, and the state of Kuwait therefore seeks to avoid emission of greenhouse gases equivalent to 7.4% of its total future emission on 2035 through its national efforts. The State of Kuwait also hopes that financial technical and technological support will be provided through the mechanisms of the convention in particular market, non-market mechanisms, and cooperative approach under article 6 of the Paris Agreement, to ensure the sustainability of future projects and to achieve greater benefit for emission reduction to implement future contribution.

(1.1) The projects of avoiding the increasing of emissions:

The State of Kuwait seeks to avoid increasing greenhouse gases emissions from 2015 to 2035 based on business-as-usual patterns (BAU), by adopting the circular carbon economy principle in development projects and plans among the sectors most contributing to greenhouse gas emissions, the energy sector it represents 96% of the total state emissions, with a total state emission of 142290750 tons in 2035 and these projects are:

Carbon circular economy pillars	project	Year of implementation	Amount of reduction-ton
Emission reduction	Sidra project- renewable energy	2015	13,700
	Improving energy distribution efficiency -1	2015	134,949
	Improving energy distribution efficiency -2	2015	112,700
	Electricity production by renewable energy	2017	115,000
	Improving energy distribution efficiency -3	2019	219,700
	Improving energy distribution efficiency -4	2020	351,800
	Production of 850 MW of combined cycle	2020	3,500,000
	70% of the liquefied gas in energy production is gas and the other 30% is fuel	2022	3,000,000
	Production of 250 MW of combined cycle	2024	1,000,000
Decarbonization	Cultivating of Mangroves	2018	50,000 Annual increase of +50,000
Carbon Reuse	Industrial Application	2015	10,950
	Carbon capture and storage	2015	100,000
	Carbon Capture and storage (green carbon)	2022	216,000
Percentage of total state emission in 2035		7.4%	

(2) Adapting with the adverse effects of climate change:

The state of Kuwait seeks to move to a low-carbon economic system that is adoptable to the adverse effects of climate change to promote and protect its natural resources and achieve sustainable development standards, and it seeks to adapt to the effects of climate change from rising temperatures, scarce rainfall, rising sea levels, limited water sources, increasing intensity of dust storms and their impact on the economic, social and health sector.

(2.2) Adaptation projects:

Fisheries sector:

- The Environment Public Authority has established the electronic environmental control information system for the protection of marine life.
- Establishment of a regional database and information center to support fisheries management (Food and Agriculture Organization UN/ The Public Authority of Agriculture Affairs and Fish Resources)
- Creation of terrestrial and marine nature resources (EPA)

Water resources Sector:

- Development and implementation of water resources programs / Kuwait Institute for Scientific Research.
- Building desalination plants.
- Rationalization of water consumption using modern techniques.
- Definitions of collected water and water conservation.
- Assessment of the technical needs of water resources.
- Using wastewater that comes from wastewater processing stations.

Coastal line Sector:

- Establishment of the electronic environmental control information system for marine life in the state of Kuwait (EPA).
- Establishment of the costal information system.
- Coastal zone management program (EPA)

Health Sector

- Common Alerting Protocol (Meteoritical Public Administration)

Third: Legislation and Laws:

1-Emission limitation legislation and laws:

The State of Kuwait has initiated formal producers to study the law of removal of subsidies for gasoline from the beginning of 2016 and gradual removal of subsidies for electricity and water in commercial and industrial sectors, and this contributes significantly to rationalization of greenhouse gas emission.
The Kuwaiti National Assembly also adopted Environmental protection act no.42 of 2014, as amended by act no.99 of 2015, the aim of this act is to protect the environment and all its sources, controlling pollution, developing the natural resources, protecting the society and the human health and all living creatures. The act consists of 181 articles dealing with all issues relating to the protection of the earth, costal, and air environments from pollution, the biological diversity, penalties and environmental damages amends, and any related general law.

The Environmental Protection Law 42/2014 deals directly and indirectly with the energy sector. Article (122) and (123) of the Environmental Protection Law stated the necessity of using energy-saving systems in the new state facilities. The law also prohibited the import of any devices or equipment that do not match with energy saving specification.

The Environmental Protection Law in Article (111) urged the relevant state authorities to develop environmental strategies, plans and work programs related to the scope of their work.

The articles of the law show the state's interest and direction in reducing greenhouse gas emissions in the energy sector by seeking to improve energy consumption management by establishing systems and rules for the efficiency of the devices used and the efficiency of energy consumption in buildings (building materials and design, air conditioning systems and lighting, etc.).

The environmental law also paves the way for the development, adoption, and implementation of a national strategy to reduce the state's consumption of energy and diversify energy sources, especially increasing the percentage of clean energies, in order to achieve the vision of His Highness the late Amir of the State of Kuwait, where His Highness announced the State of Kuwait's endeavor to increase its energy needs from renewable energy sources by 2030.

2- Legislation and laws adapting to the negative effects of climate changes:

The Environmental Protection Law No. 42 of 2014 and its amendments accorded paramount importance in some of its articles to issues related to adapting to the negative effects of climate change, as it regulated the ways of using and consuming natural resources in the field of protecting the land. Articles (40) and (41) of the law discussed regulating the camping process and land use in grazing or any other activities that may harm the soil, which contributes to reducing the phenomenon of desertification and soil vulnerability. In addition, articles (102) and (103) are specified for managing natural reserves to maintain biodiversity. Regarding water resources management Articles (88) and (89) have set the foundations to develop a program for water management in the country and the standards, regulations for water conservation to adapt to the scarcity of water resources in the country. To adapt to the expected rise in sea level and its impact on the coasts of the country articles (66) and (99) of the Law are dedicated for the marine environment and the need to create a national network for monitoring and regulating the marine environment and conducting studies to monitor sea level rise. Considering that the State of Kuwait suffers from numerous crises and natural disasters such as sand and dust storms and flash floods waves, the law established Article (118), which states the needs to prepare emergency plans and crises and natural disasters management plans.

Regarding food security, the state has issued laws related to entirely prevent fishing in Kuwait's bay to maintain biodiversity and fish stocks. Furthermore, there are laws specialized in banning fishing of some species of fish and shrimp in the territorial waters and allows it only in specified seasons to prevent the depletion of fish stocks.

The legislator also seeks through the Environment Protection Law No. 42/2014, as amended some of its provisions in Law No. 99/2015 to promote environmental culture in Kuwait society and spread information relating to the environment for public to change some the behavioral patterns among the citizens and residents to increase public awareness with the concept of natural resources sustainability and the proper usage of it.

Fourth: The process of planning and implementation:

For the state of Kuwait to be able to implement the procedures of mitigating greenhouse gas emissions and adapting to climate change impacts and achieve sustainable development criteria, Kuwait needs the availability of technological and financial support and build national capacities from centers, committees and mechanisms included in the framework agreement such as technological mechanisms consisting of the Technology Executive Committee (TEC) and the Climate Technology Centre & Network (CTCN), as well as the Green Climate Fund (GCF). In accordance with provisions of Article (4.7) of the Framework Convention which states that the extent to which the developing countries fulfill its obligations under the Convention will depend on the developed party's providence of support to developing parties in the field of finance, technology transfer, to ensure an effective global cooperative action on climate change.

The State of Kuwait will start preparing a low-emissions development strategy 2050 in accordance with the requirements of the Paris climate agreement, based on the principle of a circular carbon economy. And the state of Kuwait seeks to combine the outputs of this strategy with the new developing plans by endorsing new projects to serve the Kuwait vision 2035 until 2050.

Fifth: fairness and ambition:

The state of Kuwait assigns great importance to international efforts that deal with global warming and believe that addressing this phenomenon is a common but differentiated responsibility among the countries of the world. Therefore, the State of Kuwait is keen on increasing its capacity in dealing with issues related to climate change simultaneously with its efforts in adapting with the negative impacts of this phenomenon and its consequences on the social and economic aspects.

Although it did not participate in causing this phenomenon, the geographical location of the State of Kuwait made it vulnerable to the effects of climate change, which appeared to be very apparent in recent years through a significant rise in temperatures, the scarcity of rain, and the increase in dust and dust storms that cause life in the country to stop and damage the public

health of citizens. And residents, which contributes to increasing losses and economic burdens on the state, in addition to the possibility of the state losing parts of its coastal zone because of rising sea levels 1.4-3% of its coastal lands, affecting 5% of its GDP.

The State of Kuwait will suffer from economic and social consequences of negative impacts of response measures, where Kuwait is considered one of the countries that its economy dependent on oil and will be affected negatively from international policies and procedures of the UNFCCC. The Secretariat of OPEC as well as many international consultancy entities have prepared several studies indicating in its wholeness that because of the intensive focus on fossil fuel sectors, particularly oil and oil products.

Given the national circumstances of the state of Kuwait, which is currently facing numerous economic, social, and environmental challenges because of the outbreak of the corona pandemic during the past two years in addition to the growing population and the increasing demand of resources, particularly water and energy, which is accompanied with the decline in the national income because of mitigation policies of developed countries. Also taking into consideration the state's responsibility to provide employment opportunities, housing and to maintain the citizen's living standard, the contribution of the State of Kuwait determined at the national level to avoid the equivalent of 7.4% of its emissions on 2035 is considered very ambitious and fair.

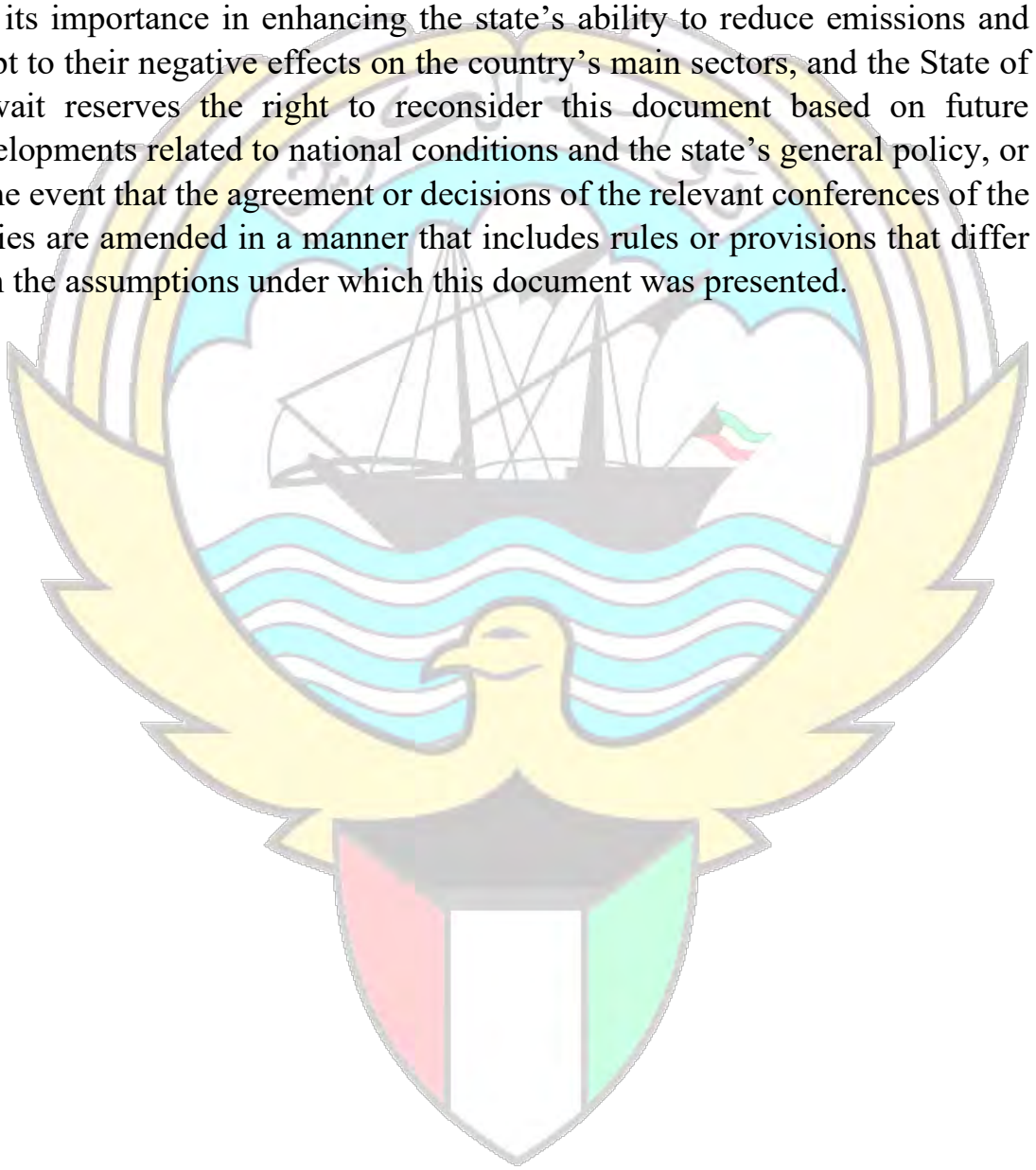
Sixth: General observations and assumptions:

The State of Kuwait provided an update of its Nationally Determined Contributions for the period from 2015 to 2035, as information was extracted from the latest documents submitted by the State of Kuwait to the Secretariat of the United Nations Framework Convention on Climate Change, represented in the second national communication (SNC) July 2019, the first Biennial update report (BUR) September 2019, and the national Adaptation plan (NAP) February 2021.

The update of the first contribution document has been prepared based on the development projects and plans of the country and based on the principle of the circular carbon economy, which achieves cooperation between the

government sector and the private sector in the country. The State of Kuwait is also counting on market, non-market mechanisms and cooperative Approach within Article six of the Paris Agreement to achieve greater ambition in reducing greenhouse gas emissions and including them in the upcoming national contributions, in addition to the means of implementation (financial and technical support and capacity building).

and its importance in enhancing the state's ability to reduce emissions and adapt to their negative effects on the country's main sectors, and the State of Kuwait reserves the right to reconsider this document based on future developments related to national conditions and the state's general policy, or in the event that the agreement or decisions of the relevant conferences of the parties are amended in a manner that includes rules or provisions that differ with the assumptions under which this document was presented.



Annex: Information to facilitate clarity, transparency and understanding

1. Quantifiable information on the reference point (including, as appropriate, a base year)	
a. **Reference year**(s), base year(s), reference period(s) or other starting point(s)	Base year 2015, GHG 2035 Business-as-Usual Emissions Projection.
b. **Quantifiable** information on the **reference indicators**, their values in the reference year(s), base year(s), reference period(s) or other starting point(s), and, as applicable, in the target year	Kuwait's net GHG emissions in 2035 relative to BAU are estimated to be total of 142,290,750MTCO2e.
c. For **strategies**, plans and actions referred to in Article 4, paragraph 6, of the Paris Agreement, or polices and measures as components of nationally determined contributions where paragraph 1(b) above is not applicable, Parties to provide **other relevant information**	Not applicable.
d. **Target relative** to the reference indicator, expressed numerically, for example in percentage or amount of reduction	Reduction of 7.4% in 2035 relative to BAU, with total GHG emissions capped to 131,715,950 MTCO2e in 2035, with amount of reduction of 10,574,800 MTCO2e
e. **Information** on **sources of data** used in quantifying the reference point(s)	The reference indicator will be quantified based on national total GHG emissions in 2015 State of Kuwait reported on the second national communication (SNC), first biannual updated report(1BUR) and the National Adaptation plan (NAP). Also, the vision of "new Kuwait 2035"
f. **Information** on the circumstances under which the Party may **update** the values of the reference indicators	The base year for the 2035 BAU emissions is predicted at about 142,290,750MTCO2e, assuming a sustained moderate GDP growth rate of 1.8% per year, a total population of 7250523.871million by 2035. The base year for 2035 may be recalculated and updated based on the covid-19 pandemic and further methodological improvements. The Biennial Transparency Report (BTR) will provide details on updates made.
2. Time frames and/or periods for implementation	
a. **Time frame** and/or period for implementation, including start and end date, consistent with any further relevant decision adopted by the CMA;	2015-2035

b. Whether it is a **single-year or multi-year** target, as applicable.	Single-year target in 2035.
3. Scope and coverage	
a. General description of the target;	Kuwait's economic target to reduce 7.4% compared to BAU by 2035 covers sectors of (**Energy, IPPU, Agriculture, Forestry and Other Land Use)**, where the energy sector is the primary emission source.
b. **Sectors, gases, categories and pools** covered by the nationally determined contribution, including, as applicable, consistent with IPCC guidelines;	**Sectors:** Energy, IPPU, Agriculture, Forestry and Other Land Use, waste **2035 Carbon Control Target Plan Gases:** • Carbon Dioxide (CO2). • Methane (CH4). • Nitrous Oxide (N2O).
c. How the Party has taken into consideration **paragraphs 31(c) and (d)** of decision 1/CP.21;	Kuwait's NDC is an economy-wide target that includes all categories of anthropogenic emissions or removals. The energy sector emitted the most greenhouse gases in 2015, making up 75% of total emissions. This emission pattern will continue in the next decade, primarily due to the emissions from the oil and gas supply chain and electricity generation using natural gas and diesel. By 2025, the planned renewable power plants and energy efficiencies will reduce emissions from electricity generation. Over the following years.
d. Mitigation co-benefits resulting from Parties' adaptation action and/or economic diversification plans, including description of specific projects, measures and initiatives of Parties' adaptation action and/or economic diversification plans.	Kuwait's 2050 strategy towards a low carbon economy based on a circular carbon economy.
4. Planning process	
a. Information on the planning processes that the Party undertook to prepare its nationally determined contribution and, if available, on the Party's implementation plans, including, as appropriate: i) Domestic institutional arrangements, public participation and engagement with local communities and indigenous	The enhanced target results from a comprehensive impact evaluation, analysis of the future vision and strategies 2050, and stakeholder feedback gathered through public consultation. The standards of sustainable development for the State of Kuwait were taken into account, as it is a developing country with a single source of income, as approved by the agreement in the eighth item of Article 4, which states: in which actions related to financing, insurance and technology transfer

peoples, in a gender-responsive manner. ii) Contextual matters, including, inter alia, as appropriate: a) National circumstances, such as geography, climate, economy, sustainable development and poverty eradication; b) Best practices and experience related to the preparation of the nationally determined contribution; c) Other contextual aspirations and priorities acknowledged when joining the Paris Agreement	to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of implementing measures to respond to climate change" and in particular on "countries whose economies are highly dependent on income from production, processing, export and/or consumption types of fossil fuels and related energy-intensive products" as mentioned in paragraph (h). The ambition of the State of Kuwait is to transform into a low carbon equivalent economy and avoid increasing greenhouse gas emissions compared to business as usual, based on the country's development plans and projects for the period from 2015 to 2035, and the state seeks to achieve this goal voluntarily by adopting Working with the principle of a circular carbon economy in dealing with the climate change file in the State of Kuwait by implementing some projects and enacting laws and legislation in the fields of mitigating emissions and adapting to the negative effects of climate change that have common benefits with mitigation, according to its national conditions and economic data.
b. Specific information applicable to Parties, including regional economic integration organizations and their member States, that have reached an agreement to act jointly under Article 4, paragraph 2, of the Paris Agreement, including the Parties that agreed to **act jointly** and the terms of the agreement, in accordance with Article 4, paragraphs 16–18, of the Paris Agreement;	Not applicable
c. How the Party's preparation of its nationally determined contribution has been informed by the outcomes of the global stock take, in accordance with Article 4, paragraph 9, of the Paris Agreement;	Kuwait's climate change strategy was formulated considering the best available science. The latest reports by IPCC which approved by the conference of parity has served as the basis for the evaluation of the second NDC and IPCC 2006 GHG inventory guidelines.

d. Each Party with a nationally determined contribution under Article 4 of the Paris Agreement that consists of adaptation action and/or economic diversification plans resulting in mitigation co-benefits consistent with Article 4, paragraph 7, of the Paris Agreement to submit information on: i) How the economic and social consequences of response measures have been considered in developing the nationally determined contribution; ii) Specific projects, measures, and activities to be implemented to contribute to mitigation co-benefits, including information on adaptation plans that also yield mitigation co-benefits, which may cover, but are not limited to, key sectors, such as energy, resources, water resources, coastal resources, human settlements and urban planning, agriculture and forestry; and economic diversification actions, which may cover, but are not limited to, sectors such as manufacturing and industry, energy and mining, transport and communication, construction, tourism, real estate, agriculture and fisheries.	The State of Kuwait will suffer from economic and social consequences of negative impacts of response measures, where Kuwait is considered one of the countries that its economy dependent on oil and will be affected negatively from international policies and procedures of the UNFCCC.
5. Assumptions and methodological approaches, including those for estimating and accounting for anthropogenic greenhouse gas emissions and, as appropriate, removals:	
a. Assumptions and methodological approaches used for accounting for anthropogenic greenhouse gas emissions and removals corresponding to the Party's nationally determined contribution, consistent with decision 1/CP.21, paragraph 31, and accounting guidance adopted by the CMA;	The State of Kuwait uses IPCC methodology and guidelines 2006 as guided by 1/CP.21 Article 4, paragraph 13 of the Paris Agreement for the inventory of their GHG emissions and removals. These procedures done as the financial support received.
b. Assumptions and methodological approaches used for accounting for the implementation of policies and measures or strategies in the nationally determined contribution;	The State of Kuwait will use appropriate methods and assumptions when reporting its progress in implementing the second NDC in its Biennial Transparency Report (BTR)

c. If applicable, information on how the Party will take into account existing methods and guidance under the Convention to account for anthropogenic emissions and removals, in accordance with Article 4, paragraph 14, of the Paris Agreement, as appropriate;	The State of Kuwait uses IPCC methodology and guidelines 2006 as guided by 1/CP.21 Article 4, paragraph 13 of the Paris Agreement for the inventory of their GHG emissions and removals.
d. IPCC methodologies and metrics used for estimating anthropogenic greenhouse gas emissions and removals;	Tier 1 method of the IPCC methodologies and guidelines 2006. Metrics: Global warming potential (GWP) values on a 100-year timescale in accordance with IPCC's Second Assessment Report will be used to calculate CO2 equivalents.
e. **Sector-, category- or activity-specific** assumptions, methodologies and approaches consistent with IPCC guidance, as appropriate, including, as applicable: i) Approach to addressing emissions and subsequent removals from **natural disturbances** on managed lands; ii) Approach used to account for emissions and removals from **harvested wood products**; iii) Approach used to address the effects of **age-class** structure in forests;	Not applicable. There is no forest in the State of Kuwait. But, in the BUR the redaction of emission on Land was -13.190 $GgCo_2e$ in 2016.
f. **Other assumptions and methodological approaches** used for understanding the nationally determined contribution and, if applicable, estimating corresponding emissions and removals, including: (i) How the **reference indicators**, baseline(s) and/or reference level(s), including, where applicable, sector-, category- or activity-specific reference levels, are constructed, including, for example, key parameters, assumptions, definitions, methodologies, data sources and models used; (ii) For Parties with nationally determined contributions that contain **non-greenhouse-gas**	The State of Kuwait uses IPCC methodology and guidelines 2006 as guided by 1/CP.21 Article 4, paragraph 13 of the Paris Agreement for the inventory of their GHG emissions and removals for the four sectors **(Energy, IPPU, Agriculture, Forestry and Other Land Use, waste)** Also, using the default value of emission factors.

components, information on assumptions and methodological approaches used in relation to those components, as applicable; (iii) For climate forcers included in nationally determined contributions not covered by IPCC guidelines, information on how the climate forcers are estimated; (iv) **Further technical information**, as necessary;	
g. The intention to use **voluntary cooperation under Article 6** of the Paris Agreement, if applicable.	Reduction of 7.4% in 2035 relative to BAU voluntary funded, other financial support facilitate from the using of the new mechanism. Furthermore, article 6 of the Paris Agreement is an additional mechanism to achieve cost-efficient emission reductions, facilitate the transfer of carbon mitigation technology, and deliver significant sustainable development benefits.
6. How the Party considers that its NDC is fair and ambitious in light of its national circumstances	
a. How the Party considers that its NDC is **fair and ambitious** in the light of its national circumstances;	The State of Kuwait is a non-annex I party with a vision to shift to a low carbon economy by 2050 and believes that the NDC's ambitious target conforms to Article 2 of the Convention. The NDC is an ambitious economy-wide goal that is consistent with the best available science and evidence.
b. Fairness considerations, including reflecting on equity;	The State of Kuwait will use appropriate methods and assumptions when reporting its progress in implementing the second NDC in its Biennial Transparency Report
c. How the Party has addressed **Article 4, paragraph 3**, of the Paris Agreement;	Kuwait's enhanced NDC represents a progression of ambition compared to its initial NDC communicated in 2018 upon ratifying the Paris Agreement.
d. How the Party has addressed **Article 4, paragraph 4**, of the Paris Agreement;	Not applicable.
e. How the Party has addressed **Article 4, paragraph 6**, of the Paris Agreement.	Not applicable.

7. How the NDC contributes towards achieving the objectives of the Convention as set out in its Article 2	
a. How the NDC contributes towards achieving the objective of the Convention as set out in its Article 2;	Kuwait considers the Paris Agreement to be in line with achieving the objective of the Convention as set out in its Article2. Kuwait's enhanced NDC is consistent with the Paris Agreement and its long-term temperature goal. See 6(a) and 6(b) for more information.
b. How the NDC contributes towards Article 2, paragraph 1(a), and Article 4, paragraph 1, of the Paris Agreement.	The State of Kuwait attaches great importance to the international efforts aimed at confronting global warming, believes that addressing this phenomenon is a common responsibility among the countries of the world, albeit to varying degrees. Therefore, the State of Kuwait is keen to raise its capabilities in dealing with issues related to climate change, simultaneously with its efforts to adapt with the negative effects of this phenomenon and its consequences in the social and economic dimensions. See 6(a) and 6(b) for more information.

Annex 37

الهيئة العامة للبيئة
دولة الكويت
ENVIRONMENT PUBLIC AUTHORITY KUWAIT

كويت جديدة
NEWKUWAIT

STATE OF KUWAIT

FIRST BIENNIAL UPDATE REPORT OF THE STATE OF KUWAIT

SUBMITTED TO
THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE
BY ENVIRONMENT PUBLIC AUTHORITY - SEPTEMBER 2019

FOREWORD

On behalf of Kuwait's government, it is my pleasure to submit Kuwait's First Biennial Update Report to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). This report was prepared according to the guidelines approved by the parties and the methodologies of the Intergovernmental Panel on Climate Change (IPCC).

Kuwait already experiences high temperatures of up to 48 degrees Celsius in the summer, with a reading of 54 degrees Celsius in July 2016 north of Kuwait City. Notably, this was the highest temperature in the Eastern Hemisphere and Asia in recorded history. With climate projections showing even higher future temperatures and a decrease in the already low annual rainfall of Kuwait, the negative impacts of climate change on the country, especially those related to food security, water resources, public health, marine ecosystems, and coastal zones, have come in to focus.

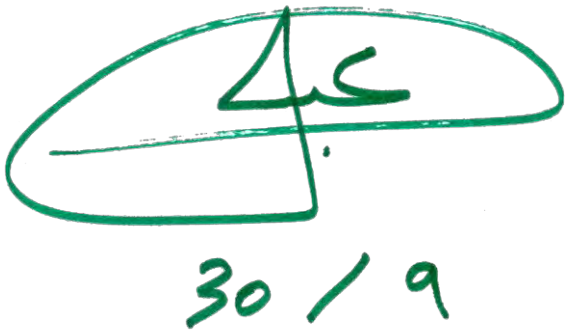
Kuwait's First Biennial Update Report presents the results of a series of studies that reveal how changes in local temperature and rainfall patterns, as well as rising seas, are expected to adversely affect vital sectors of the country. This report also includes an inventory of greenhouse gases from key sectors for year 2016, with an analysis of the emission reduction potential of a set of voluntary mitigation efforts through 2035.

In order to address climate change, the Kuwait Environment Public Authority established the Environmental Protection Law in 2014 and completed its bylaws in 2018. This represents an important pivot point for Kuwait, as there is now legislative and regulatory authority for monitoring and documenting greenhouse gas emissions. Both the public and private sectors are being engaged to ensure that future greenhouse gas emission inventories are complete, consistent, and accurate.

Sheikh Abdullah Ahmad Al Hamoud Al-Sabah

Chairman of the Board & Director General of Kuwait

Environment Public Authority



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ACKNOWLEDGMENTS

This document was the result of a fruitful partnership and cooperation between the Kuwait Environment Public Authority (KEPA) and the Regional Office for West Asia of the United Nations Environment Programme (UNEP), which oversaw the preparation of the First Biennial Updated Report project and provided training and technical support to national experts. In addition, the Global Environment Facility (GEF) provided financial support during all stages of the preparation of the document. Finally, thankful to all those who participated in the preparation of this work, particularly all ministries, governmental agencies, nongovernmental organizations, and the private sector for their support and assistance with the various working groups during the preparation of this document. Hopefully, this document will become a useful reference for policymakers, researchers, and all those interested in climate change and its negative impacts on the State of Kuwait.

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ACRONYMS AND ABBREVIATIONS:

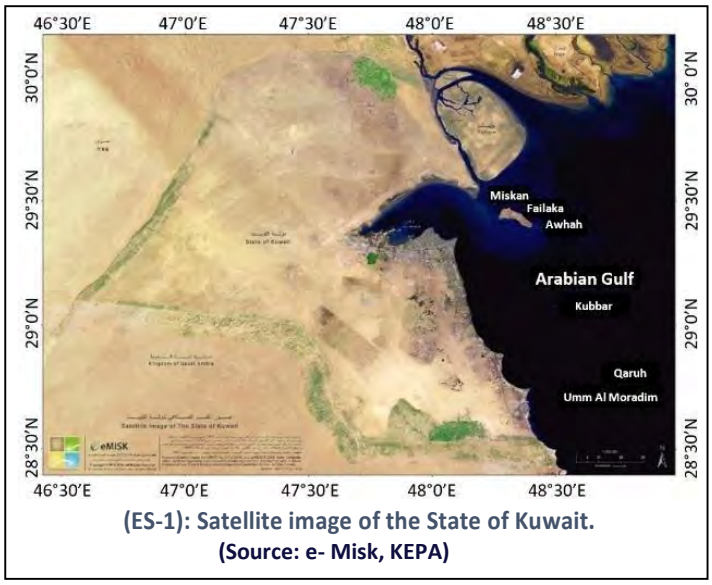
AFOLU	Agriculture, Forestry, and Other Land Use
°C	Degrees Centigrade
BCM	Billion Cubic Meters
CH_4	Methane
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
eMISK	Environmental Monitoring Information System of Kuwait
GEF	Global Environment Facility
GDP	Gross Domestic Product
Gg	Gigagrams (i.e., one billion grams)
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GW	Gigawatt (billion watts)
GWh	Gigawatt-hour (billion watt-hours)
HFC	Hydrofluorocarbons
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
KEPA	Kuwait Environment Public Authority
KEPS	Kuwait Environment Protection Society
KFAS	Kuwait Foundation for the Advancement of Sciences
Kg	kilogram
KISR	Kuwait Institute for Scientific Research
Km	Kilometers
Km^2	Square Kilometers
KMA	Kuwait Medical Association
KPC	Kuwait Petroleum Corporation
KU	Kuwait University
kWh	Thousand Watt-hours
l/cap/day	Liters Per Capita Per Day
LPG	Liquid Petroleum Gas
m	Meters
MEW	Ministry of Electricity and Water
Mm^3	Million Cubic Meters
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
N_2O	Nitrous Oxide
NC	National Communications
NDC	Nationally Determined Contribution
NGCC	Natural Gas Combined Cycle (Power Station)
NGO	Non-governmental Organization
NHA	National Housing Authority
NMVOC	Non-methane Volatile Organic Compounds
NO_x	Nitrogen Oxides
NTF	National Circumstances & Other Information Task Force

O3	Ground-level Ozone
PAAET	Public Authority for Applied Education and Training
PAAF	Public Authority for Agriculture and Fisheries
PACI	Public Authority for Civil Information
PFC	Perfluorocarbons
PM10	Particulate latter less than 10 microns in diameter
PSC	Project Steering Committee
PV	Photovoltaic (solar)
ROWA/UNEP	The Regional Office for West Asia of the United Nations Environment Programme
SEI-US	Stockholm Environment Institute – US Center
SLR	Sea Level Rise
SNC	Second National Communication
SO_2	Sulfur Dioxide
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

National Circumstances

The State of Kuwait is located at the north eastern corner of the Arabian Peninsula and has borders with the Republic of Iraq and the Kingdom of Saudi Arabia. It covers a total land area of nearly 18 thousand square kms and is roughly 170 kms across from East to West and 200 kms across from North to South. Kuwait shares a 495 kms border with Saudi Arabia to the south and 195 kms with Iraq to the north and west (see Figure ES-1).



(ES-1): Satellite image of the State of Kuwait.
(Source: e- Misk, KEPA)

Kuwait has a hyper-arid desert climate that is highly variable with recurrent extremes. Maximum daily temperatures can reach 45°C during the summer during which there is no rainfall. Much of Kuwait is characterized by loose, mobile surface sediments that have very low levels of nutrients and organic matter. While rich in terrestrial and marine biodiversity, these systems are fragile and highly vulnerable to climate change. Kuwait is also one of the world's most water-stressed countries, with the lowest per capita renewable internal freshwater availability of any country, requiring extensive seawater desalination to meet water demand. The population is overwhelmingly urban and has grown rapidly since the discovery of oil in the late 1930s, with over 98% of the population currently living in urban areas which are mostly located along the coast. A modern country with an extensive, modern and well-maintained network of road infrastructure, Kuwait also has a modern healthcare system and a healthy populace; recent trends show a decrease in the incidence of communicable diseases and an increase in life expectancy. Kuwait is one of the world's leading oil producers, possessing the world's fifth largest crude oil reserves and has one of the wealthiest economies in the Arabian Gulf region. Throughout its modern history, Kuwait has heavily relied on food imports since only a negligible fraction of food demand can be met by local agriculture.

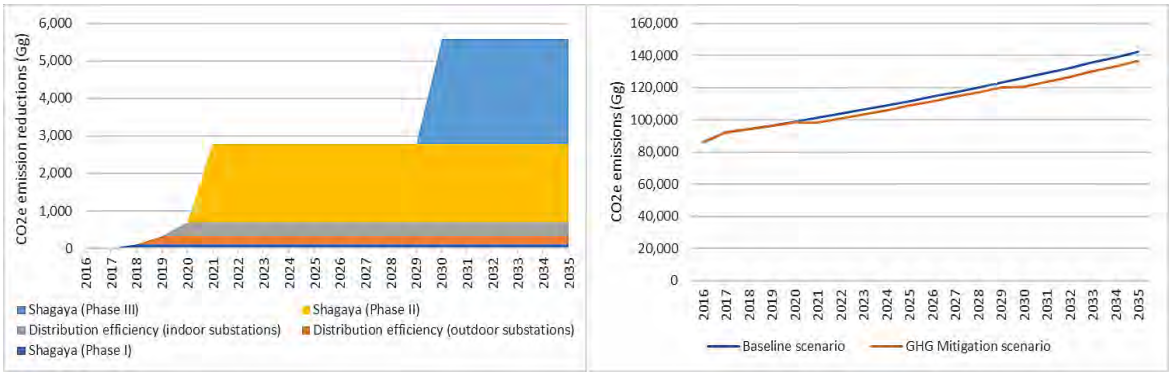
Greenhouse Gas Inventory and Mitigation Action

Kuwait compiled an update to its inventory of greenhouse gas emissions for the year 2016 (see Table ES-2). Total and net GHG emissions in 2016 were 86,336.448 Gg CO2-equivalent, which includes 82,556.572 Gg from energy; 1,932.156 Gg from industrial processes and product use; 154.371 Gg from agriculture, -13.932 Gg from forestry and other land use and 1,706.539 Gg from waste. Emissions from perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF6) in Kuwait are negligible as the products containing these gases are not produced in the country. The Tier-1 approach of the IPCC guidelines was utilized in the calculations for all reporting categories, since State of Kuwait does not have national emission factors and does not have detailed data to calculate the inventory.

	GHG Sources & Sinks	CO2-equiv	CO2	CH4	N2O
1	Energy	82556.572	81985.033	10.919	1.104
2	Industrial processes and product use	1932.156	1932.156	0.0	0.0
3	Agriculture	154.371	2.761	6.570	0.044
4	Forestry & other Land Use	-13.190	-13.190	0.0	0.0
5	Waste	1706.539	4.172	77.847	0.218
Total National Emissions		**86349.638**	**83924.122**	**95.336**	**1.366**
Net National Emissions		**86336.448**	**83910.932**	**95.336**	**1.366**

(ES-2): Kuwait Greenhouse Gas emissions for 2016

Kuwait is committed to efforts that harmonize economic growth with a low-carbon, climate-resilient development. Domestically, it has already undertaken several strategic projects to reduce its carbon footprint by promoting clean energy initiatives, introducing new low-carbon technologies, and developing long-term partnerships to exploit sustainable energy opportunities (see Figure ES-3). Progress toward such actions is already underway, and when fully implemented by 2035 will result in total annual emission reductions of about 5,600 Gg, with cumulative emission reductions of nearly 60,000 Gg of CO2-equivalent.

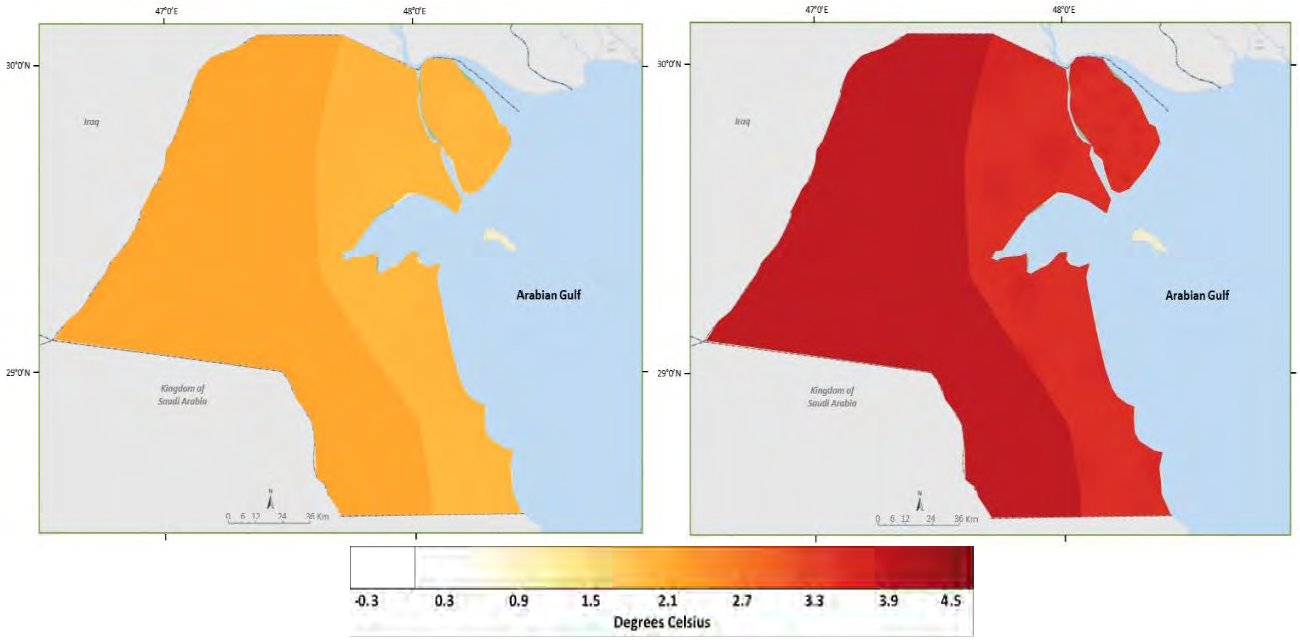


(ES-3): Left: Projected CO2e emission reductions in the GHG Mitigation Scenario; Right: Projected CO2e emissions in the Baseline and GHG Mitigation Scenarios

Vulnerability Assessments

All land areas of Kuwait will become warmer in the future, with the greatest change projected to occur during the winter months. Across the entire country, annual average temperatures show the greatest rise under RCP8.5, between 4.3° to 4.5°C by the 2071-2100 period (see Figure ES-4), compared to the historical average. Kuwait will also become drier in the future, with average annual rainfall in the western part of the country showing the greatest decrease under RCP8.5, roughly between 15% and 18% lower than the historical average. The Arabian Gulf water will also experience change. Historical monthly sea surface temperatures in the Arabian Gulf have steadily increased at a rate of 0.6 (±0.3) °C per decade, a trend three times greater than the concurrent global average.

Many sectors are vulnerable to these climatic changes, with potentially grave environmental and social effects, compounded by the country's adaptation challenges. A summary of the key findings of the vulnerability assessments is contained in the bullets below.



ES-4: Annual average projected change in temperature under RCP4.5 (left) and RCP8.5 (right) for the 2071-2100 period (Sources: CORDEX-MENA; ICBA)

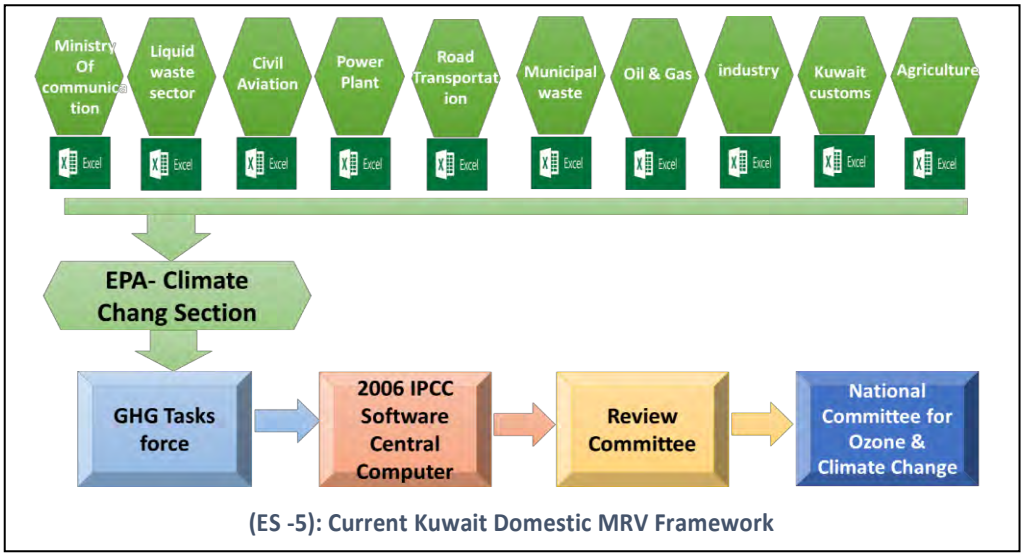
- **Coastal zones:** Rising sea levels pose threats of wetland flooding, aquifer and agricultural soil contamination, destructive erosion and lost habitat for fish, birds, and plants. Sea level rise also poses a threat to the built environment in the form of Arabian Gulf waters reaching further inland, particularly under high tide conditions and especially when combined with storm surge associated with extreme storm events. Boubyan Island would be highly impacted under by sea level rise, with roughly half the island inundated in the highest sea level rise scenario. Only the relatively higher land in the interior of the island would be visible by the end of this century. Coastal areas along Kuwait Bay are also projected to be adversely impacts by rising seas, especially the western coast near Doha Port and densely populated neighborhoods around Kuwait City.

- **Water resources:** Population growth, urbanization, industrial growth, and agricultural development are key drivers underlying Kuwait's high per capita water consumption. Coupled with a hyper-arid environment, low annual rainfall, no permanent lakes or rivers, and limited fresh groundwater resources, sustainable water resource management is a key national priority. A number of potential adaptation policies were analyzed (i.e., water tariffs, improved water efficiency, leak reduction, and improved irrigation efficiency) with each showing significant water savings and associated carbon dioxide emissions.

- **Public health:** With climate change, increased heat stress from higher temperatures and increased cardiovascular and respiratory diseases associated with more frequent dust storms, represent looming health threats to the population. These additional risks could exacerbate current major health problems such as ischemic heart disease, stroke, road injury and lower respiratory infections, whilst potentially undermining Kuwait's social protection systems.

Domestic measurement, reporting and verification (MRV) arrangements

Since the State of Kuwait signed the United Nations Framework Convention on Climate Change (UNFCCC), as the national focal point for this agreement, the Environment Public Authority has sought to develop an administrative and technical system (see Figure ES-5) to deal with the requirements of the UNFCCC through the Environmental Protection Law (Law No. 42 of 2014) and the amendments thereto that were promulgated under Law No. 99 of 2015. These legislations regulate the general policy framework for environmental protection in the State of Kuwait. The current national system for measurement, reporting and verification outlined in Figure ES-5 below will be improved in 2020 with a new MRV system that fulfills the requirements of the Convention.



(ES -5): Current Kuwait Domestic MRV Framework

Economic and Social Consequences of the Impacts of Response Measures

Climate change response measures instituted to minimize emissions of greenhouse gases often exert profound adverse effects on sustainable development plans and programs of many developing countries. These effects are particularly severe on those countries whose economies are heavily dependent on a single sector such as hydrocarbons and tourism. The State of Kuwait will have its own evaluation system for the adverse effects of climate change and the impact of response measures on the country, with work going on to enhance the modeling activities and data sets for assessing the impacts of implemented response measures on the national circumstances of State of Kuwait. To do so, Kuwait needs to be provided with support such as financial support, technology need assessments and national capacity building.

The State of Kuwait is working on maintaining public life and continuing all services and developing facilities in all aspects based on the 2035 Vision "New Kuwait"(see Figure ES-6). Pursuing economic diversification in the State of Kuwait requires the professional development of Kuwait's human resources sector. The country suffers from a shortfall of professional human resources. To start building human resource capacity, the country needs to invest in the infrastructure of its education, research and technology development sectors. Strong levels of domestic investment and financing in the country's human resources to develop skills and expertise are necessary.

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ES-6: 2035 vision New Kuwait logo

Constraints, gaps, needs, and support received

- ***Constraints, gaps, and needs to be addressed in relation to the undertaking of climate change-related actions:*** Inadequate capacity (technical, financial and institutional) remains one of Kuwait's significant challenges as it confronts climate change. Enhancing capacity will depend on overcoming serious institutional, financial and technical constraints and gaps that currently interfere with affective action. With adequate support, Kuwait can build climate change resilience and explore the viability of low-emission development trajectories.

- ***Support received for the implementation of climate change-related actions and for the preparation of the BUR:*** The state of Kuwait received financial support from Global Environment Facility (GEF) for preparing and communicating Initial National Communication of the State of Kuwait, Second National Communication of the State of Kuwait and the biannual updated report. The technical support for these reports was provided by the Regional Office for West Asia of the United Nations Environment Programme (UNEP-ROWA).

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CHAPTER ONE

National Circumstances and Institutional Arrangements

1. National Circumstances

1.1 Geography

The State of Kuwait is located at the northeastern corner of the Arabian Peninsula (see Figure 1-1) and has borders with Saudi Arabia to the south and Iraq to the north and west. Kuwait lies between latitudes 28°30'and 30°5' North and longitudes 46°33' and 48°30' East, covering a total land area of 17,818 km2 that includes nine uninhabited islands. Kuwait is roughly 170 km across from East to West and 200 km across from North to South. Kuwait shares a 495 km border with Saudi Arabia to the south and 195 km with Iraq to the north and west. The capital of Kuwait is Kuwait City. The country is divided into 6 administrative governorates; and the governorates are further subdivided into administrative areas. The country's topography is predominantly flat sandy desert, and is characterized by two distinct areas, as follows:

- *Northern zone.* This area includes Kuwait Bay and five islands: Boubyan, Warba, Maskan, Failaka, and Ouha. Kuwait Bay is a shallow but very important coastal and marine habitat with high productivity and diversity. Its coastal zone accounts for nearly half of the country shoreline. The two largest islands (Boubyan, 863 km^2, and Warba, 212 km^2) remain in an undisturbed condition and are home to migratory birds and rich marine biodiversity. Boubyan is the second largest island in the Arabian Gulf and is home to pristine marine and terrestrial ecosystems of regional and international importance. The northern half of the island is a designated marine protected area named Mubarak Al Kabeer Marine Reserve (MKMMR) - recently designated as a RAMSAR Convention Site.[1]
- *Southern zone.* The area extends from Ras Al-Ardh to the border with Saudi Arabia. Its coastal stretches include sandy and mixed shores, as well as the coral reef islands of Kubbar, Qaruh and Um Al-Maradim. Many intertidal marshes, known as *sabkhas*, are also found in this zone; the largest being Al-Khiran Sabkha that was transformed into a large waterfront city. The southern region of this zone is a monotonous plain covered by sand. Al-Ahmadi hill, 125-m high, is the sole exception to the flat terrain, while the Wadi Al- Batin and Ash-Shaqq are the only major valleys, portions of which lie within the western and southern reaches of the country, respectively. Rocks ranging in age from early Miocene (less than 24 million years) to recent are exposed within the boundaries of Kuwait.

Figure 1-1: Satellite image of the State of Kuwait.
(Source: eMISK, KEPA)

[1] In 2015 Kuwait became the 169th Contracting Party of the Ramsar Convention on Wetlands; and on 17 May 2017 announced the designation of Mubarak Al-Kabeer Marine Reserve.

1.2 Land and Vegetation

Much of Kuwait is characterized by loose, mobile surface sediments. Soils are divided into ten groups, all of which have very low levels of nutrients and organic matter (see Figure 1-2). Soil moisture content is also very low because of high evaporation rates but also due to widespread hard pans (locally known as *gutch*) that reduce water permeability. Less than 1% of Kuwait's land area is considered arable.

The vegetation of Kuwait is broadly classified as an open scrub of the Saharo - Arabian floristic region, which is contiguous with that of the Northern Plains of eastern Saudi Arabia (Royal Botanical Gardens-Kew, 2010). Kuwait occupies part of the large, low-lying desert plain covering most of Eastern Arabia and is mostly characterized by desert and coastal plains (see Figure 1- 3). Coastal areas comprise important marine habitats, many with high productivity and diversity, including salt marshes and tidal mudflats.

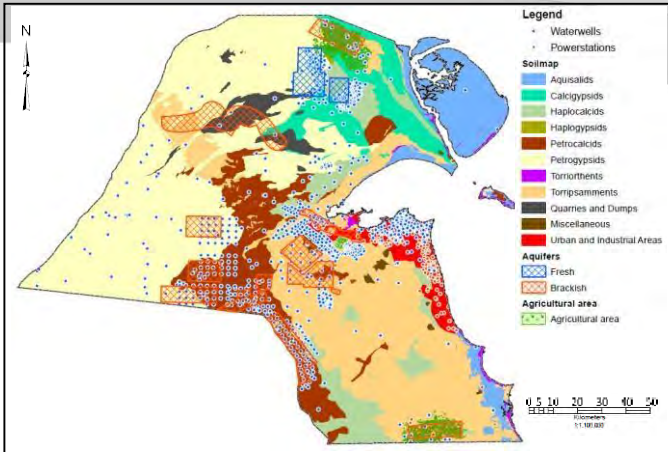

Figure 1-2: Soils, aquifers and groundwater-irrigated agricultural areas of Kuwait.
(Source: PAAF, KISR)

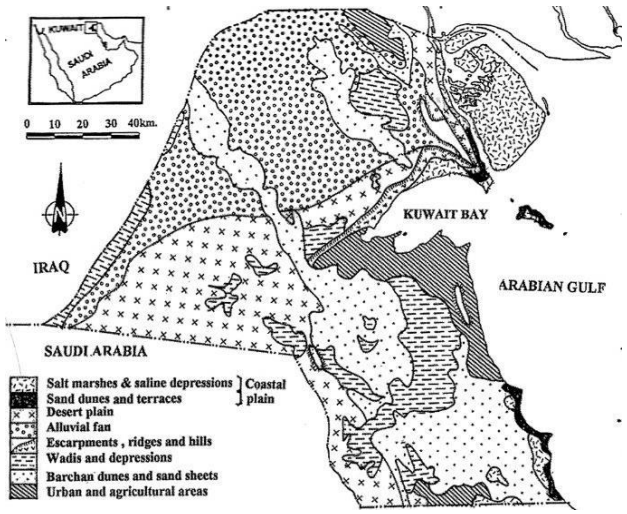

Figure 1-3: Ecosystems of Kuwait.
(Source : Samira AS Omar, Raafat Misak ;2007, KISR)

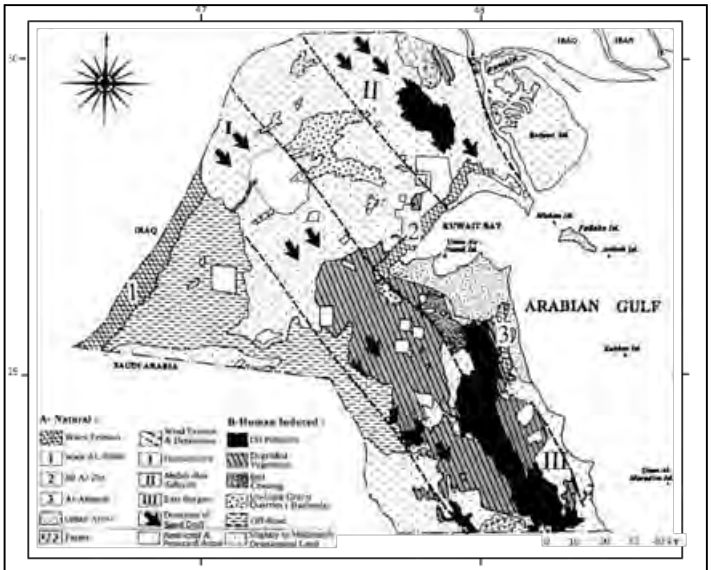

Figure 1-4: Preliminary land degradation map of Kuwait.
(Source : Al-Dousari et al., 2000)

1.3 Desertification

Several studies have assessed desertification in parts of Kuwait (Shahid *et al.,* 1999; Al-Dousari *et al.,* 2000; Omar *et al.,* 2001; Misak *et al.,* 2002; Al-Awadhi *et al.*, 2005). Seven processes or indicators of land degradation have been recognized, with a general agreement that these processes affect about 70% of Kuwait's land area. They are deterioration of vegetation cover; soil crusting and sealing; soil erosion by wind; soil erosion by water; soil compaction; soil contamination by oil; and soil salinization. These indicators are mapped in Figure 1-4.

Deterioration of vegetation cover and a decline in the alpha diversity of plant species is one the most obvious indicators of desertification in Kuwait's desert ecosystem. Overgrazing is considered the prime driver of this vegetation degradation on rangelands, a conclusion supported by several studies that document much greater vegetation cover in areas fenced off and unavailable to livestock (Omar, 1991; Zaman, 1997; Shahid *et al.*, 1999). This form of desertification is particularly severe around watering points where it is exacerbated by soil trampling and compaction due to the congregation of animals (Al-Awadhi et al., 2005).

Other important localized causes of vegetation deterioration are spring camping, the uprooting of woody shrubs to use as fuel and military maneuvers. One survey indicates that at least 65% of Kuwaiti soils are affected by some degree of compaction, inhibiting the infiltration capacity of soils by 40–100% and increasing their bulk density by up to 50% (Misak et al., 2001).

Wind erosion occurs naturally on many of Kuwait's desert surfaces: those consisting of active sand sheets and sand dune fields. Elsewhere, some vegetated sand sheets have also been mobilized where their stabilizing cover of vegetation has suffered from degradation and trampling. These mobile sediments represent a serious hazard to human activities. The annual costs of clearing sand encroachment from oil installations in Kuwait is more than US$1 million. The annual expenditure needed to remove sand from Ali As-Salem airbase is similar (Ramadan & Al-Dousari, 2013). Local sources of fine particulates contribute to the numerous dust storms that affect Kuwait, although the country is also affected by desert dust transported from neighboring countries and further afield.

Associated impacts include hazards to aircraft and maritime traffic, effects on oil operations and green energy production, and serious human health problems due to the low air quality.

1.4 Biodiversity

Kuwait is committed to its international obligations regarding the conservation of its native biodiversity. On 5 June 2017, Kuwait ratified the Nagoya Protocol, which is a supplementary agreement to the Convention on Biological Diversity that sets forth obligations on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization. With this ratification Kuwait became the 100th Party to such Protocol. On the same date, Kuwait also ratified the Cartagena Protocol on Biosafety to the Convention on Biological Diversity and became its 171st Party.

The Worldwide Fund for Nature (WWF) classifies Kuwait's terrestrial ecosystem as a desert and xerophytic (Greek xero dry, phuton plant) scrub. This classification is based on the high variability in intra-annual annual rain fall (see earlier Figure 1-2), and the high evaporation rate exceeding rainfall.

About 375 plant species have been recorded in Kuwait of which about two thirds (256 species) are annuals. Low shrubs and herbaceous perennials form the main constituents of the perennial vegetation with only a few large shrubs, and a single tree species present (Halwagy & Halwagy 1974, Halwagy et al. 1982, Mandaville 1990, Omar et al. 2001, Ghazanfar 2006).

Kuwait has a colorful terrestrial and marine biodiversity (see Figure 1-5). This diversity is fragile and vulnerable to the impacts of climate change; desertification and other threat resulting from anthropogenic activities, including habitat destruction, overgrazing, pollution, and illegal hunting and overfishing. The last inventory of wild animal species in Kuwait documented the presence of more than 300 bird species, more than 20 mammalian species, and 40 reptile species. In Kuwait, 648 species of insects have been recorded, belonging to 414 genera and 22 orders. The largest order is that of beetles Coleoptera with 230 known species, then butterflies and moths Lepidoptera with 76 recorded species, followed by bees, wasps and ants Hymenoptera with 71 species, then flies Diptera with 69 species, and finally the locusts Orthoptera with 34 known species (Al-Houty,1989).

The native flora of Kuwait consists of 374 plant species including dwarf perennial bushes, annual grasses, and herbs. This includes 256 annuals, 83 herbaceous perennials, 34 under shrubs and 1 tree. The native plants have designed their own mechanisms to survive in the country's extreme environmental conditions. The perennials in particular have to face the harsh climate more than the annuals, which propagate only after the seasonal rainfall (Shamal Azzour: https://www.aznoula.com). Important plant communities in this floristic region in Kuwait are briefly described in the bullets below (Halwagy & Halwagy, 1974; Halwagy *et al.*, 1982; Mandaville, 1990; Omar *et al.*, 2001; Ghazanfar, 2006).

Figure 1-5: Examples of biodiversity in Kuwait.
Top left: Lizard; Top right: Al-Sheriab (shore Crab); Bottom right: Arabian red fox (Vulpes arabica); Bottom left: Black-winged Stilt (Credits: Faisal Al-Nomas; KEPA)

- *Haloxylone salicornicum community* extends from Iraq in the northeast down to the northern edge of the Rub' al Khali in Saudi Arabia. Found predominantly on sandy and sandy-gravelly soils, this is the largest community in northeast Arabia and is composed of the dominant shrub *Haloxylon salicornicum*. In Kuwait, it is present in the north and north- eastern parts. Associates are *Astragalus spinosus* and *Chrozophora spp.*
- *Rhanterium epapposum community.* Extends from eastern Saudi Arabia and south to the United Arab Emirates. It is present on deep and shallow sand. The dominant species is *Rhanterium epapposum* with associates *Convolvulus oxyphyllus* and *Moltkiopsis cilata*. Other species such as *Gynandriris, Anthemis*, *Cornulaca* form associates in specific soil and topography. *Rhanterium epapposum* is very palatable to livestock, and overgrazing has greatly affected its occurrence. It is not common in Kuwait, presently found only in protected area.
- *Stipagrostis plumosa community*. Found mostly in the west and south west of Kuwait with the dominant grass, *Stipagrostis plumosa* is a result of degradation and disturbance. Under proper management this community develops into the *Rhanterium epapposum* community, or on saline soils, into the *Haloxylon salicornicum* community. In the south- west *Centropodia forsskalii*, a perennial grass, is dominant with *Stipagrostis plumosa* as the chief associate (recognized as a separate community by Omar *et al.* 2001).
- *Cyperus conglomeratus community*. Found throughout the Arabian Peninsula, being a community on sand, both on mobile and stable dunes and sand sheets, forming hummocks. In Kuwait found in the southern part the country. An excellent sand binder, and not readily eaten by livestock, it can thrive with moisture from dew. Associates are usually annual species (*Astragalus annularis*, *Brassica tournefortii*, *Plantago albicans*).
- *Halophytic communities*. Three halophytic communities – *Zygophyllum*, *Panicetum* and *Halophyletum* from coast inland are composed primarily of halophytic shrubs. *Salicornia europaea* grows on low, frequently inundated mud banks or along creeks, sometimes associated with *Aeluropus lagopoides* and *Bienertia cycloptera*, or with *Juncus rigidus* on the fringes of creeks. A *Halocnemum strobilaceum* community occupies the lower marshes along the shoreline with the seaward edge inundated very frequently by tides. A *Seidlitzia rosmarinus* community occurs further inland, followed by Nitraria retusa above the high tide mark dominating the middle marshes, and

finally, the *Tetraena qatarensis* (syn. *Zygophyllum qatarense*) community occurs on elevated, coarse sandy sites on the landward edge of the marsh.

The salt marshes are fringed by nonhalophytic communities such as the *Cyperus conglomeratus* community, the *Rhanterium epapposum-Convolvulus oxyphyllus-Stipagrostis* plumose community and the *Haloxylon salicornicum* community, the latter covering most of the territory of Kuwait.

Kuwait has a rich profile of invertebrate and vertebrate fauna. The intertidal zone is colonized by many species of Ocypode crabs, of which *leptochryseus kuwaitnese* is endemic. The blue-spotted Mudskipper *Boleophthalmus boddarti* is also another inhabitant of the intertidal zone. The most common is the black scorpion *Androctonus crassicayda*, while the most common spiders are the wolf spiders *Pardosa sp.*, the crab spiders *Thomisus sp*, the sun spiders *Galeodes sp.*, the velvet mites *Dinothrombium sp*, and *Tarantula sp* (KEPA, Fifth National Report, 2014).

One of the most common insects in Kuwait is the ground beetle (Tenebrionidae). The most famous species is probably Trachyderma hispida. This black beetle is omnipresent in houses and in the desert. Active during daytime, this beetle burrow the larvae and pupae beneath soil cover.

The reptile fauna of Kuwait is depauparate with no endemic species, although 40 species have been recorded. The common reptiles of Kuwait include the dhub *Uramastyx microlepis*, the Agma lizard and the wirral *Varanus griseus*. There are several species of snakes in Kuwait such as the sand boa *Eryx jayakari*, the Arabian boa *Malpolon moilensis* and the sand the sand viper *Cerastes cerastes*.

Twenty-eight mammalian species live in Kuwait. Sadly, four large mammal species have been exterminated; the dorcas gazelle, the mountain gazelle (Idmi), the Arabian sand gazelle and the Asiatic cheetah (fahd). Other large carnivores such as the wolf, caracal and jackal are now extremely rare. Habitat destruction and extensive and unregulated hunting are driving endangered mammalian species, such the fennec fox, the red fox, the honey badger, the Indian grey mongoose and the wild cat, to extinction.

Due to ecological and anthropogenic activities, most large mammals that were native to Kuwait were wiped out or have disappeared. (Kuwait Times, 11 March 2017). Over the past decades, the desert of Kuwait has witnessed a dramatic decline in its biodiversity, as many species have disappeared, such as Arabian oryx Oryx leucoryx, Arabian wolf Canis lupus arabs, striped hyena Hyaena hyaena, the golden jackal Canis aureus, mellivora capensis, dorcas gazelle Gazella dorcas, sand gazelle Gazella subgutturosa, fox Ruppell Vulpes rueppellii, and others. (https://www.aznoula.com) In addition, several species of birds such as houbara bustard Chlamydotis undulate, and lanner falcon Falco biarmicus feldeggi were also wiped out. Concerning reptiles, there are over 40 species of reptiles and amphibians recorded in the dry areas of Kuwait.

However, no specific studies can be found about their current status, but as with the other native fauna, their distribution is limited and restricted to remote areas with minimum human interference. In general, the fate of desert reptiles is not expected to be better than the fate of extinct birds and other species. The loss and fragmentation of habitat, the human impact and overcrowding are the main causes of extinction. Fragmentation of habitats continues to threaten wildlife in Kuwait.

Genetic clustering, species isolation, and the intensification of genetic mutations that may lead to population breakdown in isolated groups are some of the threats that habitat fragmentation poses. (https://www.aznoula.com).

The Kuwaiti government strives to preserve the national biodiversity through several policies and procedures. Environmental police are enforcing the implementation of the environment protection law on violators hunting or polluting the environment or fishing in restricted areas. Article 100 of Kuwait's Environmental Act, in force since 2014, bans hunting, collecting or destruction of nests in the areas where wild species live. The article states that native fauna, including all mammals, birds and reptiles, cannot be killed, collected, hunted, have their nests destroyed, or be harmed by any activity.

Kuwait has also allocated 11.65% of its terrestrial and coastline as nature reserve and protected parks. At the present there are twelve reserve areas across the country (see Figure 1-6). The largest and most significant reserves are as follows:

- ***Sabah Al-Ahmad Nature Reserve.*** Located at the north- east of Kuwait, it covers 325 km^2 and is where threatened animals and plants are reintroduced, and natural characteristics of the native ecosystem is preserved.
- ***Mubarak Al-Kabeer Reserve.*** Located in the north of Boubyan Island and the entire territory of Warba Island, it covers 510.2 km^2 and consists of low sandy and muddy surfaces, numerous channels and bays with rapid currents and tides rich in food abundance, which contributes to a richness in marine organisms. The reserve accommodates dolphins during the summer and migratory birds coming from Europe, such as flamingos, watercress and small derricks in winter.

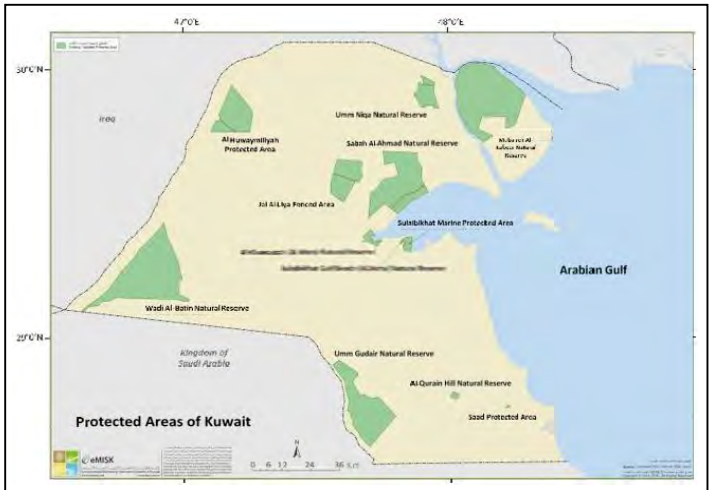

Figure 1-6: Protected Areas of Kuwait.
(Source : EPA eMISK – Kuwait)

Migratory birds use Kuwait as transit base in different times of the year. The Al-Jahra Pool Nature Reserve located in northern Kuwait is a wet and green sanctuary area that attracts a wide variety of birds, both migrant and wintering species. To date, 220 bird species have been recorded in the Reserve (Bird Life International, 2012). Another site for migratory birds is Kubbar Island, located roughly 30 kilometers off the southern coast of Kuwait, and a breeding ground for three migratory species of terns, nesting in Kubbar from early May to August.

However, the vegetation of Kuwait is under threat of extinction due to many factors including the setting up extensive recreational camps, gravel quarrying, oil exploration and the destructive activities during the 1990/1991 war; all have increased pressure on Kuwait's vegetation. Decades of low enforcement and compliance of ecosystem protection laws is another major cause of the destruction of the native biodiversity. A study conducted in protected and unprotected areas has shown that the plant cover in the unprotected areas is 80% less than that of the protected areas. (Shamal Azzour: https://www.aznoula.com).

1.5 Land Use Change and Forestry Sector (LULUCF):

The State of Kuwait has an area of 17818 km2, and with the development, renaissance, implementation of its development plans, the State of Kuwait utilized its territory to expand urban areas, establish development and recreational projects, develop the state infrastructure and establish reserves in large areas to provide a suitable environment for the growth of animals, plants and biodiversity (see Figure 1-6). Accordingly, the land areas of the State of Kuwait are classified as follows:

- Forest Land (FL): Defined as tree plantations acting as wind breaks managed by the government agencies located around the residential areas.
- Cropland (CL): Government owned lands, long term leased to growers for food production.
- Wetlands (WL): Wet areas where land is covered with water for periods of time.
- Settlements (SL): Residential areas where housing projects and other urban areas facilities are located.
- Other Land (OL): These areas are other lands outside urban and cropped areas and in this report considered as grazing areas.

Land use changes between 1994 and 2016 were determined from satellite images, see Table (1-1). Land conversions were determined for the following categories:

- Other land converted to forest land.
- Other land converted to cropped land.
- Other land converted to residential areas.
- Forest land converted to residential areas.

Year	FL	CL	WL	SL	OL	Total
	hectare	hectare	hectare	hectare	hectare	hectare
1994	3201	14850	33206	19920	1710623	1781800
1995	3201	27277	33206	19920	1698196	1781800
1996	3227	33375	33206	20320	1691672	1781800
1997	3227	33900	33206	20320	1691147	1781800
1998	3227	34960	33206	20720	1689687	1781800
1999	3227	36700	33206	20720	1687947	1781800
2000	3227	38000	33206	21520	1685847	1781800
2001	3227	38000	33206	21590	1685777	1781800
2002	3227	38700	33206	25151	1681516	1781800
2003	3397	38800	33206	24291	1682106	1781800
2004	3367	39500	33266	24951	1680716	1781800
2005	3367	39500	33266	24951	1680716	1781800
2006	3317	39500	33266	25357	1680360	1781800
2007	3296	40800	33266	25656	1678782	1781800
2008	3399	40800	33266	26026	1678309	1781800
2009	3399	41100	33266	27156	1676879	1781800
2010	4143	42600	33266	27406	1674385	1781800
2011	4325	43200	33266	28251	1672758	1781800
2012	4325	43400	33266	30008	1670801	1781800
2013	4325	43700	33266	34483	1666026	1781800
2014	4314	47000	33266	36483	1660737	1781800
2015	4314	48300	33266	36483	1659437	1781800
2016	3854	54600	33266	36933	1653147	1781800

Table 1-1: Land use change between the years 1994 and 2016.

(Source: Mohammad Jamal, (PAAF), 2018).

1.6 Water Resources

Due to its climate, Kuwait suffers from a scarcity of conventional fresh water. Endogenous precipitation is 121 mm/year (long-term average), which amounts to 2.156k 109 m3/year in 2014, which is respectively low. It increases to 39.18 mm in December 2017 from 13.26 mm in November of 2015 as shown in Figure 1-7 (Y. Villacampa, 2008).

With the increasing growth of population, water from wells is no longer enough, and so the government built a desalination plant in Kuwait in 1953, followed by others, two in Doha with capacity reaching 138 M gallons per day. A third plant was built for desalination by reverse osmosis nearby. There are three main water sources for urban and agricultural uses in Kuwait, desalinated water groundwater and treated wastewater (Y. Villacampa, 2008).

There are no permanent rivers in the country and the high level of evaporation means that streams and runoff water only last a few hours after rain. Groundwater replenishment is even scarcer due to the dryness of the soil and the high evaporation rate. The groundwater produced internally amounts to virtually nothing, as is the surface water, meaning that there is no overlap between the ground and surface water. The accounted groundwater inflow from Saudi Arabia through lateral underflow is estimated to be 20 MCM/year (Aquastat, 2016), and groundwater in Kuwait does not flow into neighboring countries' groundwater basins. The total renewable water resources per capita are 5.139k m3/year in 2014 (Aquastat, 2016).

Groundwater in Kuwait can be categorized into three classifications according to the salinity level in the water. Fresh groundwater has less than 1 g/L of a soluble salt, and it is mainly considered a freshwater reservoir from drinking water rather than used for irrigation. Due to the precipitation patterns, which include intense rainfall in a short period of time, and the soil types that allow filtration, fresh groundwater can be found in the fields of Raudhatain and Umm

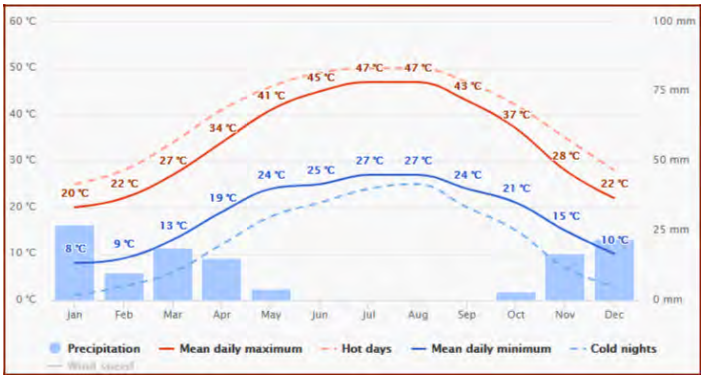

Figure 1-7 AVERAGE ANNUAL TEMPERATURES AND PRECIPITATION

(Source: meteoblue: https://www.meteoblue.com/en/weather/forecast/week/kuwait-city_kuwait_285787)

Figure 1-8 KUWAIT'S GROUNDWATER RESOURCES

(Source: eMISK, EPA)

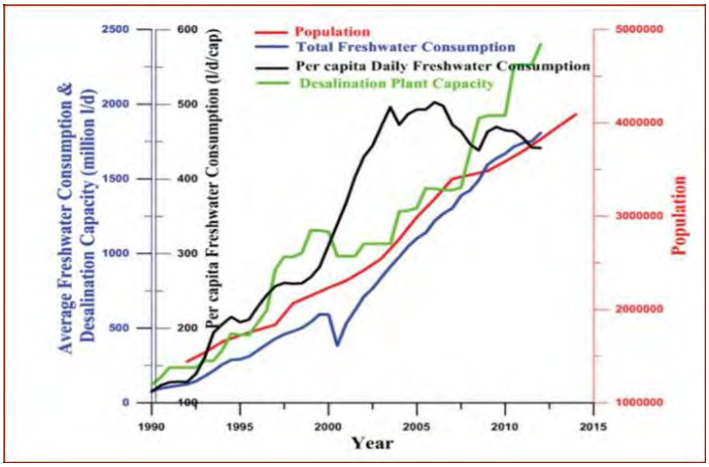

Figure 1-9 VARIATION OF FRESHWATER WATER CONSUMPTION, POPULATION GROWTH, AND DESALINATION PLANT CAPACITY IN KUWAIT 1990 -2015

(Mukhopadhyay & A. Akber, 2018)

Al Eish. Water extraction at these aquifers is 5,500 and 3,500 m3/day respectively.

Another type of groundwater is the Saline groundwater. The content of soluble salts in this type of groundwater is between 7 g/L to 20 g/L. It cannot be used for either agriculture or domestic use. The brackish groundwater is another type of groundwater present in Kuwait. It contains higher amounts of soluble salts than the fresh groundwater coming at an amount of 1 to 7 g/L. This type of water is used domestically, for agriculture and drinking water for animals, namely cattle. The source of this water is the Al Shaya, Al Qadeer, Al Solaybeia, Al Wafra, and the Al Abdali fields. The distribution of groundwater fields in Kuwait is shown in Figure 1-8. The outtake from these fields is estimated at 545,000 m3/day (Y. Villacampa, 2008), which is significantly higher than the fresh groundwater outtake.

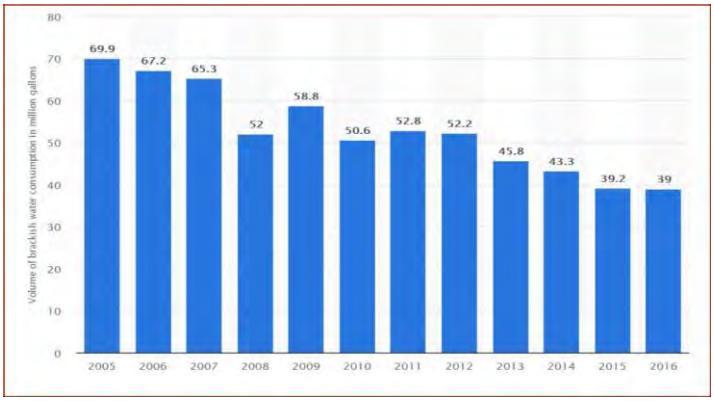

Figure 1-10 BRACKISH WATER CONSUMPTION IN KUWAIT

(Statista 2019 https://www.statista.com/statistics/648858/kuwait-average-daily-consumption-ofbrackish-water/)

In 1993 the water withdrawal was calculated to be 538 MCM; however, in 2002 it has increased to 913 MCM and that is due to the increasing water consumption by the Kuwaiti individual (Figure 1-9) and (Figure 1-10). 44% of the water withdrawn is being used for domestic uses, 2% for industrial purposes and the rest is for irrigation, which amounts to 492 MCM; 80% of it is for productive agriculture, 300 MCM is brackish water from the Al Abdali and Al Wafra private wells, 66 MCM is treated wastewater.

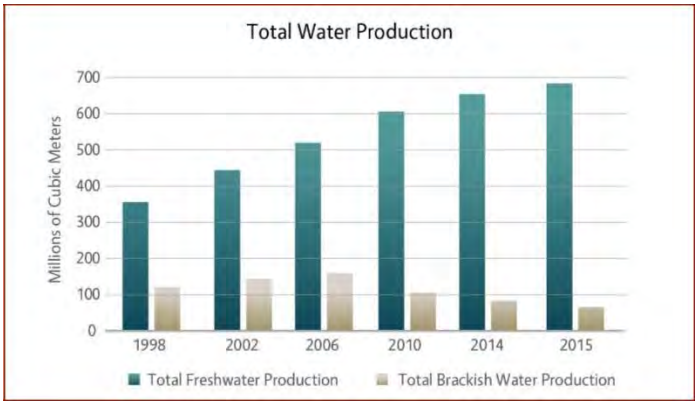

Figure 1-11: Total Freshwater and brackish water

(Source: KEPA, GIS portal, eMISK.)

The quality of the groundwater is deteriorating due to the excessive withdrawal which reached its peak in 2006 at 164.7 MCM. At which point the Ministry of Electricity and Water (MEW) realized that water preservation was necessary for future prosperity. Thus, the fresh and brackish water consumption started gradually decreasing as of 2007-2008 (Figure 1-11). The current groundwater withdrawal rate from each of the Wafra and the Adbali wells is estimated to be 300,000 - 400,000 m3/d.

Raudhatain, which is a freshwater field in the north, started with a production rate of above 9090 m3/d in the years 1963-1967, now pumping about only 4545 m3/d. The decrease of outtake is due to the increasing relativity of the total dissolved solids in the water acquired. By the year 1989, the water produced from the two water wells decreased to about 300 m3/d (Mukhopadhyay & A. Akber, 2018).

Producing groundwater, be it fresh, brackish or saline water has the accompanying costs of pumping and desalination treatment, which includes the multi-stage flash evaporation

Figure 1-12: WASTEWATER TREATMENT PLANTS

(Source: eMISK, EPA)

process, Figure 1-12. The cost of the thermal process is largely dependent on the consumption of energy during the operation accounting to about 50% of the water unit cost. In 2014, desalination capacity was recorded to have reached 2.4 M m3/d. Wastewater treatment has similar cost priorities; over 90% of the population of Kuwait has access to a central sewage system collecting both domestic and industrial wastewater. The total length of pipelines stretches over 650 km.

In 2004 a municipal wastewater treatment plant was constructed by a private consortium on Build – Operate – Transfer (BOT) formula in Sulaibiya, the plant uses Reverse Osmosis Process (RO) and has the capacity of 375,000 m3/d. In 2006 the efficiency of the plant was at 94.7%, producing 355,102 m3/d of treated wastewater from a 375,000 m3/d influent (Abdel-Jawad et al.).

Future demand for water is increasing and does not show any signs of stabilizing. The availability of desalinization capacity will depend on the economic growth in the country. Burney et al. carried out a study projecting the water demand in Kuwait by 2025, and results show that it will rise to 2 M m3/d to 8.3 M m3/d. There seem to be several available options for rationalizing water demand, one of many is to reduce the gap between the increase of income and the government-fixed price of water, another is the used of reclaimed municipal wastewater. In 2007, 76% of the treated wastewater was used for landscaping and agriculture (Mukhopadhyay & A. Akber, 2018).

1.7 Climate

Kuwait has a hyper-arid desert climate that is highly variable with recurrent extremes. Maximum daily temperatures can reach 45°C during the summer during which there is no rainfall (see Figure 1-13). The climate is marked by four distinct seasons, with long, hot and dry summers and short winters, as briefly described in the bullets below.

- *Winter.* The winter season occurs over a 2-month period between 6 December and 15 February. These months are cooler, often with a cold northwesterly wind. The lowest temperature recorded was −4°C recorded at Kuwait International Airport in January 1964. Low temperatures, clouds, rain and a cold northwesterly wind called (*Shamal*) characterize this season. Two distinct climatic periods within the winter season are evident.

Spring. The spring season is a 3-month period from 16 February to 20 May and is characterized by moderate temperatures, rain, cloudy conditions and hot southerly winds. The climate during the spring is divided into two distinct climatic periods, as briefly described in the bullets below. Two distinct climatic periods within the spring season are evident.

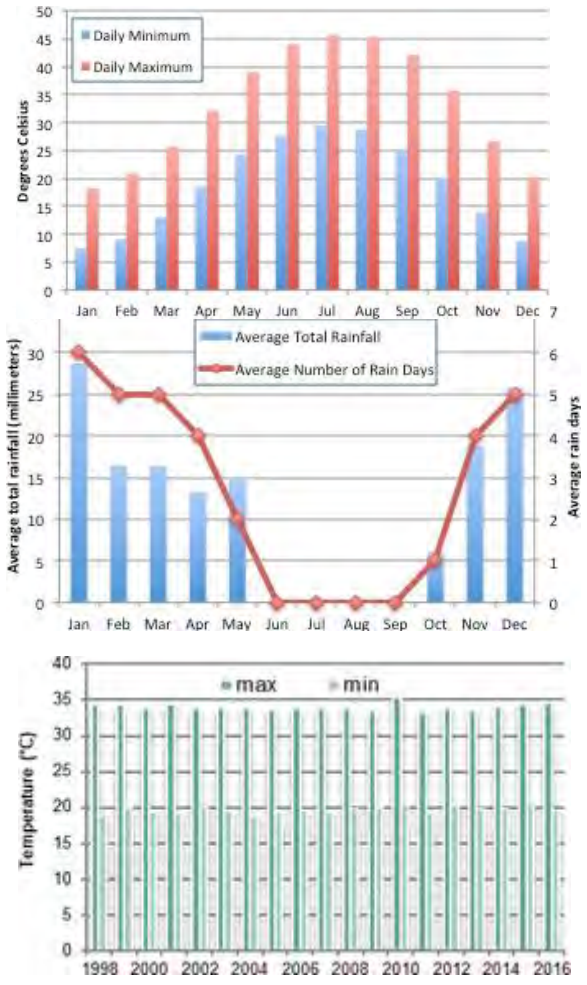

Figure 1-13: Top: Daily minimum and maximum temperatures in each month, averaged over 1962- 2016; Middle: Total rainfall in each month, averaged over 1962- 2016; Bottom: Highest and lowest average annual temperature recorded over the period 1998- 2016.
(Source: Kuwait Civil Aviation - Metrological Department)

- *Summer.* The summer season occurs over a roughly 5-month period from 21 May to 4 November and is characterized by a significant increase in both humidity and temperature. Summer is typically hot, dry and humid, with daily maximum temperatures ranging from range from 43°C to 48°C, with the highest-ever recorded temperature of 54.0 °C at Mitribah in northwest of Kuwait on July 21, 2016 (Kuwait Civil Aviation Metrological Department). This was the highest-ever temperature reliably recorded on the planet in last 76 years, as documented by the World Meteorological Organization (WMO). The prior highest temperature (52.9°C) was also recorded at Mitribah. The climate during the summer is divided into three distinct periods.
- *Autumn.* The autumn season is considered to occur over a single month- long period from 5 November through 5 December and is characterized by moderate temperatures, greater cloud cover, more frequent rain showers, and increasingly cold nights.

The climate of Kuwait is further characterized as follows:

- *Rainfall.* Figure 1-14 summarizes annual rainfall over the period 1998 to 2016. Rainfall is concentrated in the winter and spring months, totals are highly variable from year to year, and drought is a recurrent phenomenon. Average annual rainfall is typically around 112 millimeters (mm) per year, varying from 75 to 150 mm/yr. Annual levels at Kuwait International Airport have been recorded as low as 34.4 mm and as high as 218 mm, while 319.5 mm was recorded in Umm Almaradim Island in October 2013.

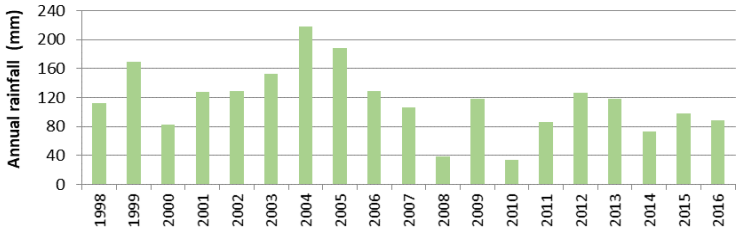

Figure 1-14: Average annual rainfall over the period 1998-2016.
(Source: Kuwait Civil Aviation - Metrological Department)

- *Humidity:* From mid-August through September, humidity can exceed 95% in coastal areas. This is due to high seawater temperatures coinciding with tropospheric temperature inversions. Over the period 1987 through 2017, average relative humidity was 57%.

Figure 1-15: Recent severe dust storms over Kuwait City.
Left: Storm on 17 June 2018. (Photo: Sarah Al-Sayegh); Right: Storm on 18 February 2018 (Photo: Kuwait Times, 19 February 2018)

- *Dust storms:* Given the geographical location, dust storms are regular phenomena in Kuwait. While they can occur in any season, dust storms are particularly frequent in summer and can reach speeds up to 150 km per hour (see Figure 1-15). Dust sources are the Mesopotamian region that includes Syria, Iraq, western Iran, and the north-eastern portion of the Arabian Peninsula. Dust activity in the Tigris- Euphrates basin begins around May, reaches a maximum in July and is much reduced by September–November. In spring, the region is affected by north- westerly Shamal winds that transport dust down to the Gulf. Dust storms are aggravated by practices of overgrazing and camping practices. They are known to contribute to serious health impacts in Kuwait such as asthma attack incidence rates of 175 per day, as well as increasing road traffic accident rates that are over three times the normal rates.

1.8 Population

Kuwait has an overwhelmingly urban population that has grown rapidly since the discovery of oil in the late 1930s, with over 98% of the population living in urban areas. Between 1996 and 2018 the total population increased from 1.6 million to 4.8 million, at an average annual rate of 4.0% (see Figure 1-16). Over this time, the Kuwaiti population as a share of the overall population has declined from nearly 37.2% to nearly 30.4%. In contrast, the expatriate population has grown more rapidly over the same period - about 5% per year on average - while their ratio of total population rose from nearly 62.8% to 69.6% (PACI, 2018).

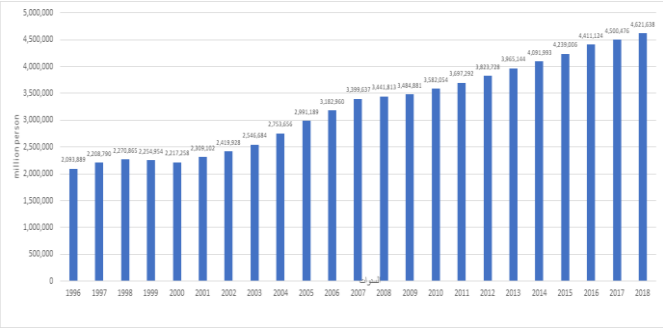

Figure 1-16: Population composition

(Source: The Public Authority for Civil Information,

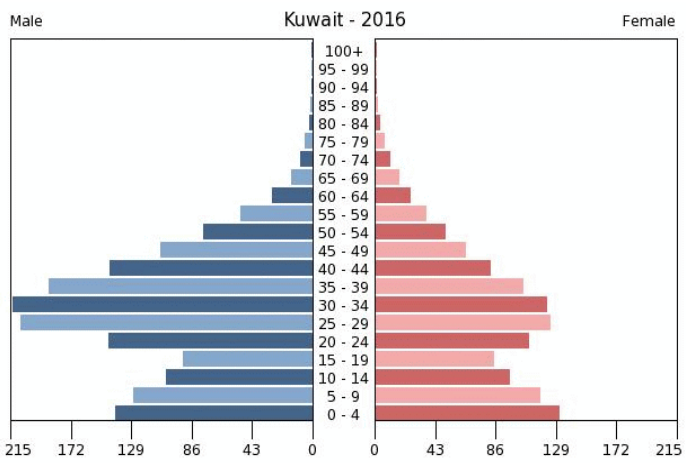

Figure 1-17: Population pyramid, 2016.

(Source: Public Authority for Civil Information, paci.gov.kw)

Kuwait's population is, like those of its Gulf neighbors, heavily skewed relative to age and gender (see Figure 1-17). By the end of 2017, most of the total population (about 78%) was between 16 and 64 years of age and males roughly comprised 63%. This is in large part due to the presence of a large number of expatriate workers in the country in that age bracket (about 86%) that are mostly male (nearly 69%).

In contrast, Kuwaitis under the age of 20 accounted for the majority, about 45.2 percent, of the Kuwaiti national population in 2016. On the other hand, the gender distribution in the case of Kuwaiti national population is modestly biased towards females (51%).

Regarding educational levels, illiteracy rate among the total population during the last 10 years was about 3 percent, while those who just read and write stood at 27 percent, and holders of school certificates ranging from primary to secondary represented 45.4% of the population (see Figure 1-18).

1.9 Public Health

Due to a modern healthcare system, there has been a decrease in the incidence of communicable diseases and an increase in life expectancy over the recent past. Today, the burden of disease has shifted towards non-communicable diseases and injuries. Trends are showing steady increases in the incidence of coronary heart disease, cancer and accidents and injuries (mainly road traffic accidents). In addition, the incidence of diabetes and obesity is on the rise. Various NGOs have begun to focus attention on these conditions.

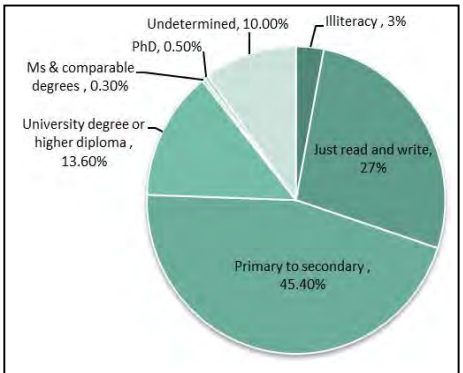

Figure 1-18: Educational profile.

(Source: Alghais and Pullar, 2016)

In recent decades e.g. 1990s to 2010s, the number of motorized vehicles has grown significantly lead to increased air pollutant emissions (PM10, CO, NOx, O3, SO2 and VOCs) and poor urbans; quality (Al Bassam; and Khan, 2004). Many studies have shown strong associations between particulate matter (PM) levels and a variety of adverse health outcomes, with particulate matter (PM) levels are high enough in Kuwait to impose substantial health risks (Ward Brown et al., 2008).

1.10 National and Regional Development Priorities and Objectives

Since 2010, the national development plan has been implemented with objectives and programs based on the vision of His Highness Sheikh Sabah Al-Ahmad Al-Sabah to transform the state of Kuwait into a financial, cultural and institutional leader in the region by 2035, attracting investors, creating a competitive economy led by private sector and promoting production efficiency.

The Kuwait National Development Plan sets the nation's long-term development priorities. It is organized around five themes, or desired outcomes, and seven pillars, or areas of focus for investment and improvement. Each pillar has a number of strategic programs that are designed to have the most impact on achieving the vision of a New Kuwait and some projects have a direct relation to mitigation of GHG emissions of the business as usual scenario and adaptation to the negative impact of climate change as follows:

In the development of infrastructure, Kuwait seeks to develop and modernize the national infrastructure to improve the quality of life for all citizens. For example, in the land transportation system -- The Sheikh Jaber Al-Ahmed Causeway project and the development project of the 4th ring road; in the marine transportation system -- The Mubarak Al-kabeer Port project and the development projects for Shuwaikh, Shuaibah and Doha Ports; in the air transport system -- The Kuwait Airport Expansion project - Terminal II and the development of east and west runways at the international airport project; In the development and increase of production capacity of electrical and water energy -- The construction project of the Doha Reverse-Osmosis Seawater Desalination Plant-Phase I, the supply, installation, operation and maintenance project of gas turbine units with composite cycle system to increase electrical power at al-Sabiya power station and water distillation by 750 MW-Phase III, the supply, installation, operation and maintenance of the gas turbine project (Phase I) at al-Sabiya station to the combined cycle system, and the supply, installation, operation and maintenance of the gas turbine project (Phase III) at the al-Zour Southern station site to the Combined Cycle system.

In the utilization of renewable energy, Kuwait is embarking on the Al Sheqaya Renewable Energy Complex project; the supply, installation, operation and maintenance project of PV panels on the Sebiyyah's ground water tanks; and the Water Desalination Center project using renewable energy. To improve the efficiency of waste management, projects include the development and rehabilitation of landfill sites in different areas, and the municipal solid waste treatment project (Kabad).

In order to develop a prosperous and diversified economy to reduce the country's dependence on oil revenues there are three main projects to be implemented in the oil sector -- The Al-Zour Refinery project, The Bio-fuel project and The Olefins III and Aromatics II integrated with al-Zour Refinery project.

1.11 Economy

Kuwait's economy is fairly small, comparatively rich, semi-highly dependent on oil exports. Petroleum accounts for the majority of gross domestic product (GDP), export revenues and government income. Crude oil & natural gas sector dominates the economy. On average, it represents nearly 50% of the country's real GDP.

Other sectors are not actually fully independent of the oil and gas sector as they are heavily dependent on oil and gas revenues. Social services, for example, are entirely funded by public oil revenues. The largest manufacturing industries are oil-based, and most other activities are heavily subsidized with oil income. Figure 1-19 (left) shows the percentage contribution of oil and non-oil sectors to real GDP (at constant prices of 2010) between 2006 and 2015. Figure 1-19 (right) shows the growth trend of these two sources of real GDP during the same period. Because of such a reliance on oil income, Kuwait's economy continues to be highly vulnerable to changes in global oil demand, as well as international oil market price volatility.

Over the period 2006–2015, nominal GDP per capita has shown a decline of 12.6% from nearly 30.7 thousand U.S. dollars in 2006 to nearly 26.7 thousand U.S. dollars in 2015. However, during the same period of time, real GDP per capita has shown a strong growth of 63.6% from 18.6 thousand U.S. dollars in 2006 to 30.2 thousand U.S. dollars in 2015 (see Figure 1-20, left). Over the same period of time, the GDP per capita using the purchasing power parity (PPP) basis has averaged 80.4 thousand U.S. dollars, which is one of the world highest levels. However, PPP-GDP per capita has declined by 6.4 percent. Figure 1-20 (right) shows the decline in GDP per capita at PPP basis over the period 2006 – 2015.

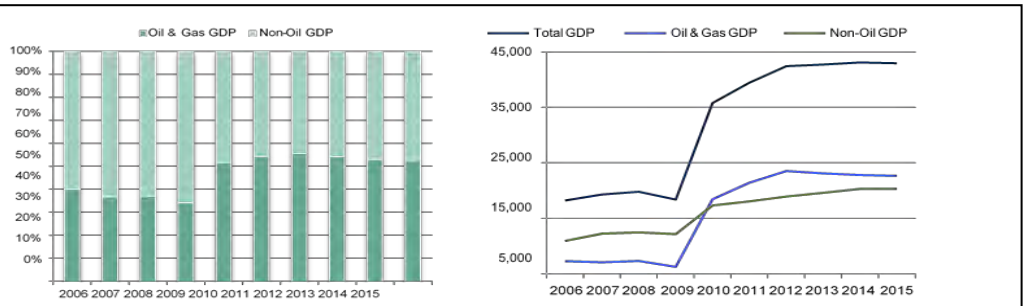

Figure 1-19: Shares of oil and gas sector and non-oil sectors of total real GDP, 2006-2015 (left); Trends in the contribution to total real GDP from oil and non-oil sectors,2006-2015(right). **(Source: A. Al-Mejren-2018)**

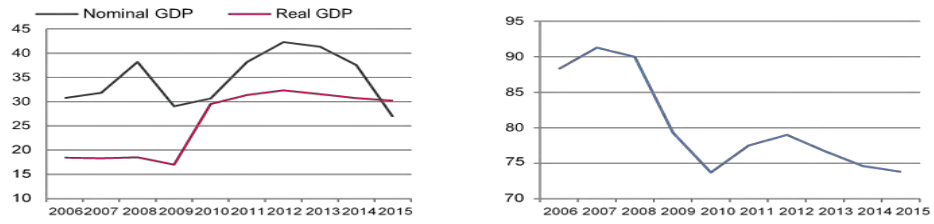

Figure 1-20: Nominal GDP per capita versus real GDP per capita, 2006-2015 (left); GDP per capita at purchasing power parity, 2006-2015(right).
(Source: A. Al-Mejren-2018)

In addition to the oil and gas sector, there are four other activities with large GDP shares. They include social services, financial services, transport and manufacturing. Together, these sectors account for about 90% of the non-oil sector's contribution to real GDP and 42% of the entire real GDP, with the remaining 5% of non-oil GDP accounted for by agriculture, utility, construction, and trade sectors. An overview of the major sectors is provided in the bullets below. Figure 1-21 presents their relative contribution to GDP in 2015.

- *Social services:* The contribution of this sector to real GDP is in the form of government expenditures on basic services (e.g., health care). The overall contribution to overall real GDP in 2015 was about 17%.
- *Financial services:* This sector, which includes banking, insurance, real estate and other financial and business services, plays a substantial role in the nation's economy where its contribution to real GDP was about 14%.
- *Transport:* This sector includes road and ports development, storage and communication services. Its contribution to real GDP in 2015 was about 6%.
- *Manufacturing:* This sector consists primarily of petrochemical industries, building materials, metal and steel production. Its overall contribution to real GDP was about 5%.

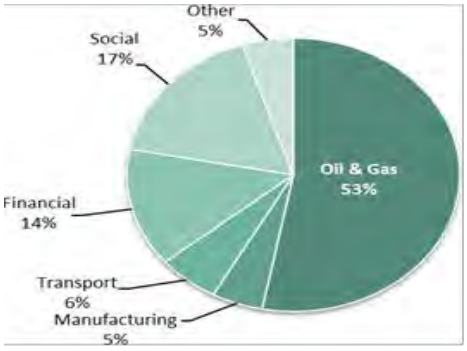

Figure 1-21: Sectoral contribution to Kuwait's real GDP 2015.
(Source: Central statistical Bureau, Kuwait)

1.11.1 Key Economic Sectors

- ***Oil***

Kuwait, a member of the Organization of Petroleum Exporting Countries (OPEC), is one of the world's leading oil producers. It has the world's fifth largest crude oil reserves and is one of the ten largest global exporters of crude oil and oil products. As result of Kuwait having a strong economy, it had a per capita Gross Domestic Product (GDP) in 2015 of 30.2 thousand U.S. dollars. The country enjoys macroeconomic and financial stability and has a very solid financial position with accumulation of considerable public and external accounts surpluses.

Kuwait Petroleum Corporation (KPC), the Ministry of Oil, and the Supreme Petroleum Council are the government institutions that are responsible for the petroleum sector in Kuwait. KPC is an umbrella establishment with multi subsidiaries including Kuwait Oil Company (KOC), which manages crude oil and natural gas production; Kuwait Gulf Oil Company, which manages offshore crude oil and natural gas operations in the Partitioned Neutral Zone between Kuwait and Saudi

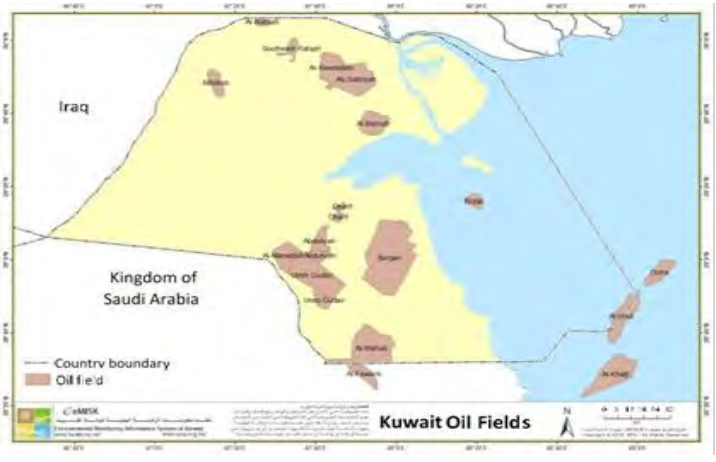

Figure 1-22: Kuwait's oil fields.
(Source: eMISK, EPA)

Arabia, the Petrochemical Industries, and Kuwait National Petroleum Company (KNPC), which operates the country's three oil refineries.

The Ministry of Oil estimates the country's proven oil reserves at 101.5 billion barrels, just over 7% of the world total. Additional reserves of about five billion barrels is held in the Partitioned Zone with Saudi Arabia. Much of Kuwait's reserves and production are concentrated in a few mature oil fields that were discovered in the early to middle decades of the past century. Figure 1-22 shows the distribution of Kuwait's oil fields.

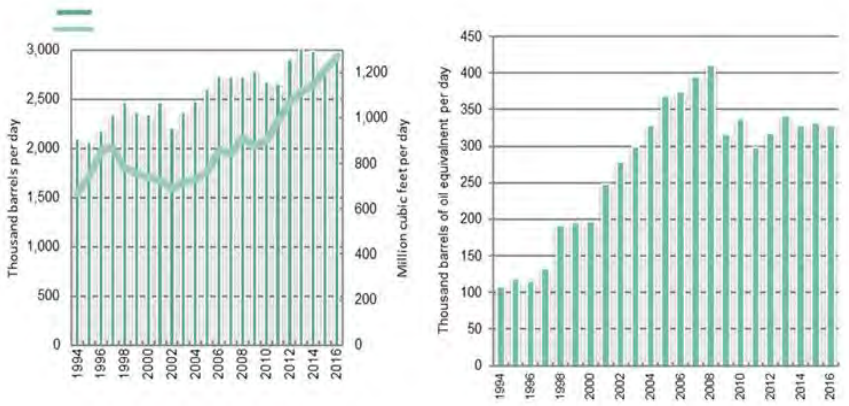

Figure 1-23: Kuwait's daily crude oil and dry natural gas production, 1994-2018 (Left). **(Source: Kuwait Petroleum Corporation);** Right: Kuwait's daily crude oil and oil by product consumption, 1994-2018. **(Source: Organization of Arab Petroleum Exporting Countries (OAPEC) Data Base)**

Gross crude oil production in Kuwait reached about 2.883 million barrels per day in 2016 while natural gas production exceeded 1,200 million cubic feet per day in that year (see Figure 1-23, left). In January 2018, KPC officials disclosed plans for the company to spend over $500 billion to boost its crude production capacity to 4.75 million barrels per day by 2040. Nearly $114 billion of this amount was allocated over the next five years (2018-2022). Kuwait's current (2018) crude oil production capacity is about 3.15 million barrels per day (bpd).

About one-sixth of Kuwait oil and gas production is consumed in the domestic market. According to estimates by KNPC, which produces and markets the refined products, half of the domestic consumption goes to power plants and seawater desalination units, while the rest is consumed mainly by the oil industry itself, followed by the transport sector. Only a small proportion is consumed by households. Figure 1-23 (right) shows the Kuwait's daily consumption of crude oil and oil products in thousands of equivalent barrels of crude in the period 1994 – 2016. The decline in oil consumption since 2009 was due, among other factors, to the shift toward the use of more natural gas in power stations and petrochemical industries. Finally, due to low natural gas production relative to consumption requirements, Kuwait has been a net importer of natural gas since 2009. In 2016, Kuwait's total imports of natural gas reached about 152.3 billion cubic feet, nearly 417 million cubic feet per day. (KNPC data).

- ***Natural Gas***

Regarding natural gas, Kuwait had an estimated 1.8 trillion cubic meters of proven natural gas reserves as of 2015. Kuwait's reserves are not considered significant relative to global reserves and this has spurred an extensive drive in natural gas exploration. The utilization of the discovery of large non-associated gas reserves, which was discovered in the northern area of the country had been delayed by parliamentary opposition since 2006. However, in September 2016, Kuwait awarded contracts to international companies to enable the start-up of production of gas from these reserves by 2018. Yet, the $3.6 billion second phase plan of the project is on hold after tenders were unexpectedly cancelled in late 2017.

Total daily average production of associated and non-associated natural gas increased during 2016 to 1,737 million standard cubic feet per day (MMSCFD) against a target of 1,530 MMSCFD, i.e. higher by about 14%. In addition, average production of dry (non-associated) gas reached 1272 million cubic feet per day, i.e. nearly 464.4 billion cubic feet in 2016. In addition, average gas exported to the LPG unit in KNPC amounted to 1625 million standard cubic feet per day (MMSCFD), exceeding the target of 1465 MMSCFD. On the other hand, KOC has succeeded in reducing gas flaring to 1%, and strives to achieve less than 1% in line with its strategy. However, despite its efforts, repeated closure of KNPC's Acid Gas Removal Plant had pushed KOC's gas flaring rate to 1.31%, higher than the tolerance level of 1.15%.

- *Electricity*

Regarding electricity, given Kuwait's harsh climate, high population growth rate, and rapid socio-economic growth, demand for electricity is steadily increasing to keep pace, particularly during the hot summer period due to air conditioning- and water desalination-related electricity demand. For Kuwait, coping with such multidimensional growth in electricity demand has proved to be a major challenge with repeated power outages experienced in 7 residential areas during the hottest month of July 2016 when temperatures exceeded 50°C.

Total installed electric capacity in 2016 was about 18,850 megawatts (MW). Small (18-42 MW) and medium (100-200 MW) gas turbines account for about 40% of total installed capacity and are usually used in emergencies or during the time of peak load. Due to the high operational costs and low thermal efficiency of gas turbines, they are usually kept as standby with a high level of availability.

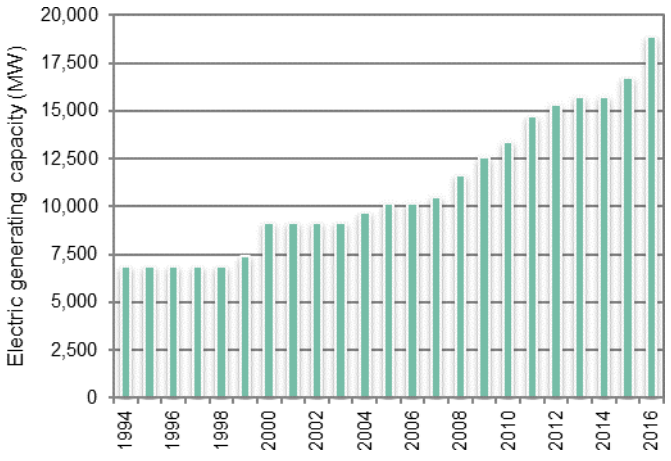

Figure 1-24: Total installed electric capacity, 1994-2016.

(Source: Ministry of Electricity and Water, Statistical Yearbook 2017: Electrical Energy)

The remaining electric capacity consists of steam turbines ranging in size from 120 to 300 MW and combined cycle units (185-280 MW). Natural gas, heavy fuel oil, crude oil and gas oil, are all used as primary fuels for electric generation depending on boiler design, with priority given to natural gas relative to its availability. Figure 1-24 presents the development of total power installed capacity in MW between 1994 and 2016.

Over the period from 2000 to 2015, electricity generation has been increasing by 5.1% on average per year. (Ali and Alsabbagh, 2018). The Ministry of Electricity and Water (MEW) is solely responsible for generation, transmission and distribution of power and water in Kuwait. Although the country has been slow to reform such avital sector, progress is taking place as the government looks to attract foreign investors. Three major Public-Private Partnership projects are expected to be launched soon: the 2.7 GW Al-Zour North Second and third Project, the three phases of 5.4 GW Al- Khiran Project and the 3.6 GW Al- Nwaiseeb Project. Within the vision of New Kuwait, Kuwait started a three- phase process, with the goal of generating a total of 3,070 MW of renewable energy (15% of the country total annual consumption) by 2030. The first phase is comprised of 70 MW energy park built on a 100-square- kilometre area in Al-Shigaya, a desert zone about 100 km west of Kuwait City.

The second and third phases are projected each to produce 1,500 MW individually. The country determination to increase investments in the renewable sources of energy, mainly solar and wind has intensified after its decision to abandon its plan to construct a nuclear plant.

Kuwait ranks fifth in the world in terms of per capita electricity consumption. Between 1971 and 2014, Kuwait's per capita electricity consumption has been growing by an average annual rate of 3.8% (from 3,011.95 kWh in 1971 to 15,213 kWh/cap/year in 2014). The residential sector accounts for 64% of the country's total electricity consumption due to air conditioning demand in order to adapt to high temperatures, a much higher share the OECD countries (31%) (IEA, 2017).

While the country's harsh weather is a key factor behind this level of demand, the highly subsidized energy tariffs is believed to be the biggest driver behind such extraordinary electricity consumption in Kuwait. The cost of electricity is subsidized by more than 90%. Electricity cost of production is about $0.130 per KWh but is priced to consumers about $0.007 per KWh. (https://oxfordbusinessgroup: Rising Cost Growing Demand Has Prompted Drive Boost Generating Capacity and Explore Alternatives).

Over the past decade, Kuwait has adopted policies aimed at reducing per capita electricity consumption and has organized several public awareness campaigns to specify the urgency of energy conservation. Policies attempt to reduce electricity consumption in the building sector in general in Kuwait. These policies include the update of the Energy Conservation Program in 2014, the use of renewable energy to generate electricity and the setting of renewable energy penetration targets. Within the government energy reform initiative of 2016, electricity and water rates have been revised and adjusted to encourage consumers to rationalize consumption. The new tariffs became effective on 22 November2017.

- *Transportation*

Kuwait has an extensive, modern and well-maintained network of road infrastructure. In addition, Kuwait's most recent Midrange Development Plan ((2017-2018) includes several ambitious projects that expand and upgrade the country's major highways and other means of transport. In fact, the development of transport infrastructure in general is an essential part of the "New Kuwait" vision. Various transport key projects are in progress including the expansion of airport facilities, a railway, a metro, bridges and seaports. In light of the ongoing technological advancement in the telecommunications industry which has become a basic part of all contemporary infrastructure, Kuwait also recognizes that the term "infrastructure" goes beyond the traditional concept of land, sea and air transportation.

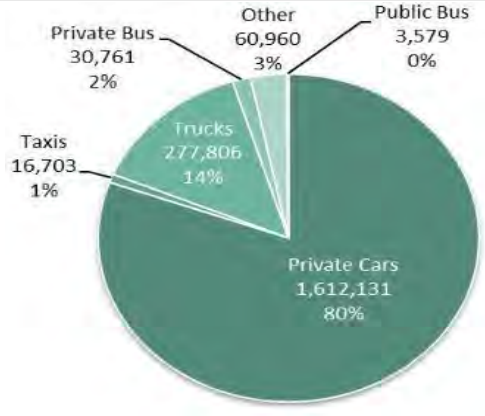

Figure 1-25: Vehicle stock profile, 2016.

(Source: CSB, the annual statistical abstract 2015/2016)

To achieve a "sophisticated modern transport and communication infrastructure", the government is striving to realize five targets: (1) increasing the capacity of Kuwait's International Airport; (2) addressing the domestic traffic problem; (3) developing new economic and urban centers at the Northern part of the country, (4) maximizing the capacity of ports to support the transition of Kuwait to a financial and commercial hub; and (5) modernizing the technologies of the telecommunications sector and keeping abreast of the continuous advancement in this field.

Kuwait has an extensive, modern and well-maintained network of road infrastructure. By 2016, the total length of paved roads exceeded 7,100 kms. Yet, despite such great expansion in road capacity, the pace of increase in the number of vehicles in Kuwait outperforms such expansion. In the same year, the number of vehicles number had exceeded 2 million, of which 80% were private, because of is it because of low fuel costs, as an adaptation measure due to heart, Lack of adequate climate-adapted public transport infrastructure. The rest consists of public and private trucks, buses and taxis. (Figure 1-25) presents the distribution of vehicles by type in Kuwait in 2016.

The second pillar of the Mid-Range Plan which deals with the domestic traffic problem includes the development of new roads and ports that link the Northern part of Kuwait with neighboring countries, limiting traffic congestion and involving the private sector in the construction of the needed infrastructure. This program includes the 37-km long Sheikh Jaber Al-Ahmad Sea-Bridge terminals (Figure 1-26), which seeks to increase the efficiency of the transport network, reduce the traffic congestion and shorten the distance between Kuwait City and Sabiya at the Northern part of Kuwait Bay. The Bridge which entered its pre-final completion phase includes the construction of two artificial islands containing buildings for traffic and emergency services, the authority which monitors the maintains the bridge, a fuel station and a marina, as well as a main navigation bridge with a height of 23 meters and an opening of 120 meters for the passage of ships.

Figure 1-26: Sheikh Jaber Al-Ahmad cross-sea bridge.
(Source: eMISK)

In addition, the 570 km long railway network project, which aims to increase trade volume and to facilitate the movement of passengers among GCC countries, will have a positive impact on the domestic traffic by reducing the need for road transport and reducing pollution resulting from the use of vehicles and trucks. The project also aims to encourage the private sector to participate in the construction and development of the national projects and to benefit from its practical experience, which has a positive impact on the local economy, especially through the transfer of technology and knowledge, thus enhancing the efficiency of employees and raising the level of services provided as well as creating more career opportunities.

Figure 1-27: Kuwait international airport new terminal
(Source: Ministry of Public Works website)

Air Transport. The development of Kuwait's air transport system includes the increase of the capacity of the country's international airport to 25 million passengers through the construction of new passengers' facilities using the highest world specifications, adding new terminals (Figure 1-27), increasing the efficiency and the capacity of the runway to enable it to receive modern aircraft and the Airbus A380, adapting the latest technologies of air navigation and the latest international standards, and adding a new air control tower serving the third runway and the middle corridor.

Figure 1-28: Shuwaikh seaport.

(Source: Kuwait Ports Authority website)

Maritime Transport. There are further plans to develop the maritime transport system to maximize the capacity of the ports to enable it to support the transformation of Kuwait into a regional financial and commercial hub. At the top of the maritime transport program is the project of Mubarak Al-Kabeer Port, which seeks to increase trade exchange activities, boost the volume of regional trade, increase the volume of investments, increase economic resources, raise economic growth rates, develop the services provided by sea ports, increase their absorptive capacity and contribute to the reconstruction and development of the new northern urban area. Mubarak Al-Kabeer port will have a capacity of 24 berths, an ability of receiving outsized ships and a capability to handle nearly eight million containers. The project will help in the creation of an industrial zone and providing thousands of new job opportunities.

The development of Shuwaikh seaport (see Figure 1-28) is an essential part of the program. It aims to increase the efficiency of the navigation channel in the port to accommodate larger number of up-to-date container vessels with deeper depths, in addition to the enhancement of safety factor.

- ***Built Infrastructure***

Since the first half of the twentieth century, Kuwait City has transformed itself from a small walled city to a metropolitan area experiencing rapid and unprecedented population growth with only a relatively small increase in the extent of its urban area. Most of the highly urbanized areas are located along the coast (see Figure 1-29). This has led to a number of lifestyles, economic and environmental challenges (Alghais and Pullar, 2016).

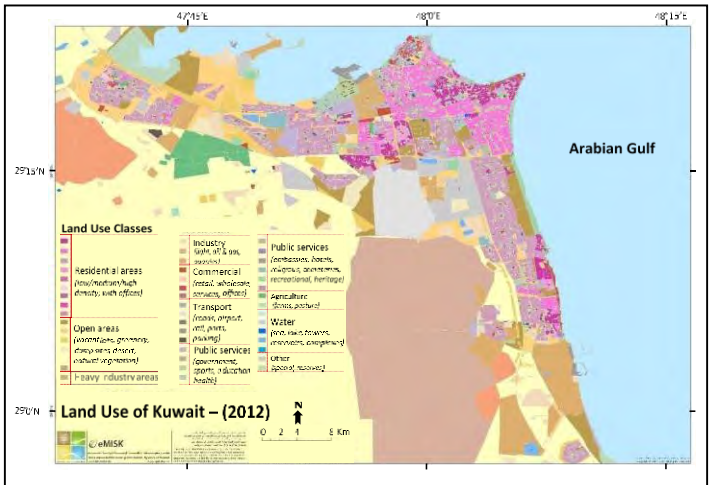

Figure 1-29: GIS map of land use in State of Kuwait.

(Source: eMISK, KPA)

Future urban developments are planned for beyond the periphery of existing urban centers. Two of the most prominent are briefly described in the bullets below.

- **Kuwait's Islands Project. The initial phase of an ambitious project to transfer five of the Kuwaiti uninhabited islands (Boubyan, Failaka, Warba, Miskan and Ouha) into economically feasible areas was presented to His Highness the Amir who backed the initiative as part of the Kuwait future strategy and a corner stone of the vision to transform Kuwait into a regional and global trade and financial hub, while also boosting development of all other sectors of the economy. The project aims to support the country's development through various projects on these islands, which will turn them into free trade zones that link the East to the West. The Supreme Council of Planning is studying the benefits of adopting other international models to create a comprehensive and multi-purpose free trade zone in these islands to enhance Kuwait's regional and international competitiveness and attract foreign investment. Realization of the project will require new legislation, exceptional resolutions, and other governmental measures.**

Figure 1-30: Conceptual rendition of Silk City to be built at Subyia. **(Source: Tamdeen Group)**

- ***Madinat Al-Hareer (Silk City).*** **Madinat Al Hareer project (see Figure 1-30) was initially proposed by the Tamdeen Group, a private corporation before its approval by the government where it becomes part of the Kuwait future strategy. The project site is Al- Subiya in northern Kuwait and would cover about 250 km^2. The project is planned to be built in phases and be completed within 25 years at an estimated cost of US$ 132 billion. The city will be connected to Kuwait City via the Jaber Causeway. It will accommodate at its center a one-kilometer high skyscraper tower (Burj Mubarak) that will be surrounded by mixed- use tall buildings. The proposed capability of the city housing is expected to reach 700,000 people. One of its four villages are the Ecological Village which will includes national parks and reservations for wild animals and rare planets as well as nature reserves for migrating birds from central Asia and Africa. The village will include a center for environmental studies and vast green spaces, as well as be surrounded by a green belt of gardens and vast green spaces. The Chinese government has shown interest in collaborating on the project along with others in the five Kuwaiti islands as part of the Chinese 'One Belt, One Road' initiative promoting economic prosperity of Eurasia countries.**

- ***Industry***

In 2016, the industrial sector's contribution to GDP was 7.2% (current prices) and 5.7% (constant prices). Since 1994, nearly all manufacturing industries demonstrated some improvement in term of their contribution to the GDP (see Figure 1-21). Chemicals and chemical products exhibit an almost two-fold increase in the GDP through the years 2000-2016. This alone gives chemical industries a special significance. Although growing, recycling has the lowest GDP contribution compared to other manufacturing activities.

- *Agriculture and Fisheries*

An arid climate and poor soils mean that Kuwait's arable area is limited. The Public Authority for Agriculture Affairs and Fish Resources (PAAF) records only 18,900 ha as being cropped, although crops provide 56% of the gross value of agricultural production in Kuwait (CBS data). In real terms, the agriculture sector's contribution to GDP is very small, 0.53% in 2016 (World Bank development indicators).

Farming systems are composed of small- and intermediate holders as well as specialized agribusinesses focused on growing date palms, greenhouses, open field vegetables, livestock production, and dairy/poultry production. Farms differ in size, productivity, profitability and marketing potential (see Figure 1- 31). Cropping systems are based on pure stand cultivation; monoculture and irrigation techniques vary from basin, furrow to micro-irrigation. Concerns related to yield limitation exist and are mainly caused by pests and poor crop management and systems optimization practices.

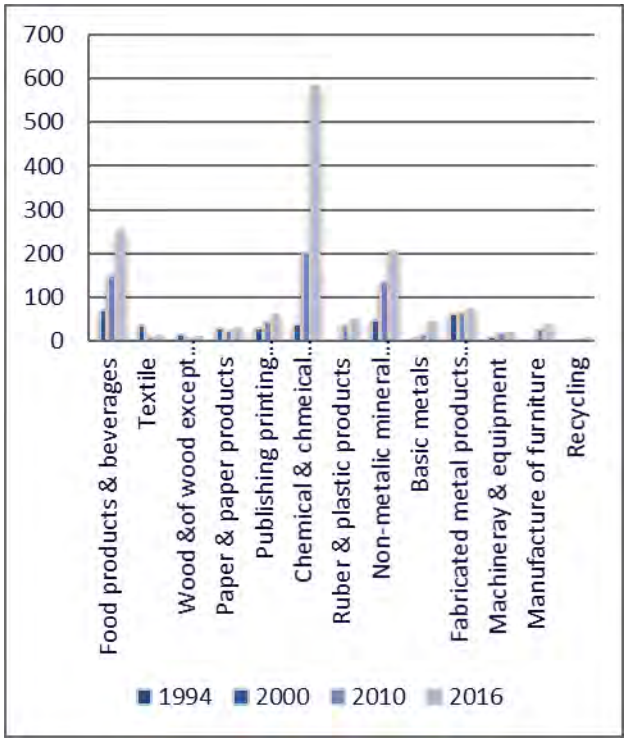

Figure 1-31: Contribution of manufacturing activities to GDP in million KD, 2016.
(Source: Central Statistical Bureau)

Livestock and animal production provide about 38% gross value of agricultural production in Kuwait (CBS data). Livestock production under Kuwait's harsh climatic conditions and shortage of good quality fresh water at reasonable cost makes fodder production and livestock production in Kuwait difficult. All local livestock production is subsidized, particularly the dairy industry, and depends heavily on most animal feed being imported, which means higher costs of production, requiring subsidies for most local livestock products to compete pricewise with imported products. Grazing is widespread, with sheep, goats and camels the main livestock involved (see Table 1-2).

The Public Authority for Agricultural Affairs and Fish Resources (PAAF), was established in 1983 to manage all types of activities in the agriculture sector and to formulate policies for developing plant, animal, and fishery resources, including land allocation. In order to support local agricultural production PAAF heavily subsidizes selected agricultural activities. (Table 1-1) summarizes the various agricultural subsidies provided by the government during the fiscal year of 2015-2016. A portion of the subsidies is directed towards the expansion of protected agriculture production in greenhouses, encouraging water saving irrigation technology, and the utilizing treated wastewater in irrigation.

Table 1–2: Breakdown of agricultural subsidies, 2015-2016 (Source: Public Authority for Agricultural Affairs and Fish Resources)

Subsidy	Value of Subsidy (million US$)	Subsidy share(%)
Subsidy for plant productions	8.2	27%
Subsidy for fodders	15.7	51%
Subsidy for fisheries	0.5	2%
Subsidy for milk and cows	3.9	12%
Subsidy for palm trees	1.8	6%
Other Subsidies	0.5	2%
Total	30.6	100%

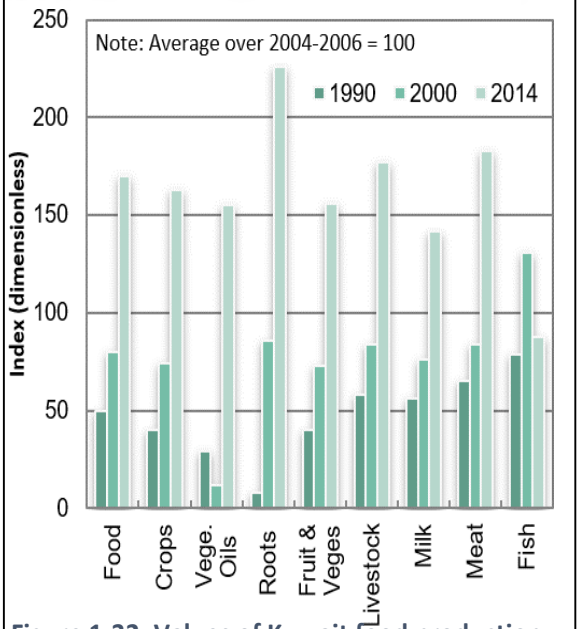

Figure 1-32: Values of Kuwait food production indices. **(Source: PAAF)**

Over the years, Kuwait's food production has been growing substantially. Figure 1-32 reflects the growth of the value of such production for three years (1990, 2000 & 2014) using the index number of each type of food production (excluding cereals because of the sharp increase in its 2014's value). Kuwait's crops, which are mostly grown in greenhouses in Wafra, Abdally, Jahraa and Sulaibiya, include tomatoes, cucumber, pepper, okra, green beans, marrow, eggplant, strawberry, onion, mallow, coriander, peppermint, melon, parsley, cabbage, lettuce, snake cucumber, dill, cauliflower, purslane, watermelon and red radish. Roots and tubers include Potatoes, Radishes and Root Beets; while vegetables are varied including onions, and green leafy vegetables. Total value of crops products has increased threefold from 2006-2007 to 2016-2017.

The country's key policy objective in agriculture is to provide for some of the local needs. To enhance the locally available food, 500 plots of land (see Figure 1-33), each with 50,000 square meters, were allocated by PAAF in Al-Abdali, the northeastern town, to support meat and poultry production in particular.

A sub-project of 200 integrated farms was also launched aiming to increase plants, crop production and to support other agricultural activities such as sheep farming, fish farming, poultry and other activities. However, 50 larger plots, each with 170,000 square meters for raising cattle and milk production are being removed as the current location obstructs a proposed railway route.

Since the 1990s, overfishing and environment degradation caused 50% decline in the total local fisheries product (Al-Husaini et al., 2015). Fish products are actually the most important renewable food resource (finfishes and shrimps) with an annual production about 4,500 tonnes, representing only 16% of total demand. Most of the commercial important species are zobaidy (Pampus argenteus), harmoor (Epinephelus coioides), suboor (Tenualosa ilisha) and newaiby (Otolithes ruber). Total imported fish products including both fresh and frozen reached 23,285 tonnes in 2012.

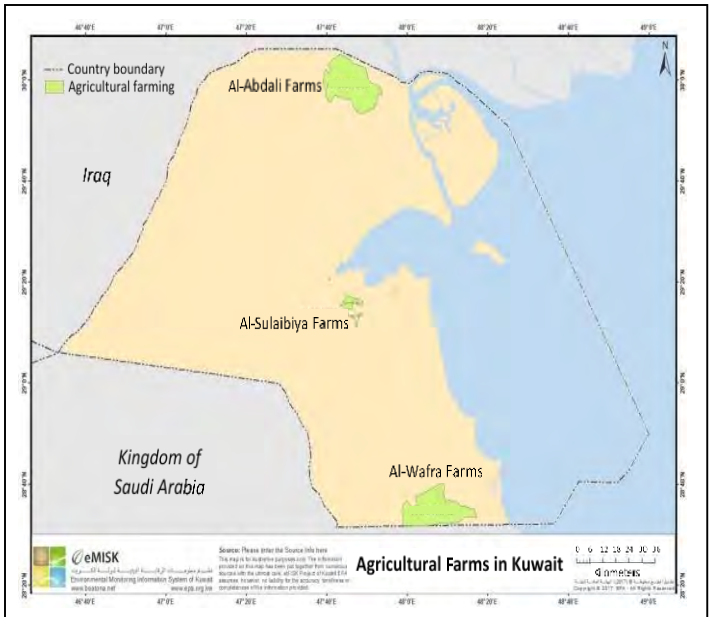

Figure 1-33: Agriculture areas in Kuwait. **(Source: eMISK)**

Aquaculture practices have been growing in response to the emergence of protected coastal and marine areas. The reduced access to fishing has been partly offset by fish farming projects. These projects provide fish and shrimp to local market throughout the year at reasonable prices. Among these projects is a 10 km2 pilot project of floating fish culture in the Al-Khiran area, with an expected productivity of nearly 2,000 to 3,000 tonnes of fish annually. The proposed Boubyan Island project has an expected yield of 3,000 tonnes of fish, 3000 tonnes of shrimp, and 60 tons of marine algae.

Other proposed projects include the cultivation of wild fish in Al-Sulaibia, Al-Wafra and Al-Sabia, utilizing treated wastewater for fish farming. The proposed 8 km2 Al-Sabia shrimp farm project will include 300 breeding ponds and two water pumping stations with an expected production capacity of 2,000 tonnes of shrimp annually. In addition, there is a shrimp reproduction plant with an annual capacity of six million shrimp larvae.

Aquaculture is a relatively new and potential source of fish production in Kuwait. It is currently being expanded to supplement local depleted landings from capture fisheries. Two types of aquaculture systems are practiced in Kuwait: (i) culture of Nile tilapia (Oreochromis niloticus) in concrete tanks using brackish water in agricultural farms, and (ii) culture of marine species such as gilthead bream (Sparus auratus), European sea bass (Dicentrarchus labrux) and sobaity sea bream (Sparidentex hasta) in cages located in the Kuwait Bay. Two key events – the mass fish kills in 2001 in the Kuwait Bay and the Iraq war in 2003 – crippled production. Most of the cages were destroyed as nobody was allowed to go near the cages due to security reasons during the war.

As for green areas, PAAF is active in establishing parks and gardens as well as projects of planting trees and greenery on the sides of roads and in public squares. In this regard, there are 134 public parks, and 635 projects of side road planting extended to nearly 1,700 kms long. The landscaping areas cover about 1.2 million square meters. The projects are divided into 12 sites with an area of 34 thousand acres, in addition to a number of parks such as Al-Salmiya Bolivar, Al-Wafra and Al-Abdali.

- ***Food Security***

Throughout its modern history, Kuwait has heavily relied on food imports since only a negligible fraction of food demand can be met by local agriculture. Kuwait produces roughly 1% of its crops from its arable land, using traditional agriculture practices (Analysis of Hydroponic Agriculture in Kuwait - Market trend, Growth and Opportunities (2015-2020), December 2017, Mordor intelligence). Almost all of its fruits and vegetable produce come from hydroponic or horticulture practices (see Figure1-34).

Kuwait has always faced a unique set of food security challenges due to its climate, limited arable land and water scarcity. Full food self-sufficiency, meaning the country producing all its food requirements, is understood to be an impractical and unachievable goal with an expectation of continued reliance international food trade markets. The Council of Ministers established a Ministerial Committee to supervise the development of a Food Security Investment Strategy for Kuwait. The overwhelming conclusion of the evaluation was that Kuwait currently enjoys a high level of food security.

Figure 1-34: Hydroponics farming in Kuwait.
(Source: Kuwait News Agency website)

Food is readily available and accessible to all residents and Kuwait ranks internationally as one of the most food secure countries thanks to its economic circumstances and government policy.

Kuwait is resource rich, has a large international wealth reserve, easy access to the global food markets, a generous government food subsidy program and significant strategic reserves of basic food commodities. Nevertheless, opportunities have been identified for improving efficiency through the use of incentives and reforms, including the reforms to the system of subsidies, reduction in food waste and encouraging greater efficiency through competition within the supply chain.

- *Environmental and Waste Management*

Despite the small geographical area of the country and the relatively small population, Kuwait has one of the highest per capita rates of municipal solid waste (MSW) generation in the world, 1.32kg/capita/day. Kuwait produces more than 1.9 million tons of municipal solid waste annually. Figure 1- 35 summarizes the typical composition of MSW, with the largest share being organic food wastes at 45%. Paper and plastics, prime candidates for recycling and reuse, together make up 40% of total solid waste generation.

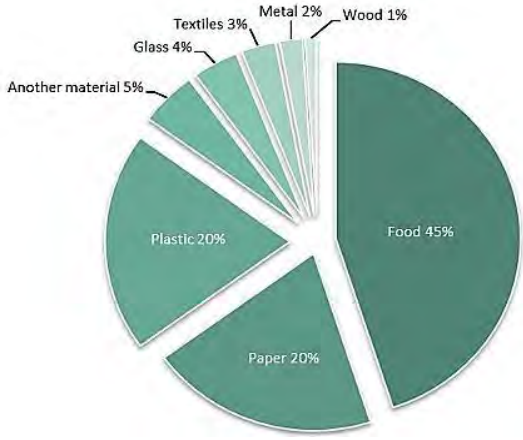

Figure 1-35: Weighted averages of all waste composition.

(**Source: KM, Fichtner; 2013)**

Until recently, the dominant MSW disposal method has been landfills. In contrast to its limited area, Kuwait used to have a relatively large number of landfills sites (14 in total), of which 11 have been closed prior to achieving their capacity, because of improper disposal methods and concerns related to public health and environment. Such dumpsites generate huge amount of toxic gases (methane, carbon dioxide etc.) and are plagued by spontaneous fires. Characteristics of the three remaining landfills - Mina Abdullah, Al-Jahra and South of 7th Ring Road - are summarized in Table 1-3. The total area of these landfills is estimated at 9.44 km^2.

Table 1–3: Municipal solid waste generation, 2016 (Source: KM)

Landfill	Area size (km^2)	Solid waste (thousand tonnes)
Mina Abdullah	**2.42**	**478.3**
South of 7th ring road	**5.35**	**1,381.8**
Al-Jahra	**1,67**	**465.**
Total	**9.44**	**2,325.2**

The management of domestic wastewater is the responsibility of the Ministry of Public Works. In 1965, the first sewer system was established in Kuwait, and the first domestic wastewater treatment plant was commissioned in the 1970, with a capacity of 100,000 m^3/day. By 1994, there were 3 established domestic wastewater treatment plants; and to meet the further increase in the rate of water consumption per person (275 liter/day) more domestic wastewater treatment plants were built, which make the number reach on total of 7 treatment plants. Table 1-4 lists the domestic wastewater treatment plants, along with the treatment type, design values and daily inflow.

Figure 1-36: Kuwait industrial area

(Source: eMISK)

There are 7 industrial areas, as presented in Figure 1-36, where most industrial units are located. In the past, most of these industrial areas were not connected to the sewer system, resulting in the industrial wastewater effluents discharged directly to the environment without treatment. In 2010, an industrial wastewater treatment plant was established in Al-Wafra area with a capacity of 8,500 cubic meters per day, with the possibility of increasing the capacity to about 15 thousand cubic meters per day. With the passing of Environment Law No. 42 in 2014, as amended by Law No. 99 in 2015; Article 35 committed all government agencies and the private sector to treat industrial wastewaters produced by their facilities. Accordingly, the Central Station was designated to receive the industrial treated wastewater from the different sectors.

The Ministry of Health is responsible for the disposal of medical wastes, the treatment of such wastes through sterilization by autoclave and final backfilling in the Kuwait Municipality landfill sites. Most medical wastes are sent to incinerators. Currently, the Ministry of Health manages three incinerators as listed in the Table 1-5.

Table 1–5: Incinerators of Kuwaiti Ministry of Health (Source:MOH)

Incinerator name	Online year	Capacity (kg/hour)
Shuaiba-1	2002	500
Kabd-1	2009	500
Shuaiba-2	2014	500

Table 1–4: Domestic wastewater treatment plant characteristics (Source:MPW)

Treatment plant	Treatment type	Design inflow (thousand m^3/day)
Sulibiyah (Al-Ardeiah)	Reverse Osmosis	425
Kabd (Al-Jahra)	Tertiary treatment	180
Al-Reqah	Tertiary treatment	180
Um-Alhaiman	Tertiary treatment	27
Wafrah (not working)	Tertiary treatment	4,500
Subah Al-Ahmad Marine city	Tertiary treatment	5,000
Khiran City (not functional yet)	Tertiary treatment	1,500

1-12 The role of women

In many developing countries where the populations are reliant on natural resources for their livelihoods, women commonly face higher risks and greater burdens from climate change impacts. Such conditions are not applicable in Kuwait society. The economic development driven by the oil and gas industry paved a path of socio-economic prosperity in Kuwait. In 1976 the government established Kuwait's Fund for Future Generations, and it has set aside 10% of the state's revenues annually for it. There are various calls and attempts to diversify the economy in Kuwait, with top down efforts leading towards establishing Kuwait as an economic center in the region. While the youth are leading the bottom up trend of establishing various small and medium projects minimizing the dependence on the government jobs.

Since 1960s, a comprehensive scheme of social welfare was created. Kuwaiti women have enjoyed access to higher education and relative freedom to advocate for improved economic and cultural rights, particularly as compared to women in neighboring countries. Women in Kuwait have almost equal access to various resources.

It is well established that education has a dramatic impact on addressing the impacts of global warming. General education in Kuwait is obligatory for all Kuwaitis between the ages of 6 and 14. Girls and women do seem to excel in all levels of education through advanced degrees. For example, the top percentage of High school graduates are girls, and about three-fifths of Kuwait University students are women. Women with more years of education have fewer, healthier children and actively manage their reproductive health. Education also enables women to face the most dramatic climatic changes. A 2013 study found that educating girls "is the single most important social and economic factor associated with reducing vulnerability to natural disasters." This decreased vulnerability also extends to their children, families, and the elderly.

Although women have been empowered through education, their participation in higher levels of decision-making processes does not reflect their percentage in higher degree holders and professionals. The social climate often prevents women from fully contributing to general policymaking, and particularly climate-related planning, policymaking and implementation. Nonetheless, many women are very active in NGOs advocating measures to reduce environmental impacts in general and climate change in particular.

2. National Institutional Arrangements Relevant to the Preparation of National Communications and Biannual Updated Reports

2.1 National Government Structure

The State of Kuwait is a constitutional, hereditary emirate ruled by princes (Emirs) drawn from the Al-Sabah family. The Constitution of Kuwait, endorsed by the Constituent Council on 11 November 1962, has elements of a presidential and a parliamentary system of government. The country has six (6) governorates: Al- Kuwait (capital), Al-Jahra (largest), Al-Ahmadi (several major oil refineries), plus governorates located close to the capital: Al-Farwaniyah, Hawalli, and Mubarak Al-Kabeer.

His Highness Sheikh Sabah Al-Ahmad Al-Jabir Al-Sabah is the Emir of Kuwait, head of state and Commander-in-Chief of Kuwait's armed forces. The Emir, a member of al-Sabah dynasty that has been ruling since approximately 1752, exercises his executive authority through the Prime Minister and the Council of Ministers. The Emir is constitutionally empowered to appoint the Prime Minister.

Legislative power is vested in the Emir and the parliament which convenes in the National Assembly building (see Figure 1-37). Parliament consists of fifty members, who are chosen in direct elections that are held every four years.

Figure 1-37: Kuwait National Assembly building.

(Source: KNA official website)

In accordance with the country's constitution, the fifteen cabinet ministers are also members of parliament. Kuwait's parliament is not only the oldest legislative assembly among in Gulf Cooperation Council (GCC) states but possesses the greatest political authority of any in the GCC. Since 2005, all Kuwaiti citizens, both male and female at least 21 years of age, are eligible to vote.

The Emir is empowered by the Constitution to dissolve the parliament and call for new elections, or in cases of national emergency can dismiss the parliament outright and/or suspend certain articles of the Constitution and assume supreme authority over the country. Either the Emir or the parliament can propose amendments to the constitution; a two-thirds majority of the members of the Assembly is required to adopt a change.

The nomination of a successor to the Emir is the prerogative of the ruling Al-Sabah family, and is subject to parliamentary approval under the Constitution. If the nominee does not win a majority of votes of the Assembly, the parliament must vote on and approve another candidate for the post.

The Constitution allows for the establishment of political parties. At the current time, a law has not yet been enacted to regulate them. As a result, no political parties are operational in Kuwait in a formal sense. Nevertheless, several members of parliament identify themselves and function as de facto political parties on the basis of religious sect/belief, social class or tribe.

Kuwait has an independent judiciary system. Civil laws are based on a combination of British common law, French civil law, and Islamic religious law, the latter having a considerable role in personal and family matters. In each of the country's six governorates there is a summary court.

There is also a court of appeals; a Cassation Court, which is the highest level of judicial appeal; and a Constitutional Court.

2.2 National Institutional Arrangements Relevant to the Implementation of Climate Change Actions

The institutional structure of climate change in the State of Kuwait falls within the framework of an institutional system starting from the First Deputy Prime Minister of Kuwait who in turn chairs the Supreme Council of Environment, where the Environment Public Authority is among the members of that council as shown in Figure 1-38.

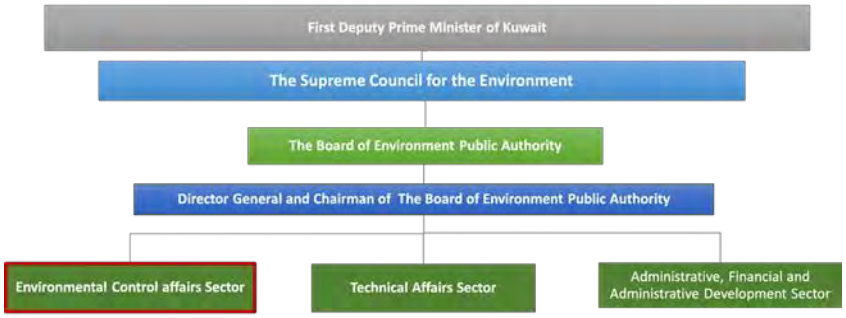

Figure 1-38 Structure of Environment Public Authority

The Kuwait Environment Public Authority (KEPA) is the national focal point for the United Nation Framework Convention of Climate Change (UNFCCC). The Climate Change Section is a unit of the Air Quality Monitoring Department and is the implementing entity of the UNFCCC in the State of Kuwait. The two major responsibilities of the Climate Change Section are as follows:

- Leading the negotiating team, which includes all the state stakeholders concerned with climate change; and
- Managing the reporting system such as Nationally Determined Contributions (NDCs), National Communications (NCs) & Biennial Update Reports (BURs).

The KEPA Director General presides over the Board of the Environment Public Authority, which organizationally has three sectors: The Administrative, Financial and Administrative Development Sector, Technical Affairs Sector, and Environmental Control Affairs Sector. The Climate Change Section is one of the sections under the Air Quality Monitoring Department. The graph below Figure 1-39 shows the institutional arrangement for the management of climate change issues in the Environment Public Authority.

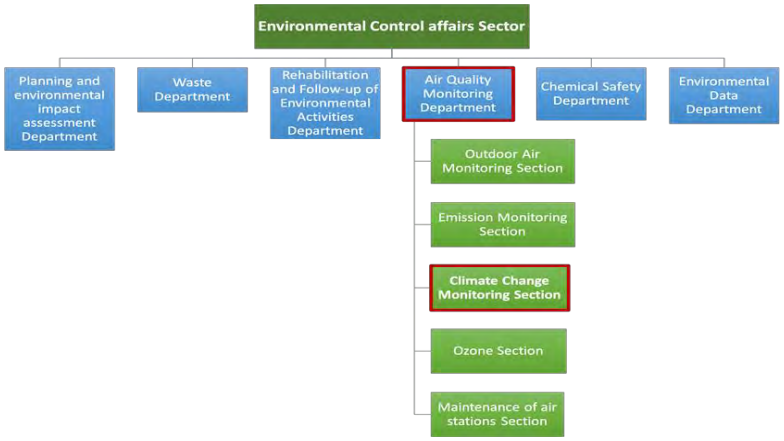

Figure 1-39 Structure of Environmental Control Affairs Sector

To facilitate climate change activities, the National Committee on Ozone and Climate Change (see figure 1-40) was established, chaired by the Environment Public Authority, with representatives from the General Secretariat of the Supreme Council for Planning and Development, Ministry of Oil, Kuwait Petroleum Corporation, Ministry of Electricity and Water, Ministry of Foreign Affairs, and General Directorate of Civil Aviation, as members.

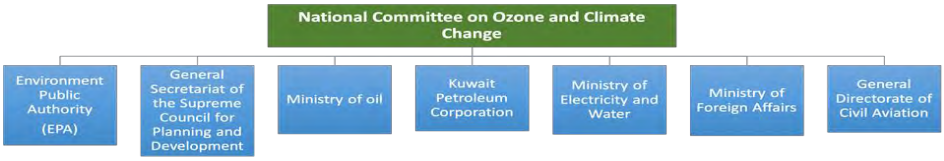

Figure 1-40 National Committee on Ozone and Climate Change

The National Committee on Ozone and Climate Change subsequently established the Climate Change Negotiation Group Committee to handle climate change negotiations as shown in figure (1-41)

Figure 1-41 Climate Change Negotiation Group Committee

2.3 National Institutional Arrangements Relevant to UNFCCC National Reporting

The preparation of Kuwait's UNFCCC national reports such as the national communications, biennial update reports, national greenhouse gas inventories, and other such reports is undertaken by a national team managed by the Climate Change Section in the Air Quality Monitoring Department of the Kuwait Environment Public Authority. The national team was selected primarily from relevant ministries and institutions and with the senior management of the Climate Change section from KEPA for coordinating the team, some of those experts were members of the negotiating team who are familiar with climate change issues and the Convention and its related legal instruments.

The knowledge developed during the preparation of Kuwait's Initial National Communication (INC) was utilized to build up the organizational and technical structure of the Second National Communication (SNC) and biennial updated reports (BUR). The capacity was built up by engaging and training key stakeholders, namely KEPA technical staff, public sector staff, and civil society stakeholders. Key organizations participating in the development of the SNC and the BUR are indicated throughout the Acknowledgements section.

A Project Steering Committee (PSC) oversees the overall coordination and implementation of the SNC, while the National Climate Change & Ozone Committee provides overall policy and cross-sectoral guidance. The KEPA executed project activities at the national level and appoints a National Project Coordination (NPC) team that works under the supervision of a National Project Director (NPD). A small project management support team is established at KEPA to facilitate implementation and reporting. Three Task Forces (TF) were established as follows:

- *National circumstances & other information Task Force (NTF). This task force develops SNC and BUR contents regarding national circumstances, technology needs assessments, research and systematic observation, and capacity building and institutional framework sector.*
- *National GHG Inventory (SNC & BUR) & mitigation Task Force (GTF).* This task force develops SNC and BUR contents regarding emissions associated with all sectors of the Kuwaiti economy (i.e., oil and gas, energy, transport, waste sector, industry, and agriculture sector. This task force also addresses domestic measurement, reporting and verification (MRV).

- *Climate Impacts, Vulnerability and Adaptation Task Force (CIVA TF)*. This task force develops SNC and BUR contents regarding vulnerability of sectors and systems in Kuwait, namely, water resources, public health, coastal zones, and marine ecosystems. This task force also focuses on climate, dust storms, and Arabian Gulf waters.

Memberships of the various TFs from government institutions and stakeholders were established based on the technical dictates and expertise requirements of the scopes of work. Each Task Force Head submitted a report to the NPC, which was followed up by a technical review process, with subsequent revisions as needed. Figure 1-42 illustrates the organizational structure of the project.

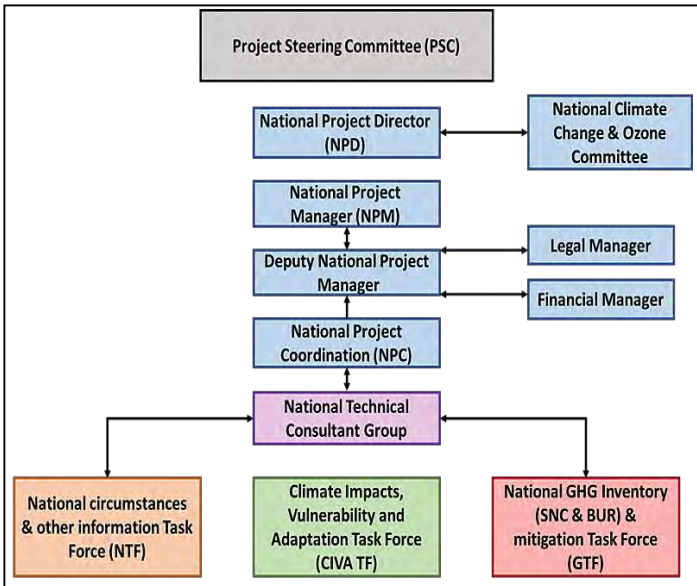

Figure 1-42: Organizations structure for the development of the SNC and BUR.

2. National Inventory Report

2.1 National GHG Inventory Overview

This section presents estimates of national anthropogenic greenhouse gas emissions and sinks for the year 2016. The inventory includes four categories: energy; industrial processes and product use (IPPU); agriculture, forestry and other land use (AFOLU); and waste. The results presented below are based on an inventory assessment prepared by Al-Sayegh et al., (2018).

Table 2-1 presents total GHG emissions and sinks for the year 2016. Total and net GHG emissions in 2016 were 86,336.448 Gg CO2-equivalent, which includes 82,556.572 Gg from energy; 1,932.156 Gg from industrial processes and product use; 154.371 Gg from agriculture, -13.190 from forestry and other land use and 1,706.539 Gg from waste. Emissions from perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF6) in Kuwait are negligible as the products containing these gases are not produced in the country.

Table 2- 1: Total GHG emissions and sinks for the year 2016

	GHG Sources & Sinks	CO2-equiv	CO2	CH4	N2O
1	Energy	82556.572	81985.033	10.919	1.104
2	Industrial processes and product use	1932.156	1932.156	0.0	0.0
3	Agriculture	154.371	2.761	6.570	0.044
4	Forestry & other Land Use	-13.190	-13.190	0.0	0.0
5	Waste	1706.539	4.172	77.847	0.218
Total National Emissions		**86349.638**	**83924.122**	**95.336**	**1.366**
Net National Emissions		**86336.448**	**83910.932**	**95.336**	**1.366**

Energy-related activities accounted for the dominant portion of GHG emissions in Kuwait in 2016. Approximately 95.6% of all GHG emissions are associated with the combustion of fossil fuels for electricity production and transport, as well as the release of fugitive emissions from oil and gas operations. Emissions from waste management accounted for 2 % of all GHG emissions, followed by IPPU and AFOLU categories which accounted for about 2.2% and 0.16% of total emissions, respectively.

2.2 GHG Emission Trends

The trend in total GHG emissions for the previous 1994 and 2000 inventory and the GHG inventory for the year 2016, per sector. Over the 1994-2016 period, total emissions have increased by about 139%; from 36211 Gg CO2-equivalent in 1994, 48678 Gg CO2-equivalent in 2000, to 86,336 Gg CO2-equivalent in 2016, or roughly 4 %/year. By 2016, national emissions reached 86,336.448 Gg CO2-equivalent.

Over the 1994- 2000 period, CO2-equivalent emissions from energy use have increased by 35.5%, or about 5.19% per year, due primarily to increased energy use for electricity generation, desalinated water production, and process heat in manufacturing. Notably over the 1994-2000 period, CO2-equivalent emissions from AFOLU, though small in absolute terms, increased by 150 %, or about 16.5% per year.

For the period from 2000 to 2016, total GHG emissions increased by 77 %, or about 3.6 % per year. While energy related GHG emissions growth continues to represent the overwhelming majority of Kuwait's emissions, the growth rate slowed to 3.6% per year, or roughly two thirds the 1994-2000 rate. This trend holds true for AFOLU- and waste-related GHG emissions, which slowed to 2 % and 2.38 % per year, respectively, and are well below their 1994-2000 growth rates. On the other hand, IPPU-related emissions grew by 5 % per year.

Table 2-2: Aggregate GHG emissions and removals (year and gas, in CO2eq)

Year	*1994*	*2000*	*2016*	*Percentage change between 1994 and 2016*
Gas	**Gg CO2-eq**			
CO2	**35080.2246**	**47056.2092**	**83910.932**	**139.2%**
CH4	**46.8417**	**66.6204**	**95.336**	**103.53%**
N2O	**0.4753**	**0.7205**	**1.366**	**187.4%**
HFCs	**0.0**	**0.0**	**0.0**	**N/E**
PFCs	**0.0**	**0.0**	**0.0**	**N/E**
SF6	**0.0**	**0.0**	**0.0**	**N/E**
Total (Gg CO2-eq)	**36211.2433**	**48678.5926**	**86336.448**	**138.42%**

***GHG inventory for 1994 is estimated by using IPCC 2006 and may not match with INC 1994.**
****GWP for CH4 = 21**
*****GWP for N_2O = 310**

Table 2-3: GHG Emissions and removals by year and sector

Year	*1994*	*2000*	*2016*	*Percentage change between 1994 and 2016*
Sectors	**Gg CO2-eq**			
Energy	**34345.0576**	**46533.4226**	**82556.572**	**140.37%**
Industrial Processes and Product Use	**1022.3166**	**873.3267**	**1932.156**	**88.997%**
Agriculture, forestry and other land use	**40.512**	**101.2701**	**141.181**	**248.49%**
Waste	**803.3571**	**1170.5732**	**1706.539**	**112.426%**
Total	**36211.2433**	**48678.5926**	**86336.448**	**138.424%**

2.3 Emissions by Greenhouse Gas Type

The following bullets provide an overview of GHG emission totals by all GHG types for the year 2016.

- ***CO2:*** Net CO2 emissions were estimated to be 83910.932 Gg, or 97.2 % of Kuwait's total greenhouse emissions in the year 2016. Figure 2-1a summarizes the contribution associated with CO2 emissions at both the sector and activity levels.
- ***CH4:*** Methane had the second largest share of greenhouse gas emissions. Total CH4 emissions were estimated to be about 95.336 Gg which equals 2002 Gg of CO2-e, or about 2.3 % of Kuwait's total greenhouse emissions on a CO2-equivalent basis. Figure 2-1b summarizes the contribution associated with CH4 emissions at both the sector and activity levels.
- ***N2O:*** Nitrous oxide emissions were very small compared to other GHGs. Total N2O emissions were estimated to be only about 1.366 Gg which equals 423.46 Gg of CO2-e, or about 0.5 % of Kuwait's total greenhouse emissions on a CO2-equivalent basis. Figure 2-1c summarizes the contribution associated with N2O emissions at both the sector and activity levels.

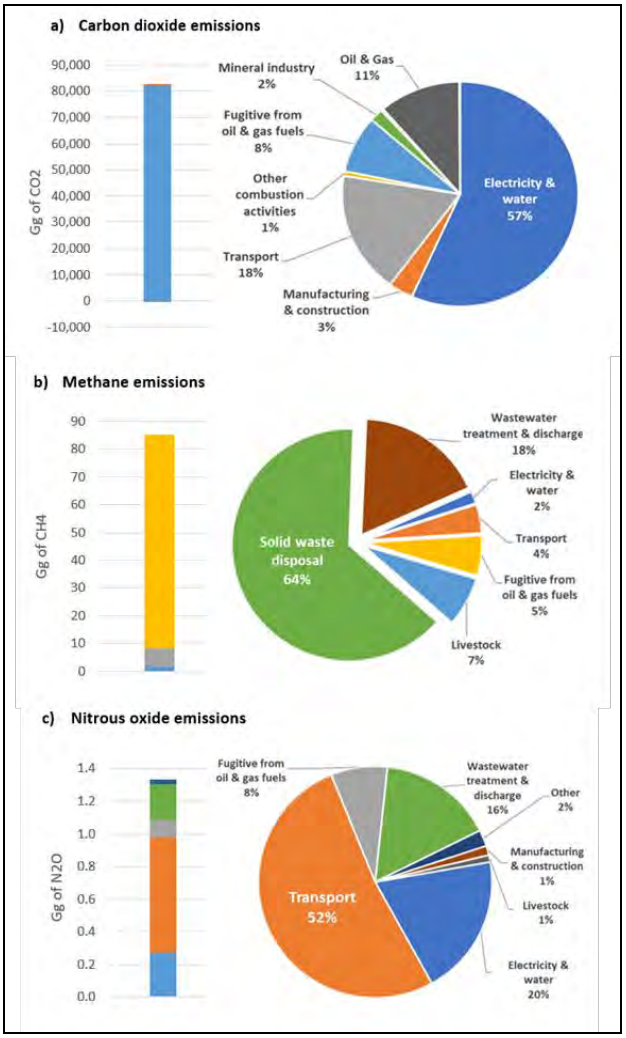

Figure 2-1: Breakdown in GHG missions, 2016 (Gg).

2.4 Sectoral Emissions Information

- Energy

The energy sector includes electricity generation, water desalination (Public Electricity & Heat Production), oil and gas stationary combustion activities, manufacturing industries and construction, other fossil fuel combustion activities, and fugitive emissions from oil & gas operations. Table 2-4 provides a breakdown in energy sector GHG emissions for the year 2016 for these source categories. Relative to overall anthropogenic GHG emissions in Kuwait, the 82556.572 Gg CO2-equivalent represents about 95.6 % of total national emissions.

TABLE 2-4: BREAKDOWN IN ENERGY SECTOR GHG EMISSIONS FOR THE YEAR 2016

GHG Sources & Sinks	CO2-equiv	CO2	CH4	N2O
Public Electricity & Heat Production	47665.808	47558.320	1.428	0.250
Oil & Gas (Stationary Combustion)	9405.310	9395.372	0.178	0.020
Manufacturing & construction	2856.533	2848.244	0.129	0.018
Transport	15000.757	14701.603	3.794	0.708
Other combustion activities	569.266	568.011	0.045	0.001
Fugitive emissions (oil & gas)	7058.898	6913.483	5.345	0.107
Total National Emissions	**82556.572**	**81985.033**	**10.919**	**1.104**

Figure 2-2 illustrates the breakdown in energy related GHG emissions in 2016 by activity. Emissions from electricity and desalinated water production are primarily associated with the combustion natural gas and oil products showed the highest share of GHG emissions about 58%. The contribution of upstream and downstream activities, in oil and gas industry, of the total GHG emissions is about 11 %. Transport activities are based overwhelmingly on the use of gasoline and diesel oil and accounted for about 18% of total emissions from energy-consuming activities. Fugitive emissions of methane, a gas that has a high global warming potential, accounted for about 9 % of all GHG emissions in the energy industries sector. Other combustion activities and manufacturing/construction accounted for the remaining 4%.

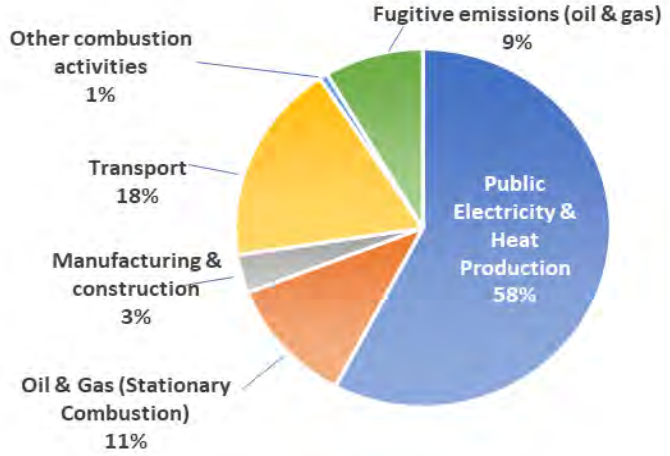

Figure 2-2: Breakdown of GHG Emissions Associated with Energy Activities, 2016.

- **Industrial Processes and Product Use**

Table 2-5 summarizes GHG emissions associated with industrial processes and product use in 2016. Industrial processes are the third largest emitter of anthropogenic GHG emissions in Kuwait, accounting for 1932.156 Gg of CO2– equivalent, or about 2.2 % of national CO2–equivalent emissions in 2016.

The mineral and chemical industries represent the sole source of emissions from industrial processes and product use. For the mineral industry, GHG emissions are associated with cement, lime and glass production and account for about 81% of total sectoral GHG emissions. For the chemical industry, emissions are solely associated with ammonia production. About the metal industry the main industries in State of Kuwait as a source of emissions are iron and steel production and ferroalloys production.

TABLE 2-5: GHG EMISSIONS ASSOCIATED WITH INDUSTRIAL PROCESSES AND PRODUCT USE IN 2016

GHG Sources & Sinks	CO2-equiv	CO2	CH4	N2O
Mineral industry	1561.889	1561.889	0.0	0.0
Chemical industry	262.743	262.743	0.0	0.0
Metal Industry	107.523	107.523	0.0	0.0
Total National Emissions	**1932.156**	**1932.156**	**0.0**	**0.0**

- **Agriculture, Forestry and Other Land Use**

Table 2-6 summarizes GHG emissions associated with agriculture, forestry, and other land use in 2016. Agricultural practices are the smallest source of anthropogenic GHG emissions in Kuwait, accounting for total national emissions and removals is only 141.181 Gg of CO2–equivalent, or about 0.16 % of net national CO2–equivalent emissions in 2016. Most of the emissions from AFOLU activities are associated with methane production from livestock. Kuwait's extensive managed green areas acted as a CO2 that resulted in a sequestration of 13.19 Gg CO2-equivalent.

TABLE 2- 6: GHG EMISSIONS ASSOCIATED WITH AGRICULTURE, FORESTRY, AND OTHER LAND USE IN 2016

GHG Sources	CO2-equiv	CO2	CH4	N2O
Livestock	142	0.0	6.570	0.013
Aggregate & non-CO2 sources on land	12.371	2.761	0.0	0.031
Total National Emissions	**154.371**	**2.761**	**6.570**	**0.044**

GHG Sinks	CO2-equiv	CO2	CH4	N2O
Land	-13.190	-13.190	0.0	0.0
Total Removal Emissions	-13.190	-13.190	0.0	0.0

GHG Sources & Sinks	CO2-equiv	CO2	CH4	N2O
Total National Emissions and Removals	141.181	-10.429	6.570	0.044

- **Waste**

Table 2-7 summarizes GHG emissions associated with waste management activity in 2016. Relative to overall anthropogenic GHG emissions, the 1706.539 Gg CO2-equivalent represented about 2 % of total national emissions. Waste-related GHG emissions are associated with solid waste disposal, incineration and wastewater treatment and discharge.

TABLE 2- 7: GHG EMISSIONS ASSOCIATED WITH WASTE MANAGEMENT IN 2016

GHG Sources & Sinks	CO2-equiv	CO2	CH4	N2O
Solid waste disposal	1281.819	0.0	61.039	0.0
Incineration & open burning of waste	4.172	4.172	0.0	0.0
Wastewater treatment & discharge	420.548	0.0	16.808	0.218
Total National Emissions	**1706.539**	**4.172**	**77.847**	**0.218**

Table 2-8. National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors (Decision 17/CP.8, Table 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)	NMVOCs (Gg)	SO_x (Gg)
Total national emissions and removals	83910.932		95.336	1.366				
1. Energy	81985.033		10.919	1.104	NE	NE	NE	NE
A. Fuel combustion (sectoral approach)	75071.550		5.575	0.996	NE	NE	NE	NE
1.Energy industries	56953.692		1.606	0.269	NE	NE	NE	NE
2.Manufacturing industries and construction	2848.244		0.129	0.018	NE	NE	NE	NE
3.Transport	14701.604		3.795	0.708	NE	NE	NE	NE
4.Other sectors	568.011		0.045	0.001	NE	NE	NE	NE
5.Other (please specify)	0		0	0	NE	NE	NE	NE
B. Fugitive emissions from fuels	6913.483		5.345		NE	NE	NE	NE
1.Solid fuels			0		NE	NE	NE	NE
2.Oil and natural gas			5.345		NE	NE	NE	NE
2. Industrial processes	1932.156	NE	0	0	NE	NE	NE	NE
A. Mineral products	1561.889				NE	NE	NE	NE
B. Chemical industry	262.743		0	0	NE	NE	NE	NE
C. Metal production	107.523		0	0	NE	NE	NE	NE
D. Other production	0				NE	NE	NE	NE
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other (please specify)	0		0	0	NE	NE	NE	NE
3. Solvent and other product use	NE						NE	
4. Agriculture		NE	6.570	0.013	NE	NE	NE	NE

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)	NMVOCs (Gg)	SO_x (Gg)
A. Enteric fermentation			**5.854**					
B. Manure management			**0.716**	**0.013**			**NE**	
C. Rice cultivation			**0**	**-----**			**NE**	
D. Agricultural soils			**NE**	**NE**			**NE**	
E. Prescribed burning of savannahs			**NE**	**NE**	**NE**	**NE**	**NE**	
F. Field burning of agricultural residues			**NE**	**NE**	**NE**	**NE**	**NE**	
G. Other (please specify)			**NE**	**NE**	**NE**	**NE**	**NE**	
5. Land-use change and forestry	**2.761**	**-13.190**	**0**	**0.031**	**NE**	**NE**	**NE**	**NE**
A. Changes in forest and other woody biomass stocks	**NE**	**-13.190**						
B. Forest and grassland conversion	**0**	**0**	**NE**	**NE**	**NE**	**NE**		
C. Abandonment of managed lands		**NE**						
D. CO2 emissions and removals from soil	**NE**	**NE**						
E. Aggregate sources and non-CO2 emissions sources on land	**2.761**	**0**	**0**	**0.031**	**NE**	**NE**		
6. Waste	**4.172**	**NE**	**77.847**	**0.218**	**NE**	**NE**	**NE**	**NE**
A. Solid waste disposal on land			**61.039**	**----**	**NE**		**NE**	
B. Waste-water handling			**16.808**	**0.218**	**NE**	**NE**	**NE**	
C. Waste incineration			**----**	**----**	**NE**	**NE**	**NE**	**NE**
D. Other (please specify)			**NE**	**NE**	**NE**	**NE**	**NE**	**NE**
7. Other (please specify)	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**
Memo items								
International bunkers	**3359.073**		**0.161**	**0.091**	**NE**	**NE**	**NE**	**NE**
Aviation	**1718.057**		**0.012**	**0.048**	**NE**	**NE**	**NE**	**NE**
Marine	**1641.016**		**0.149**	**0.042**	**NE**	**NE**	**NE**	**NE**
CO2 emissions from biomass	**NE**							

-Note: Numbers may not add up due to rounding by IPCC 2016 software.

Table 2-9: National greenhouse gas inventory of anthropogenic emissions of HFCs, PFCs and SF6 (Decision 17/CP.8, Table 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFCs[a,b](Gg)			PFCs[a,b](Gg)			SF_6[a](Gg)
	HFC-23	HFC-134	Other (to be added)	CF4	C2F6	Other (to be added)	
Total national emissions and removals	**N/E**	**N/E**		**N/E**	**N/E**		**N/E**
1. Energy							
A. Fuel combustion (sectoral approach)							
1.Energy industries							
2.Manufacturing industries and construction							
3.Transport							
4.Other sectors							
5.Other (please specify)							
B. Fugitive emissions from fuels							
1.Solid fuels							
2.Oil and natural gas							
2. Industrial processes	**N/E**	**N/E**		**N/E**	**N/E**		**N/E**
A. Mineral products							
B. Chemical industry							
C. Metal production	**N/E**	**N/E**		**N/E**	**N/E**		**N/E**
D. Other production							
E. Production of halocarbons and sulphur hexafluoride	**N/E**	**N/E**		**N/E**	**N/E**		**N/E**
F. Consumption of halocarbons and sulphur hexafluoride	**N/E**	**N/E**		**N/E**	**N/E**		**N/E**
G. Other (please specify)							
3. Solvent and other product use							
4. Agriculture							
A. Enteric fermentation							

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFCs[a,b](Gg)			PFCs[a,b](Gg)			SF_6[a](Gg)
	HFC-23	HFC-134	Other (to be added)	CF4	C2F6	Other (to be added)	
B. Manure management							
C. Rice cultivation							
D. Agricultural soils							
E. Prescribed burning of savannahs							
F. Field burning of agricultural residues							
G. Other (please specify)							
5. Land-use change and forestry							
A. Changes in forest and other woody biomass stocks							
B. Forest and grassland conversion							
C. Abandonment of managed lands							
D. CO2 emissions and removals from soil							
E. Other (please specify)							
6. Waste							
A. Solid waste disposal on land							
B. Waste-water handling							
C. Waste incineration							
D. Other (please specify)							
7. Other (please specify)							
Memo items							
International bunkers							
Aviation							
Marine							
CO2 emissions from biomass							

2.5 Other Information

- Methodology

The methodology used to develop the inventory is based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Good Practice Guidance) prepared by the Intergovernmental Panel on Climate Change (IPCC). Reference and sectoral approaches were implemented to estimate GHG emissions in each emission category. Emissions up to the year 2016 were estimated using the inventory results for the year 2000 using IPCC's Inventory Software (Version 2.54). The Tier-1 approach of the IPCC guidelines was utilized in the calculations for all reporting categories, since State of Kuwait does not have national emission factors and does not have detailed data to calculate the inventory.

GHG emissions are reported both in absolute units of carbon dioxide, methane and nitrogen oxide emissions, as well as in units of CO2-equivalent by applying 100-year GWPs of 1 for CO2, 21 for CH4, and 310 for nitrogen oxide, as recommended by the IPCC in its Second Assessment Report. Unless as otherwise noted, default emission factors from the IPCC guidelines have been used.

- Uncertainty Assessment

Emissions/removals estimates are based on three key factors: methodology, modeling, and input data and assumptions. While each of these three contributes to uncertainty levels, they were kept to as low levels as possible. There is minimal uncertainty associated with the methodology as appropriate QA/QC procedures were undertaken and the IPCC Software was used as the main tool in the inventory. On the other hand, there is uncertainty associated with input data and assumptions (i.e. emission factors and activity data). Default emission factors provided in the 2006 IPCC Guideline were adopted, thus reflecting the uncertainty embedded in these estimates.

For Kuwait, CO2 represents about 97% of GHG emissions and are associated with the categories listed previously in table 2-2. Hence, most of any uncertainty in the inventory will be associated with these categories. Using the results from Table 7a – Uncertainties generated as part of the IPCC-2006 Software Report, all the combined uncertainty levels are below 10%. This suggests a high level of confidence in the inventory results.

- Quality Control

QC/QA Program was implemented in this inventory according to IPCC good practice guidance. Specifically, the 12 QC activities called for in Table 8.1 of the guidance document were followed without exception where applicable.

- Key Category Analysis

The analysis was performed using Approach 1 recommended in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Vol.4 Ch.4. Key categories were identified using a pre-determined cumulative emissions threshold and were those that, when summed together in descending order of magnitude, add up to 95% of the total level. Given Kuwait's circumstances as a major oil producing and exporting country which leads to uniformity of emissions in Kuwait over the years (energy sector was always the leading sector in economy and therefore in GHG emissions), the analysis was limited to level assessment excluding trend assessment. Analysis was also limited to CO2 since the latter represents 97.2% of total GHG emissions. Table 2-10 summarizes the results of key category analysis.

Table 2- 10: Key category analysis results.

IPCC Category	GHG	2016 Emissions in 2016 (Gg)	Level assessment (%)	Cumulative Total of level assessment (%)
Public Electricity & Heat Production	CO_2	47558.320	56.6	-
Transport		14701.603	17.5	74.1
Oil & Gas (Stationary Combustion)		9395.372	11.2	85.3
Fugitive emissions (oil & gas)		6913.483	8.2	93.5
Manufacturing Industries and Construction		2848.244	3.4	96.9
Total National Emissions		81417.022	1	96.9

2.6 Challenges and Recommendations

The primary challenge to the development of the current GHG inventory is data-related, namely availability, accuracy, and consistency. These challenges are rooted in administrative and institutional barriers that impede the application of locally available technical capacity to collect, manage, and analyze pertinent data. Addressing these challenges should address the following:

- Establish and enforce a national statistical data system, which logs operational and production data and information, in governmental and private organizations.
- Establish strategic collaboration agreements between KEPA and public organizations to ensure a sustainable supply of related data.
- Given the above two points, a national emissions inventory system is to be developed with key sectors in the country.
- Hold periodic workshops for public organizations for training and educating critical authorities with the IPCC emissions inventory system.
- Call for and support the conduction of a national project to determine local emission factors related to the indigenous resources.
- Establish a GHG inventory committee with high-level representation from key ministries/institutions, having clear oversight and coordination authority.
- Develop an integrated database of relevant information including annual statistical abstracts and annual reports from specific entities.

2.7 Mitigation Actions and Their Effects

Kuwait is committed to efforts that harmonize economic growth with a low-carbon, climate-resilient development. Domestically, it has already undertaken several strategic projects to reduce its carbon footprint. Internationally, it has expressed through its Nationally Determined Contribution a commitment to explore future GHG emission reduction policies and measures in the energy sector (State of Kuwait, 2015).

Such actions will reflect practical ways to promote clean energy initiatives, introduce new low- carbon technologies, and develop long-term partnerships to exploit sustainable energy opportunities. Progress toward such actions is already underway, and when fully implemented, will eventually lead to substantive greenhouse gas mitigation in an increasingly carbon-constrained world.

The rest of this section is based on an analysis of potential GHG reductions in the energy sector by Alsayegh et al., (2018). The energy sector was selected as it represents the largest share of GHG emissions in Kuwait. The section concludes with a proposed set of strategic mitigation actions for achieving deeper GHG reductions in the future.

The goal of the GHG mitigation assessment was to establish annual and cumulative GHG emission reductions due to the implementation of several promising GHG mitigation options. The scope of the assessment focused on fugitive emissions from oil & gas operations and combustion-related emissions associated with electricity and desalinated water production. Together, these activities accounted for between 76% and 81% of emissions over the 1994-2016 period (see Figure 2-3).

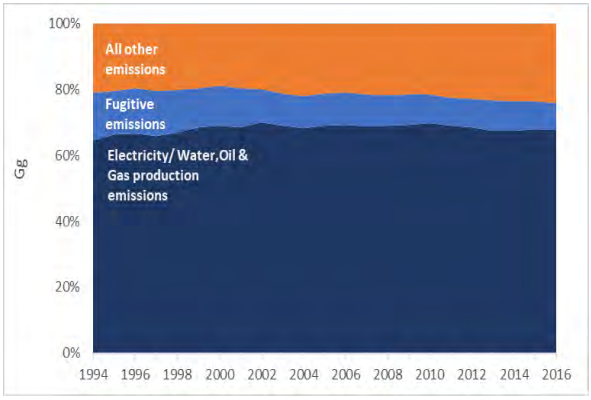

Figure 2-3: Share of oil & gas and electricity water production emissions, 1994-2016

While there are other GHG reduction opportunities in the next largest-emitting sector, transportation, which accounted for roughly 18% of emissions in 2016, a tactical decision during initial mitigation planning was made to look at the way that electricity is produced and at efficiency improvements in upstream oil & gas operations. (Refer to table 2-11: National Appropriate Mitigation Actions)

2.7.1 Baseline Scenario

Two emission scenarios were considered: A Baseline Scenario which assumed the continuation of historical trends in energy supply and demand, and a Mitigation Scenario which assumes the implementation of measures to reduce fugitive emissions, enhance supply side efficiency in electricity production and introduce renewable energy. Due to resource and time constraints, the assessment was limited to GHG reductions only (i.e., costs were not considered). The Baseline scenario incorporated activities that have taken place to date to reduce emissions. A 19-year planning horizon was considered, from 2016 through 2035.

Box 2–1: Regression model used to project Baseline Scenario emissions through 2035 The final form of the econometric model for year t is as described below. All regressions statistics confirm that the model adequately produces actual GHG emissions over the 1994-2016 period (e.g., R^2 over 0.96).

$$CO_2e_t = 6.3E+03 + 0.018178*(P)_t + 3.17E-08*(GDP)_t$$

Where:

CO_2e_t = national GHG emissions in year t

P = national population in year t

GDP = Gross domestic product in nominal US dollars in year t

A linear regression model was developed to project Baseline Scenario emissions to 2035. Population and GDP data over the 1994-2016 were used to establish trends between these variables and national CO2e emissions. The model was developed using simple regression and analysis of variance (ANOVA) techniques. Box 2-1 provides details of the final form of the model. Most of the data required to undertake the assessment was acquired from governmental sources. Average annual growth rates of 2.65%, 1.8%, and 2.0% were used for population, GDP, and inflation, respectively. Physical properties of fuels (e.g., GHG emission factors, energy densities) are based on IPCC default factors used in the development of the GHG inventory.

The Baseline Scenario incorporates emission reductions associated with several recent projects that have been implemented as part of the Clean Development Mechanism (CDM) to stimulate sustainable development and emission reduction targets under the Kyoto protocol. A brief overview of these projects is provided in the bullets below.

- Flare gas recovery at the Mina Al Ahmadi Refinery: This project aims to recover gases that are currently flared at one of the refineries operated by the Kuwait National Petroleum Company. The project involves the installation of a Flare Gas Recovery Unit (FGRU) to recover gases for subsequent commercial uses. Annual GHG emission reductions are about 54.4 Gg. The cost of this project is about 36,436,050 USD.
- Flare gas recovery at the Mina Abdullah Refinery: This project aims to recover gases that are currently flared at another of the refineries operated by the Kuwait National Petroleum Company. The project involves the installation of an FGRU to first cool and then compress the recovered gases. After the cooling and compression steps, the gases are treated in an amine absorber to remove hydrogen sulfide and then reused for thermal heat generation. Annual GHG emission reductions are about 89.5 Gg. The cost of this project is about 67,322,831 USD.
- Solar photovoltaics: This project introduces a 10 MW solar photovoltaic farm in western Kuwait partially meet electricity demand at 29 oil wells and related infrastructure in the region. The major electrical load at oil wells consists of electric submersible pumps which would otherwise be met by the central grid. Annual GHG emission reductions are about 13.7 Gg. The cost of this project is about 23,035,461.89 USD.
- Improved electric distribution efficiency: This project introduces capacitor bank technologies at various 11/0.433 KV substations to improve the power factor in the electric distribution system. Capacitor banks were implemented in 632 transformers around Kuwait City and showed substantial improvement in the average power factor, leading to a reduction in distribution losses. Annual GHG emission reductions are about 112.7 Gg. The cost of this project is about 21,620,426.37 USD.

Baseline scenario trajectories of GHG emissions, CO2e emissions per capita and CO2e emissions per $ of GDP are illustrated in Figure 2-4. The left side of the figure shows that GHG emissions are projected to grow from about 86,000 Gg in 2016 to over 142,000 Gg by 2035, an average annual increase of about 2.67% per year. The right side of the figure shows historical and projected trends for CO2e emissions as a function of population and GDP. Notably, per capita emissions showed sharp increases over the 1994-2002 period and declining per capita emissions over the 2002-2016 period, suggesting that energy efficiency and energy conservation measures have been effective in counteracting steady population growth. Additionally, while CO2e emissions as a function of GDP show inter-year volatility, there is a noticeable downward trend – from 3.6 in 1994 to about 1.0 in 2016 - suggesting that the economy is becoming more efficient from a carbon footprint perspective.

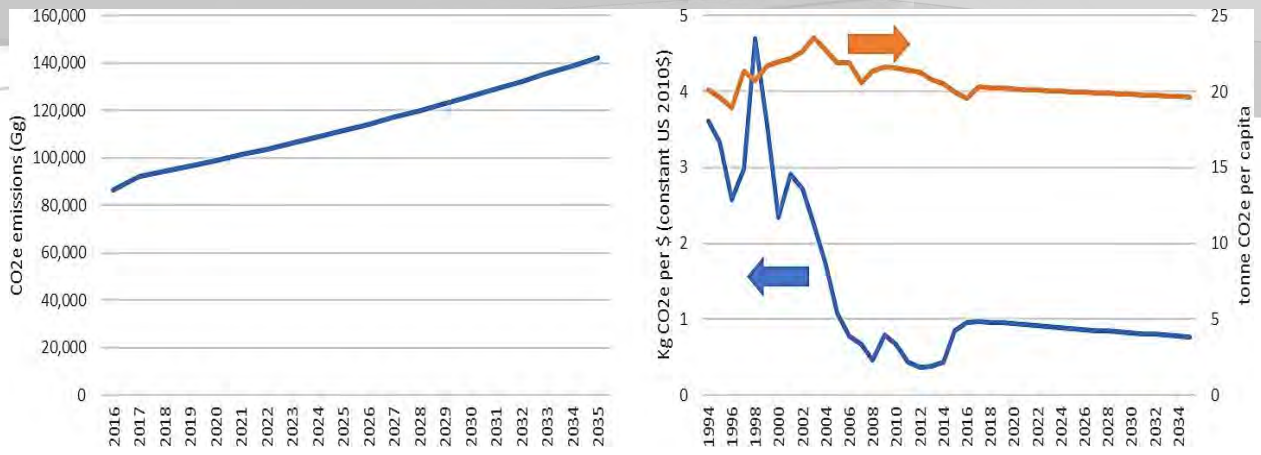

Figure 2-4: Left: Projected CO2e emissions in the Baseline Scenario; Right: Historical trends and projections for CO2e emissions per capita and per constant US$ of GDP

2.7.2 Mitigation Scenario

The GHG Mitigation Scenario incorporates emission reductions associated with several projects that have been proposed as expansions to the distribution efficiency and solar photovoltaic projects described above. A brief overview of these projects is provided in the bullets below.

- *Expansion of improved electric distribution efficiency.* This project expands the introduction of capacitor bank technologies at additional outdoor and indoor 11/0.433 KV substations to improve the power factor in the electric distribution system. Online years are 2019 and 2020 for outdoor and indoor substations, respectively. Annual GHG emission reductions are about 219.8 Gg for outdoor substations and 351.8 Gg for indoor substations, or total annual reductions of 571.6 Gg. The cost of the outdoor project is about 15,171,000 USD and the cost of the indoor project is about 13,084,000 USD. Therefore, the total project cost estimated to be 28,255,000 USD.
- *Expansion of renewable-based electricity production.* The Shagaya Renewable Energy Master Plan represents a 3-phase national vision to meet 15% of electricity requirements by renewable energy by 2030. The Plan incorporates solar thermal, solar photovoltaic and wind technologies. Phase I of the Plan introduces 50 MW of concentrated solar power, 10 MW of solar photovoltaics and 10 MW of wind in 2018 with a total installation cost for this phase is 581,151,807.81 USD. Phase II introduces an additional 1,500 MW of solar photovoltaics by 2022 with a total installation cost estimated to be 1,711,218,140.9 USD. Phase III of the Plan introduces an additional 200 MW of concentrated solar power, 1,200 MW of solar photovoltaics and 100 MW of wind by 2030 and its cost is yet to be determined. By its completion, the Plan will have introduced a total renewable energy capacity of 3,070 MW. Annual GHG emission reductions are about 5,000 Gg, equivalent to a displacement of 12.5 million barrels of oil equivalent.

The results of the GHG Mitigation scenario are illustrated in Figure 2-5. The left side of the figure shows projected CO2e emission reductions by measure. The right side of the figure shows the resulting annual GHG emissions in the Baseline and GHG Mitigation scenarios. By 2030, total annual emission reductions are about 5,600 Gg, representing a reduction of about 4% of Baseline scenario emissions in that year. Cumulatively, nearly 60,000 Gg of CO2e is avoided over the entire planning period by the measures.

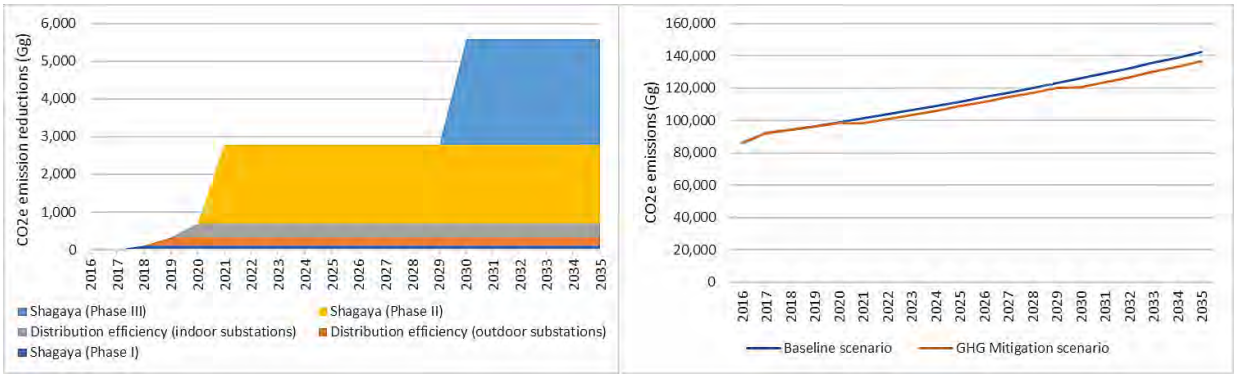

Figure 2-5: Left: Projected CO2e emission reductions in the GHG Mitigation Scenario; Right: Projected CO2e emissions in the Baseline and GHG Mitigation Scenarios

2.7.3 Future GHG Mitigation Opportunities

Going forward, there are several priority strategies that are being considered for achieving additional reductions, as outline in the bullets below.

- ***Power supply.*** **Supply side combustion efficiency can be increased by shifting from current technologies to combined cycle gas turbines and maximizing the use of reverse osmosis over multi-stage flash technology in seawater desalination. Moreover, emissions can be further decreased by fuel switching (i.e., replacing liquid fuels in existing thermal power plants with natural gas).**
- ***Transport.*** **There are several promising mitigation options for transport sector that are strategic for Kuwait. These include fuel efficiency improvements for vehicles, alternative clean fuel, transportation infrastructure improvement, as well as tariff and subsidy redistribution. The cost of the clean fuel project is 15,401,935,078.24 USD and the cost for the other improvement in this sector also expected to be high.**
- ***Industry.*** **The industrial sector in Kuwait covers chemicals, manufacturing fertilizers, cement industry, metallic products and food processing. Waste heat recovery from industrial processes is an important GHG reduction measure. Furthermore, adoption of more advanced plants, technologies, and processes are effective mitigation options leading to reduced electricity demand.**
- ***Waste.*** **Mitigation options in waste sector are based on the objectives of the National Development Plan in improving the efficiency of waste management by developing a safe waste management system for Solid, liquid and hazardous waste (Ensures the reduction of pollution levels resulting from traditional waste handling). Encourage the rehabilitation of landfill and gas utilization. Utilization of biogas from waste-water treatment. And, encourage waste recycling (Through providing all scientific consultations and provide incentives for investors to carry out recycling activities). Currently there are serval projects proposed in order to improve the efficiency of this sector with an estimate cost 1,280,202,046.28 USD.**

Therefore, Kuwait plans to build up its mitigation assessment capacities especially those related to human resources. Additionally, in order to improve the quality of future mitigation assessments, there is an urgent need to develop a national database for monitoring and reporting information related to GHG emissions and mitigation projects.

Table 2-11: National Appropriate Mitigation Actions

No.	Title	Description	Start Year	Coverage (i.e. sectors & gases)	Objectives	Result Achieved -Estimated Outcomes & Estimated Emission Reduction	Cost (US Dollar)	Use of International Market Mechanisms
1	Flare Gas Recovery at the Mina Al Ahmadi Refinery	The project involves the installation of a Flare Gas Recovery Unit (FGRU) to recover gases for subsequent commercial uses. This project registered as a CDM project.	2012	This project covers the energy sector, and the gases CH4, CO2, N2O, as well as NOx, NMVOCs, CO, and SO2	This project aims to recover gases that are currently flared at MAA refinery operated by KNPC. Avoiding burning such gasses will reduce the release of GHG emissions	Annual GHG emission reductions are about 54.4 Gg	$36,436,050	NO
2	Flare Gas Recovery at the Mina Abdullah Refinery	The project involves the installation of an FGRU to first cool and then compress the recovered gases. After the cooling and compression steps, the gases are treated in an amine absorber to remove hydrogen sulfide and then reused for thermal heat generation. This project registered as a CDM project.	2012	This project covers the energy sector, and the gases CH4, CO2, N2O, as well as NOx, NMVOCs, CO, and SO2	This project aims to recover gases that are currently flared at MAB refinery operated by KNPC. Avoiding burning such gasses will reduce the release of GHG emissions	Annual GHG emission reductions are about 89.5 Gg	$67,322,831	NO
3	Solar Photovoltaics	This project introduces a 10 MW solar photovoltaic farm in western Kuwait partially meet electricity demand at 29 oil wells and related infrastructure in the region. This project registered as a CDM project.	2015	The project covers the energy sector, and the gases CH4, CO2, N2O, as well as NOx, NMVOCs, CO, and SO2	TO lower the demand load on the central grid, leading to lower use of oil and gas for energy production and thereby leading to reduction on GHG emissions from the oil and gas sector for energy production	Annual GHG emission reductions are about 13.7 Gg	$23,035,461.89	NO
4	Improved Electric Distribution Efficiency	This project introduces capacitor bank technologies at various 11/0.433 KV implemented on 632 transformers substations to improve the power factor in the electric distribution system. This project registered as a CDM project.	2015	This project covers the energy sector, and the gases CH4, CO2,	Improved electric distribution efficiency lowers the cost of electricity leakage, thereby reducing demand on primary electricity	Annual GHG emission reductions are about 112.7 Gg	$21.620426.37	NO

No.	Title	Description	Start Year	Coverage (i.e. sectors & gases)	Objectives	Result Achieved -Estimated Outcomes & Estimated Emission Reduction	Cost (US Dollar)	Use of International Market Mechanisms
5	Expansion of Improved Electric Distribution Efficiency - Phase 2	This project introduces capacitor bank technologies at various 11/0.415 KV substations implemented on 376 transformers to improve the power factor in the electric distribution system. This project in process to registered as a CDM project.	2019	N2O, as well as NOx, NMVOCs, CO, and SO2	production and subsequently lowering demand on the use of oil and gas for electricity production and leading to reduction on GHG emissions	Annual GHG emission reductions are about 219.762 Gg	$15,171,000	NO
6	Expansion of Improved Electric Distribution Efficiency - Phase 3	This project introduces capacitor bank technologies at various 11/0.415 KV substations implemented on 610 to improve the power factor in the electric distribution system. This project in process to registered as a CDM project.	2020			Annual GHG emission reductions are about 351.791 Gg	$13,084,000	NO
7	Expansion of Renewable-based Electricity Production - The Shagaya Renewable Energy 3 phase Master Plan	Phase I of the Plan introduces 70 MW of RE capacity, (50 MW of concentrated solar power, 10 MW of solar photovoltaics and 10 MW of wind), supervised by KISR	2018	This project covers the energy sector, and the gases CH4, CO2, N2O, as well as NOx, NMVOCs, CO, and SO2	To meet 15% of electricity requirements by renewable energy by 2030. the Plan will have introduced a total renewable energy capacity of 3,070 MW. Annual displacement of 12.5 million barrels of oil equivalent and hence, reduce emissions	Annual GHG emission reductions are about 5000 Gg	$581,151,808	Not CDM project
		Phase II introduces an additional 1,500 MW of solar photovoltaics supervised and funded by KNPC	2022				$1,711,218,141	Not CDM project
		Phase III of the Plan introduces an additional 200 MW of concentrated solar power, 1,200 MW of solar photovoltaics and 100 MW of wind supervised by KAPP	2030				To be determined	

This chapter presents an overview of key sectors that are highly vulnerable to climate change in State of Kuwait. A vulnerability Assessments was providing on the Second National Communication of the State of Kuwait as one of its components. This component aimed to improve assessments on climate change impacts on, and vulnerability of different socio-economic sectors and resources at national and decentralized level, ecosystems, natural resources as well as development of adaptation actions. The climates vulnerability assessment and adaptation where be assessed for priority sectors as follows:

- Climate Modelling.
- Water Resources.
- Sea Level Rise (SLR) & Costal Developments.
- Public health & Dust storms.

As results of that, all land areas of Kuwait will become warmer in the future, with the greatest change projected to occur during the winter months. Across the entire country, annual average temperatures show the greatest rise under RCP8.5, between 4.3° to 4.5°C by the 2071-2100 period (see Figure 3-1), compared to the historical average. Kuwait will also become drier in the future, with average annual rainfall in the western part of the country showing the greatest decrease under RCP8.5, roughly between 15% and 18% lower than the historical average. The Arabian Gulf water will also experience change. Historical monthly sea surface temperatures in the Arabian Gulf have steadily increased at a rate of 0.6 (±0.3) °C per decade, a trend three times greater than the concurrent global average.

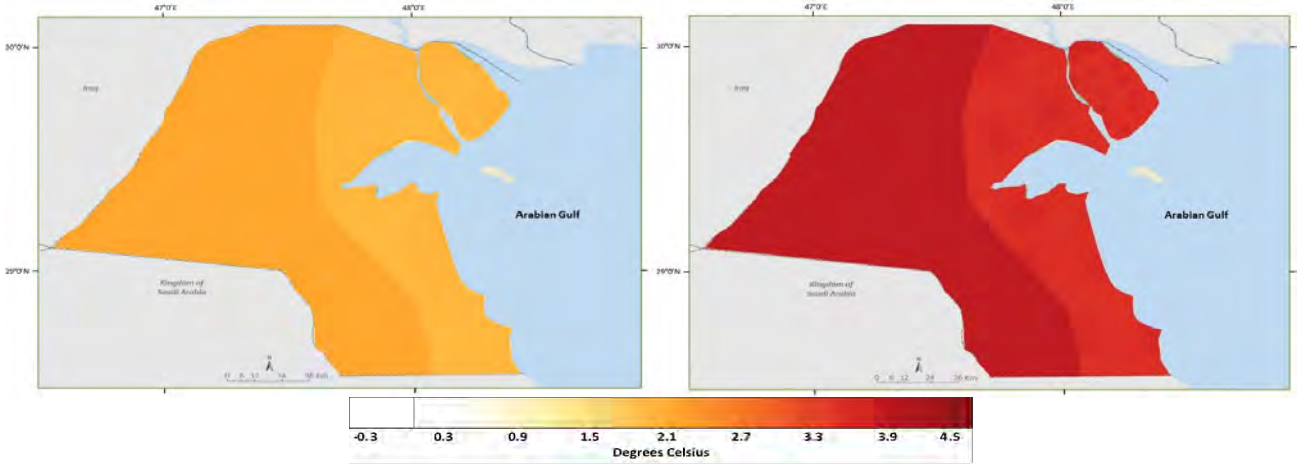

Figure 3-1: Annual average projected change in temperature under RCP4.5 (left) and RCP8.5 (right) for the 2071-2100 period
(Sources: CORDEX-MENA; ICBA)

Many sectors are vulnerable to these climatic changes, with potentially grave environmental and social effects, compounded by the country's adaptation challenges. A summary of the key findings of the vulnerability assessments is contained in the bullets below.

- Water resources: Population growth, urbanization, industrial growth, and agricultural development are key drivers underlying Kuwait's high per capita water consumption. Coupled with a hyper-arid environment, low annual rainfall, no permanent lakes or rivers, and limited fresh groundwater resources, sustainable water resource management is a key national priority. A number of potential adaptation policies were analyzed (i.e., water tariffs, improved water efficiency, leak reduction, and improved irrigation efficiency) with each showing significant water savings and associated carbon dioxide emissions.
- Coastal zones: Rising sea levels pose threats of wetland flooding, aquifer and agricultural soil contamination, destructive erosion and lost habitat for fish, birds, and plants. Sea level rise also poses a threat to the built environment in the form of Arabian Gulf waters reaching further inland, particularly under high tide conditions and especially when combined with storm surge associated with extreme storm events. Boubyan Island would be highly impacted under by sea level rise, with roughly half the island inundated in the highest sea level rise scenario. Only the relatively higher land in the interior of the island would be visible by the end of this century. Coastal areas along Kuwait Bay are also projected to be adversely impacts by rising seas, especially the western coast near Doha Port and densely populated neighborhoods around Kuwait City.
- Public health: With climate change, increased heat stress from higher temperatures and increased cardiovascular and respiratory diseases associated with more frequent dust storms, represent looming health threats to the population. These additional risks could exacerbate current major health problems such as ischemic heart disease, stroke, road injury and lower respiratory infections, whilst potentially undermining Kuwait's social protection systems.

CHAPTER FOUR

Domestic measurement, reporting and verification (MRV) arrangements

4.1 Institutional Arrangement for MRV

The Environment Public Authority is the body responsible for the protection of the environment in the State of Kuwait in accordance with the law of its establishment (Law No. 21 of 1995 and amended by Law No. 16 of 1996), which was entrusted to the Department of Environmental Affairs in the State and works as a regulatory body on the state of the environment in general. In 2014, the Environmental Protection Act (Law No. 42 of 2014 and the amendments thereto) was promulgated under Law No. 99 of 2015 which provides the general regulatory and policy framework for environmental protection in the State of Kuwait.

The Environment Public Authority is the only official body in the state to measure emissions and the adoption of emission values from all major sources in the State of Kuwait.

As the national focal point for the United Nations Framework Convention on Climate Change (UNFCCC), the Environment Public Authority (EPA) established a special section deal with the United Nations Framework Convention on Climate Change (UNFCCC) in 2007. The most important mandate of this section is to meet Kuwait's commitments to the United Nations Framework Convention on Climate Change, and its main objectives are to establish an inventory of greenhouse gas emissions from all major sources and to follow up on the implementation of mitigation programs and projects and calculate the expected reduction rates of these projects.

Through the application of Article 116 of the Environmental Law Act 42 of 2014 and its amendments, which stipulate that "the Commission is committed to cooperating with the concerned authorities in the State to develop a national plan for environmental data management adopted by the Supreme Council. The Authority shall publish and make available data to the population in the State of Kuwait in a documented and transparent manner. The executive regulations of this law shall specify the types of data, the mechanism of its circulation and the responsibility of the entities thereof."

In addition, the Environment Public Authority has attached the most importance to environmental data management in the State of Kuwait. The law includes some legal articles that oblige all sectors of the State to inform the KEPA about the size of their emissions of pollutants of various kinds through direct electronic connection with KEPA for existing projects.

On the other hand, the General Authority for the Environment, through its powers assigned to it by the Environmental Protection Act, approves all projects to be established, whether developmental or industrial, to verify its strategic objectives, namely the preservation of the three elements of the environment, air, water and land, control of climate change and integration between water cleanliness and security, conservation of land resources and the achievement of human health and ecosystem conservation.

Therefore, paragraph 14 of Article 7 on the powers of the General Authority for the Environment under the Environmental Protection Act (Law No. 42 of 2014 and its amendments) provides for "the preparation of a system to assess the environmental returns of the various projects of the State and the development of guidelines and necessary procedures." Article 16 of the law stipulates that "all parties subject to the provisions of this law shall be prohibited from starting any project or introducing any amendments or expansions to existing activities or obtaining any licenses without conducting environmental impact assessment studies in accordance with the regulations of this law."

Environmental and social assessment is a procedural tool whose breadth, depth and type of analysis depends on the nature and scope of the proposed project and its potential environmental and social impacts. This process aims at assessing environmental and social outcomes and identifying the potential environmental and social risks of the project on its area of influence. It examines project alternatives and identifies ways to improve project selection, location, preparation, planning, design and implementation by avoiding, reducing, mitigating or compensating negative environmental and social impacts and enhancing positive impacts. Mitigation or management of negative environmental and social impacts throughout project implementation. Safeguards are always preferred to mitigation or compensatory measures if this is feasible and achieves feasibility.

Moreover, economic activities and projects in Kuwait are classified as follows for purposes of determining whether environmental and social impact studies are required (based on the Environmental and Social Impact Assessment System in the State of Kuwait):

- **Category A includes a list of projects that require preparation of a comprehensive study to assess environmental and social outcomes. Because of the size and intensity of their environmental impacts, projects in this category will have potential or obvious negative social or environmental impacts and are diverse, non-refundable or unpredictable.**
- **Category B includes a list of projects requiring the preparation of the Environmental and Social Assessment Report. Because of the magnitude and intensity of their environmental impacts, projects in this category will have potential negative social and environmental impacts that are limited, location-specific, highly recoverable and can be addressed through mitigation actions.**
- **Category C includes a list of activities and trades requiring the filling of the environmental assessment form. These activities and crafts within this category will have limited environmental impacts.**

Table 4–1: projects classified

Sector	A Projects that required comprehensive study to evaluate environmental and social effects	B Projects that required the report of environment and social evaluation	Sector	A Projects that required comprehensive study to evaluate environmental and social effects	B Projects that required the report of environment and social evaluation
Chemical Industrial Sector	**Facilities to produce Petrochemicals materials**		Irrigation and agriculture and animals' sector	**Agriculture areas and forestry projects**	Aquaculture farms
	Facilities to produce and treat fossil coal			**Protected areas) Wilderness &Sea areas)**	**Forestry farms**
	Manufacture and iterate and treat grease and mineral oils			**Big projects to breed animals**	**medium projects to breed animals**
	Factories to produce essential chemicals				Veterinary Hospital
	Manufacture iron steel				
	Manufacture glass and fiber glassy wool				
Oil& Gas Sector	**All sector activities**	**All sector activities**	Water resource projects sector	**All sector activities**	**All sector activities**

Sector	A Projects that required comprehensive study to evaluate environmental and social effects	B Projects that required the report of environment and social evaluation	Sector	A Projects that required comprehensive study to evaluate environmental and social effects	B Projects that required the report of environment and social evaluation
Engineering Projects and construction sector	**Manufacture cement, gypsum and ceramics**	**Manufactures to produce Brick**	Urban Development Sector	**Structural chart to enhance Regional and civil areas**	**Build and expand residential areas**
	Facilities to produce Reinforcing steel	**Asphalt Production Plant**		**Specify industrial areas**	**Build hospitals with medium size**
		Fuel Station		**Build residential areas**	Temporary residence for the labors
				expand residential areas	Stations/small modules to Sewage treatment
				Build hospitals	
Energy Sector	**All sector activities**	**All sector activities**	Waste sector		**All sector activities**
Infrastructure big projects sector	**All sector activities**	Project of Irrigation by groundwater	Alimental and agriculture industries sector		Melting animals and plants oil
			Infrastructure medium projects sector		**All sector activities**

4.2 Current Domestic MRV Framework

Greenhouse gas emissions-related data are requested by official letters from EPA to different entities and then collected on excel sheets either as a hard copy or by emails. The Climate Change Section then distributes the collected data to the GHG task force for evaluation and uploading into the IPCC 2006 Software. A review committee was established by expert members from Kuwait University, Kuwait Institutional Scientific and Research (KISR) and Kuwait Foundation for the Advancement of Sciences (KFAS) in order to ensure that all requirements are fulfilled and to approve the output results. A higher National Committee for Ozone and Climate Change presided by the General Director of KEPA, with members that are the assistant undersecretaries from various stakeholders will give the final approval for the results to be published, as shown in Figure 4-1 below.

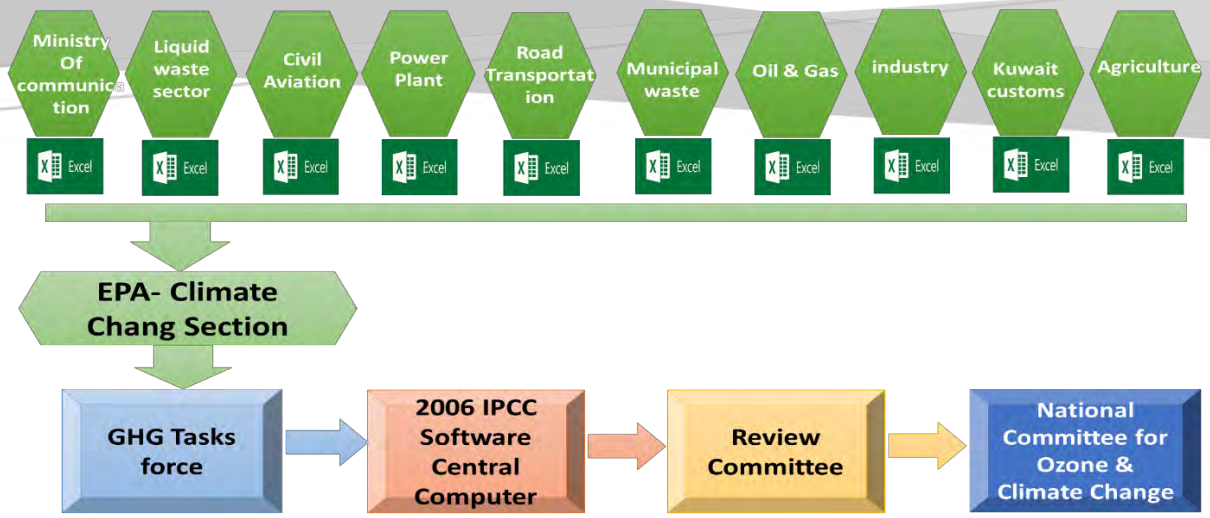

Figure 4-1: Current Kuwait Domestic MRV Framework

4.3 Domestic MRV Framework from 2020

The State of Kuwait has established a Greenhouse Gases Data base as one of the main outcomes of its Second National Communication project. This National Inventory System was developed by Dubai Carbon for the State of Kuwait. The system applies IPCC 2006 guidelines in estimating GHGs for the state of Kuwait to conform with the UNFCCC reporting requirements. This system is currently installed at KEPA and in the future it will be connected to ministries, authorities and entities in the country so that the data is received periodically.

Beginning in 2020, it is envisioned that an electronic online-based emissions measurement and reporting system will be operational. This system will allow agencies covering different economic sectors from which emissions come to input emissions data into the eMISK system for integration into the National Inventory System (NIS) that is run by the KEPA Climate Change Section. This will facilitate and make it easier for national GHG inventories to be generated as shown in Figure 4-2 below.

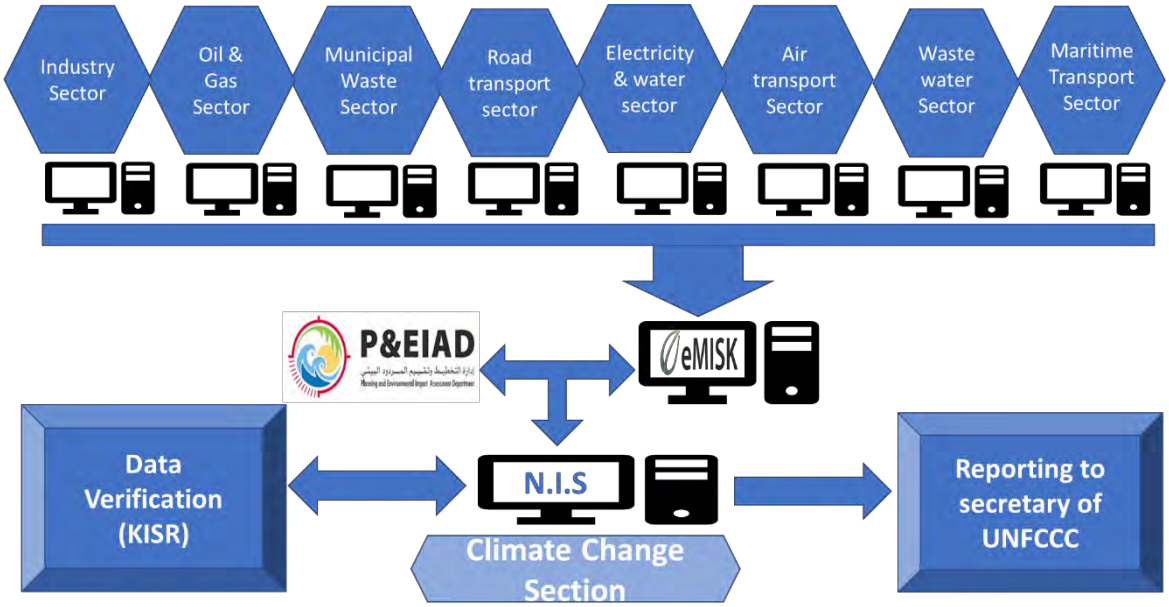

Figure 4-2: National Inventory System

The system will be operational starting in 2020 after ensuring the safe transfer of data from the main sectors to EPA, and matching emission inventory values in the national system with the issuance of the Intergovernmental Panel on Climate Change (IPCC-2006).

I. Measurement

Under the law, future projects are required to periodically report the measurement of various emissions affecting the environment, including greenhouse gases, as a requirement for the preparation of national communications and annual reports. Therefore, a national GHG inventory system has been developed from the main emissions data sources of the country.

The EPA will inventory the emissions from the industrial activities of the private and public sectors represented in category A with significant environmental impact and category B with the average environmental impact. The basic data shall include the types and quantities of fuel used for calculating rates of CO2 emitted.

II. Reporting

The Climate Change section at the Environment Public Authority will be responsible for compiling data from various sectors of the State through the National Greenhouse Gas Inventories (NIS) system, preparing annual inventories for the National Communications Service and annual reports as a requirement for the implementation of the State's obligations to the UNFCCC.

III. Verification

Following the adoption of the National Greenhouse Gas Inventories (NIS) system, the EPA will establish a partnership from one of the accredited research institutions such as Kuwait University, Kuwait Institute for Scientific Research, in the country to act as a third party to validate the data and its accuracy and comply with the requirements of the UNFCCC Secretariat and the Intergovernmental Panel on Climate Change (IPCC), and the verification structure will be at three levels as shown in Figure 4-3 below.

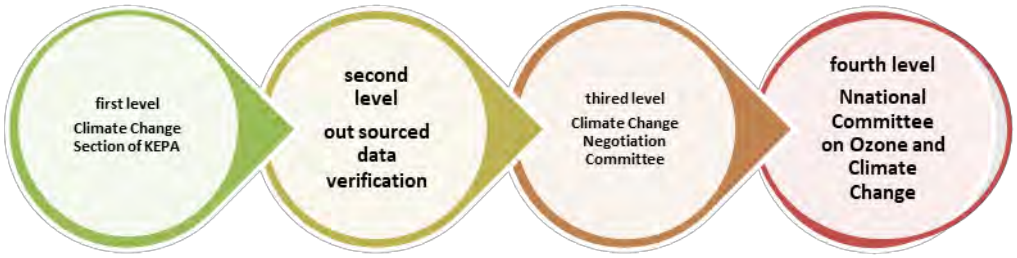

Figure 4-3: verification structure

5.1 Impact of Response Measures & UNFCCC Perspective:

Parties of UNFCCC shall take into full consideration, in the implementation of the commitments of the Convention, the specific needs and concerns of developing country Parties arising from the impact of the implementation of response measures.

When addressing climate change concerns, the Convention and its related legal instruments (Kyoto Protocol and Paris Agreement) commit Parties to strive to minimize adverse economic, social and environmental impacts on other Parties, especially developing country Parties, and in particular those identified in Articles 4 paragraph 8 part (h), paragraph 9 and paragraph 10 of the Convention, taking into account Article 3 of the Convention (UNFCCC, 1992). Article 4.8 of the Convention and Articles 2.3 and 3.14 of the Kyoto Protocol (UNFCCC, 1998) provide a basis for addressing the impact of the implementation of response measures.

5.1.1 Economic and Social Consequences of Response Measures

Risks & Vulnerabilities of Impacts of Response Measures:

Climate change response measures instituted to minimize emissions of greenhouse gases often exert profound adverse effect on sustainable development plans and programs of many developing countries. These effects are particularly severe on those countries whose economies are heavily dependent on a single sector such as hydrocarbons or tourism.

Many developing countries affected by the sectors which might be subject to significant vulnerability due to impacts of response measures (UNFCCC, 2014). The State of Kuwait is one of the developing countries that are adversely affected by response measures in areas with regards to:

- Conventional fuels (oil &gas);
- Renewable energy technologies;
- Consumer goods subject to eco-labelling and standards;
- Energy-intensive trade-exposed goods;
- Air-freighted goods;
- Tourism;
- Marine-transported goods;
- Agriculture.

Also, there are several international agreements and organizations whose decisions or norms would be influential on the impact of response measure on the State of Kuwait such as:

- World Trade Organization (WTO).
- International Originations for Standardizations (ISO).
- International Civil Aviation Organization (ICAO).
- International Maritime Organization (IMO).

Among the main challenges faced by the State of Kuwait as a result of climate change which affect the responses taken by the State to measure and address them are the geographical location of the State of Kuwait and its exposure to high temperatures, the lack of freshwater resources and the frequency of sand storms.

Therefore, some actions must be taken by the country to avoid any adverse effects of the imposition of response measures. Such actions should be related to several variables when addressing the significant adverse impacts that such response measures may have on the economic, social and environmental conditions of the State of Kuwait. These adverse impacts require that a comprehensive and structured assessment framework must be established by the State of Kuwait in order to ensure that all actions, taken to address such adverse impacts, are appropriate to national circumstances and are consistent with Kuwait's long-term sustainable development objectives and plans.

Modeling Approach of Response Measures:

Each country would have their own evaluation system for the adverse effects of climate change and the impact of response measures on their countries, with each developing country working on enhancing the modeling activities and data sets for assessing the impact of implemented response measures on their national circumstances. To do so, these countries need to be provided with support such as financial support, technology need assessments and national capacity building.

5.2 Response Measures with Economic and Social Consequences on Kuwait

-Carbon Taxes

Kuwait economy relies heavily on its oil exports, which represent virtually the only source of government income, and contribute to more than half of the country's GDP. Since the linkages between climate change and greenhouse gas emissions was established in the 1980s, crude oil and its derivatives, as key sources of emissions have come under tough pressure from the environmental policies and procedures in many developed countries. The idea of carbon taxes has been embraced by these countries. Such taxes would eventually reduce oil consumption and encourage the use of clean renewable resources, a trend that would ultimately reduce the income of oil-exporting countries, including Kuwait.

-New Sources of Energy

Additionally, the world has witnessed a shift in the nature and pattern of its dependence on oil products since the unprecedented rise in oil prices in the first half of the 1970s, where it becomes less dependent on oil in power generation which has shifted toward the use of alternative fuel such as nuclear, natural gas and renewable sources. With this shift, most of the world oil consumption goes now to the transport sector. However, this sector is also threatened by the shift from the use of oil-based fuels to other substitutes, especially with the recent development of hybrid and electric cars. Many advanced countries support the spread of such alternative means of transport which would eventually leads to lower demand on oil.

5.2.1 Kuwait National Actions to Address Economic and Social Consequences of Response Measures

Investment in Clean Fuels

In response to tightening environmental standards on oil products by developed countries, Kuwait has been quick to invest in the production of environmentally friendly oil products through the largest project in Kuwait's history - the Clean Fuel Project (15.5 billion U.S. dollar) which includes the modernization of Mina Al-Ahmadi and Mina Abdullah refineries. Kuwait also retired its Shuaiba refinery and decided to replace it with Al-Zour refinery, which is specialized in producing fuel that is compatible with emerging environmental standards in developed countries.

Investment in Other Clean Products

Kuwait has also committed itself to upgrade its petrochemical products by updating the specifications of these products in order to ensure that they meet the newly required specifications in advanced markets. Likewise, the Ministry of Commerce and Industry has committed the local manufacturing sectors to comply with the new international standards in the production of their products.

Natural Gas Energy Production and Consumption

In order to reduce harmful emissions caused by the fuel mix in electricity production in Kuwait, the Ministry of Electricity and Water has shifted most of its power generation plants from the use of oil to natural gas. Kuwait has also launched several programs to use renewable energy sources, especially solar energy. Through intensive media campaigns, Kuwait is encouraging consumers to rationalize consumption of electricity, water and fuel. Besides, since 2016, the country has moved towards changing the energy pricing structure.

Investment in Indoor Activities

Climate change forces countries with harsh weather, such as Kuwait, to invest heavily in sheltered buildings for indoor activities. Examples of such buildings include covered sport areas, gymnasium halls, schools, public facilities and markets. In addition to the high construction costs, these buildings also require high operating costs, efficient air-conditioning systems and greater consumption of electricity and fuel.

Work Disruption and Delay

Rising temperatures, in the relatively long summer period of Kuwait, that approach or exceed 50 degrees Celsius in many days of July and August, lead to a stop of outdoor activities and works. Such disruption of work increases the cost of production and delays the completion of projects.

New Development Projects

In compliance with world efforts towards lower greenhouse gas emissions, Kuwait has been adhering to environmentally friendly standards in its various new development projects, such as Sheikh Jaber Causeway project, the new urbanization projects, the new power plants project, etc.

5.3 Economic Diversification from the Point of View of the State of Kuwait

The vision of His Highness Sheikh Sabah Al-Ahmad Al-Jaber Al-Sabah, Emir of The State of Kuwait is to "rebuild Kuwait as a modern financial and trade Centre. The aim of this strategy is to diversify our economy as we can no longer be dependent solely on oil for our revenues. We need to utilize the creative energy of our young people. We have to immunize them from the stray thoughts and the deviant behavior and work on their adherence to our religion", http://www.newkuwait.gov.kw/.

The State of Kuwait is working on maintaining public life and continuing all services and developing facilities in all aspects based on 2035 vision "New Kuwait". Applying the vision, at the present time, in the investment and industrial sectors, is facing many obstacles. Kuwait is the most oil-dependent economy country in the Middle East. It has a single source of national income which is oil production. Oil revenues account for about 95% of the country's total income. The high oil-dependent revenue in the Kuwaiti economy is subject to fluctuation according to world oil prices, showing a decline as oil prices fall.

Depending on the governmental sector in investment and industry is essential given that the private sector contributes not more than 10% of the economy. Furthermore, Kuwait has strict laws and rules governing foreign investment in the country that can discourage foreign investors from investing in Kuwait. In addition, it impedes the economically competitive spirit in Kuwait compared to neighboring countries and it would reduce the opportunity for the country to be a commercial and economical center.

Establishing economic diversification in Kuwait needs professional development in Kuwait's human resources sector. The country suffers from a shortfall of professional human resources. To start building human resource capacity, the country needs to invest in the infrastructure of its education, research and technology development sectors.

The lack of suitable lands and natural resources to be utilized for heavy industries that has a direct influence on the economics of the country limits economic diversification opportunities as well.

As a conclusion, in order to achieve the vision of His Highness and achieve economic diversification, strong levels of domestic investment and financing in the country's human resources to develop skills and expertise are necessary.

6.1 Constraints, gaps, and needs to be addressed in relation to the undertaking of climate change-related actions

Inadequate capacity (technical, financial and institutional) remains one of Kuwait's significant challenges as it confronts climate change. Enhancing capacity will depend on overcoming serious institutional, financial and technical constraints and gaps that currently interfere with affective action. With adequate support, Kuwait can build climate change resilience and explore the viability of low-emission development trajectories. The subsections below outline the key constraints, gaps, and needs to facilitate compliance with UNFCCC obligations and aspirational adaptation goals.

- Constraints

Several technical, institutional, legislative, and financial constraints across various levels have been identified hindering implementation of climate change adaptation and mitigation activities in Kuwait. The following bullets are examples of such constraints:

- Lack of accurate data bases, and inadequate information and data collection, analysis and dissemination;
- Weak cooperation arrangements between agencies for providing GHG inventory data, resulting in difficulties in timely data collection; and
- Lack of familiarity with current methods and tools for undertaking a quantification of climate change impacts in vulnerable sectors.

- Gaps

The following outlines the key capacity gaps relative to understanding climate change impacts in Kuwait, as well as policies and measures associated with GHG mitigation:

- Lack of access to long-term climate information and associated uncertainties for use in conducting vulnerability and adaptation assessments;
- Inadequate institutional and technical capacity to plan and implement climate change adaptation measures; and
- Limited funding for climate change related research focused on Kuwait and surrounding region.

- Needs

Several capacity development needs were identified during the process of preparing the SNC which are also applicable to the preparation of the BUR. The following are among the key needs:

- Build public, and policy-maker awareness on climate change;
- Strengthen institutional and technical capacities through information and knowledge management;

- Enhance coordination among stakeholders at different levels, especially as it pertains to database development for future GHG inventories;
- Better integrate climate change considerations into national and sectoral development planning and policy dialogues; and
- Promote involvement of local media in building awareness regarding climate change impacts and risks.

Additionally, strengthening future capacity of stakeholders to promote and support GHG inventory development, climate change vulnerability assessment, identification of adaptation strategies, GHG mitigation analysis, and technology needs assessment is needed.

Key recommendations regarding the needs in relation to the development of national GHG inventories are summarized in the bullets below.

- Establish a national system to collect and manage activity and emission data required for updates to the inventory;
- Establish an ongoing GHG inventory committee with high-level representation from key ministries/institutions, having clear oversight and coordination authority; and
- Develop an integrated database of relevant information including annual statistical abstracts and annual reports from specific entities.

Key recommendations regarding the needs with respect to the analysis of national GHG mitigation opportunities are summarized in the bullets below

- Obtain training in methods and tools to analyze in detail the costs, benefits, and co-benefits of GHG mitigation policies and measures, starting with those included in Kuwait's nationally determined contributions;
- Build a cost and performance database regarding energy supply and energy demand management technologies and practices; and
- Develop a centralized database for monitoring and reporting information related to GHG emissions and mitigation projects.

Key recommendations regarding the needs with respect to the assessment of vulnerability of key sectors and systems, together with the formulation of adaptation strategies are summarized in the bullets below.

- Obtain training in modeling approaches to assess the impacts of a) rising season coastal zones, b) water efficiency/conservation policies on water demand, c) changing salinity/temperature on commercial fisheries, and d) emissions co-benefits of renewable energy investments on public health;
- Obtain training on how to establish a national framework that links the results of vulnerability assessments to ongoing policy dialogues regarding adaptation options and strategies; and
- Conduct seminars and training workshops to build awareness among managers and decision makers of the consequences of climate change and the need to incorporate adaptation considerations in utility, urban, and resource planning

6.2 Support received for the implementation of climate change-related actions and for the preparation of the BUR

The state of Kuwait received financial support from Global Environment Facility (GEF) for preparing and communicating the reports such as Initial National Communication of the State of Kuwait, Second National Communication of the State of Kuwait and the biennial updated report. The technical support for these reports was provided by the Regional Office for West Asia of the United Nations Environment Programme (UNEP-ROWA). Some technical assistance has been used by UN programmes to improve and build capacity. The State of Kuwait does not receive any financial support to implement any projects related to mitigation actions or adaptation projects, or any technical support from the financial funds under the Convention. Financing of mitigation and adaptation projects undertaken by the State of Kuwait on a voluntary basis from the State's own budget.

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Annex 38

State of Kuwait Second National Communication

Submitted To

The United Nations Framework Convention on Climate Change

Prepared with technical support of United Nations Environment Programme & funded by the Global Environment Facility (GEF)

By Environment Public Authority

July – 2019

FOREWORD

On behalf of Kuwait's government, it is my pleasure to submit Kuwait's Second National Communication to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). This communication was prepared according to the guidelines approved by the parties and the methodologies of the Intergovernmental Panel on Climate Change (IPCC).

Kuwait already is experiencing high temperatures up to 48 degrees Celsius in the summer, with a reading of 54 degrees Celsius in July 2016 north of Kuwait City. Notably, this was the highest temperature in the Eastern Hemisphere and Asia in recorded history. With climate projections showing even higher future temperatures and a decrease in the already low annual rainfall of Kuwait, the negative impacts of climate change on the country, especially those related to food security, water resources, public health, marine ecosystems, and coastal zones, have come into focus.

Kuwait's Second National Communication presents the results of a series of studies that reveal how changes in local temperature and rainfall patterns, as well as rising seas, are expected to adversely affect vital sectors of the country. This report also includes an inventory of greenhouse gases from key sectors, with an analysis of the emission reduction potential of a set of voluntary mitigation efforts through 2035.

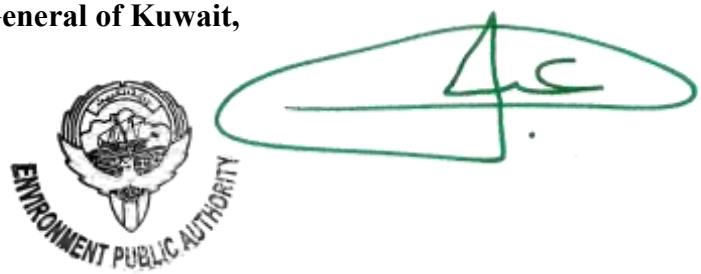
In order to address climate change, the Kuwait Environment Public Authority established the Environmental Protection Law in 2014 and completed its bylaws in 2018. This represents an important pivot point for Kuwait, as there is now legislative and regulatory authority for monitoring and documenting greenhouse gas emissions. Both the public and private sectors are being engaged to ensure that future greenhouse gas emission inventories are complete, consistent, and accurate.

Sheikh Abdullah Ahmad Al Hamoud Al-Sabah

Chairman of the Board & Director General of Kuwait,

Environment Public Authority

The State of Kuwait



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This document was the result of a fruitful partnership and cooperation between the Kuwait Environment Public Authority (KEPA) and the Regional Office for West Asia of the United Nations Environment Programme (UNEP), which oversaw the preparation of the Second National Communication project and provided training and technical support to national experts. In addition, the Global Environment Facility (GEF) provided financial support during all stages of the preparation of the document. Finally, I would like to thank all those who participated in the preparation of this work, particularly all ministries, governmental agencies, nongovernmental organizations, and the private sector for their support and assistance with the various working groups during the preparation of this document. Hopefully, this document will become a useful reference for policymakers, researchers, and all those interested in climate change and its negative impacts on the State of Kuwait.

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LIST OF ACRONYMS

°C	degrees centigrade
AFOLU	Agriculture, Forestry, and Other Land Use
ANOVA	analysis of variance
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
AVHRR	Advanced Very High-Resolution Radiometric satellite
Bcf	billion cubic feet
BCM	billion cubic meters
BIPV	Building-integrated PV systems
CCS	Carbon capture and storage
CDM	Clean Development Mechanism
CFP	Clean Fuels Project
CH_4	methane
CIS	Coastal Information System
CIVATF	Climate Impacts, Vulnerability and Adaptation Task Force
CNG	Compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CORDEX	Coordinated Regional Climate Downscaling Experiment
CVI	coastal vulnerability index
e-MISK	environmental monitoring information system of Kuwait
FGRU	Flare Gas Recovery Unit
GCC	Gulf Cooperation Council
GCM	General Circulation Model
GDEM	Global Digital Elevation Model
GDP	gross domestic product
GEF	Global Environment Facility
Gg	Gigagrams (i.e., one billion grams)
GHG	Greenhouse gas
GIS	Geographic information system
GLOBE	Global Learning and Observations to Benefit the Environment
GW	gigawatt (billion watts)
GWh	gigawatt-hour (billion watt-hours)
GWI	Global Water Intelligence
H_2S	hydrogen sulfide
HFC	hydrofluorocarbons
ICBA	International Center for Biosaline Agriculture
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
KEPA	Kuwait Environment Public Authority
KEPS	Kuwait Environment Protection Society

KFAS	Kuwait Foundation for the Advancement of Sciences
kg	kilogram
KISR	Kuwait Institute for Scientific Research
km	kilometers
KM	Kuwait Municipality
km2	square kilometers
KMA	Kuwait Medical Association
KPC	Kuwait Petroleum Corporation
KU	Kuwait University
kV	kilovolt (thousand volts)
kWh	thousand watt-hours
l/cap/day	liters per capita per day
LIDAR	Light Detection and Ranging
LNG	Liquified natural gas
LPG	liquid petroleum gas
m	meters
m/s	meters per second
m3	cubic meters
MENA	Middle East and North Africa
MEW	Ministry of Electricity and Water
MHTL	Mean high tide level
Mm3	million cubic meters
MMSCFD	million standard cubic feet per da
MOH	Ministry of Health
MOU	Memorandum of understanding
MPW	Ministry of Public Works
MRV	Measurement, Reporting and Verification
MSF	multi-stage flash
MSW	Municipal solid waste
N2O	nitrous oxide
NC	National Communications
NCD	Noncommunicable disease
NDC	Nationally Determined Contribution
NGCC	natural gas combined cycle (power station)
NGO	Nongovernmental organization
NHA	National Housing Authority
NMHC	nonmethane hydrocarbon
NOAA	National Oceanic and Atmospheric Administration
NOX	nitrogen oxides
NRP	New Refinery Project
NTF	National circumstances & other information Task Force
O_3	ground-level ozone
PAAET	Public Authority for Applied Education and Training
PAAF	Public Authority for Agriculture and Fisheries

PACI	Public Authority for Civil Information
PFC	perfluorocarbons
pH	Potential of Hydrogen
PM_{10}	particulate matter less than 10 microns in diameter
PSC	Project Steering Committee
PV	photovoltaic (solar)
QSAS	Qatar Sustainability Assessment System
R&D	research and development
RCM	Regional Climate Model
RCP	Representative Concentration Pathways
RO	reverse osmosis
ROWA/UNEP	Regional Office for West Asia of the United Nations Environment Programme
SCPD	Supreme Council for Planning and Development
SEI-US	Stockholm Environment Institute – US Center
SLR	Sea level rise
SNC	Second National Communication
SO_2	sulfur dioxide
SSS	sea surface salinity
SST	sea surface temperatures
TDS	total dissolved solids
TNA	Technology Needs Assessment
TWW	Treated wastewater
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USGS	United States Geologic Survey
WEAP	Water Evaluation and Planning model

EXECUTIVE SUMMARY

The State of Kuwait is located at the northeastern corner of the Arabian Peninsula and has borders. State of Kuwait covers a total land area of nearly 18 thousand square km and is approximately 170 km wide from East to West and 200 km long from North to South. Kuwait shares a 495 km border with Saudi Arabia to the south and 195 km with Iraq to the north and west.

National Circumstances

Kuwait has a hyper arid desert climate that is highly variable with recurrent extremes. Maximum daily temperatures can reach 45°C in the summer during which there is no rainfall. Much of Kuwait is characterized by loose, mobile surface sediments that have very low levels of nutrients and organic matter. While rich in terrestrial and marine biodiversity, these systems are fragile and highly vulnerable to climate change. Kuwait is also one of the world's most water-stressed countries, with the lowest per capita renewable internal freshwater availability of any country, requiring extensive seawater desalination to meet the water demand. The population is overwhelmingly urban and has grown rapidly since the discovery of oil in the late 1930s, with over 98% of the population currently living in urban areas which are mostly located along the coast. A modern country with an extensive, modern and well-maintained network of road infrastructure, Kuwait also has a modern healthcare system and a healthy populace; recent trends show a decrease in the incidence of communicable diseases and an increase in life expectancy in the country. Kuwait is one of the world's leading oil producers, possessing the world's fifth largest crude oil reserves in the world and has one of the wealthiest economies in the Arabian Gulf region. Throughout its modern history, Kuwait has heavily relied on food imports because only a negligible fraction of food demand can be met by local agriculture.

Greenhouse Gas Inventory

Kuwait compiled an update to its inventory of greenhouse gas emissions for the year 2000 (see Table ES-1). The total and net greenhouse gases (GHG) emissions in 2000 were 48,712 Gg CO2-equivalent, including 46,533 Gg of emissions from energy; 873 Gg of emissions from industrial processes and product use; 102 Gg of emissions from agriculture, forestry, and other land use, and 1,205 Gg of emissions from waste. Emissions from perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF6) in Kuwait are negligible because the products containing these gases are not produced in the country.

	GHG Sources & Sinks	CO_2-eq	CO_2	CH_4	N_2O
1	Energy	46,535	46,192	7.5	0.61
2	Industrial processes and product use	873	873	0.0	0.0
2	Agriculture, forestry and other land use	102	-9.2	5.0	0.019
4	Waste	1170	0	54.1	0.11
	Total National Emissions	48,683	47,065	66.6	0.74
	Net National Emissions	48,683	47,056	66.6	0.74

Vulnerability and Adaptation

All land areas of Kuwait will become warmer in the future, with the greatest change projected to occur during the winter months. Across the entire country, annual average temperatures show the greatest rise under RCP8.5, this scenario predicts an increase between 4.3° and 4.5°C in temperature compared to the historical average by the 2071-2100 period. Kuwait will also become drier in the future, with average annual rainfall in the western part of the country showing the greatest decrease under, i.e., values approximately 15% and 18% lower than the historical average, under RCP8.5. The Arabian Gulf water will also experience change. Historical monthly sea surface temperatures in the Arabian Gulf have steadily increased at a rate of 0.6 (±0.3) °C per decade, which is three times greater than the concurrent global average.

Many sectors are vulnerable to these climatic changes, with potentially grave environmental and social effects, compounded by the country's adaptation challenges. Key findings of the vulnerability assessments are summarized in the bulleted list below.

- *Coastal* zones: Rising sea levels pose threats such as wetland flooding, aquifer and agricultural soil contamination, destructive erosion and habitat loses for fish, birds, and plants. Sea level rise (SLR) also poses a threat to the built environment via the extension of Arabian Gulf waters farther inland, particularly under high tide conditions and especially in combination with storm surges associated with extreme storm events. Boubyan Island will be greatly impacted by SLR, with roughly half the island inundated in the highest SLR scenario. Only the relatively high land in the interior of the island will be visible by the end of this century. Coastal areas along Kuwait Bay are also projected to be adversely impacted by rising seas, especially the western coast near Doha Port and the densely populated neighborhoods around Kuwait City.
- *Water resources:* population growth, urbanization, industrial growth, and agricultural development are key drivers underlying Kuwait's high per capita water consumption. Coupled with a hyper arid environment, low annual rainfall, no permanent lakes or rivers, and limited fresh groundwater resources, sustainable water resource management is a key national priority. A number of potential adaptation policies have been analyzed (i.e., water tariffs, improved water efficiency, leak reduction, and improved irrigation efficiency) with each policy showing significant water savings and reduction in carbon dioxide emissions.
- *Marine ecosystems*: Kuwait's marine waters and coastal areas include highly productive habitats, e.g., intertidal mudflats, seagrass, algal beds, mangroves, and coral reefs. These habitats support important commercial fisheries, marine biodiversity and endangered species such as green turtles. Recent trends show a loss of coral reef coverage with increasing Gulf water temperatures, as well as massive fish kills.
- *Public health:* with climate change, increased heat stress from higher temperatures and increased cardiovascular and respiratory diseases associated with more frequent dust storms, represent looming health threats to the population. These additional risks could exacerbate current major health problems such as ischemic heart disease, stroke, road injury and lower respiratory infections, while potentially undermining Kuwait's social protection systems.

Greenhouse Gas Mitigation

Kuwait is committed to efforts that harmonize economic growth with a low-carbon, climate-resilient development. Domestically, the country has already undertaken several strategic projects to reduce its carbon footprint by promoting clean energy initiatives, introducing new low-carbon technologies, and developing long-term partnerships to exploit sustainable energy opportunities. Progress towards such actions is already underway, when these actions are fully implemented by 2035, they will result in total annual emission reductions of approximately 5,600 Gg, with cumulative emission reductions of nearly 60,000 Gg of CO_2e.

Constraints, Gaps and Needs

Inadequate capacity (technical, financial and institutional) remains one of Kuwait's significant challenges as the country confronts climate change. Enhancing capacity will depend on overcoming serious institutional, financial and technical constraints and gaps that currently interfere with effective action. With adequate support, Kuwait can build climate change resilience and explore the viability of low-emission development trajectories.

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1. National Circumstances

This chapter provides a description of Kuwait's national circumstances, as well as an overview of the national socioeconomic, climatic, and environmental context in which climate change challenges are being addressed.

1.1. Geography

The State of Kuwait is located at the northeastern corner of the Arabian Peninsula (see Figure 1-1) and has borders with Saudi Arabia to the south and Iraq to the north and west. Kuwait lies between the latitudes 28°30'and 30°5' North and longitudes 46°33' and 48°30' East, covering a total land area of 17,818 km^2 that includes nine uninhabited islands. Kuwait is approximately 170 km across from East to West and 200 km across from North to South. Kuwait shares a 495 km border with Saudi Arabia to the south and a 195 km border with Iraq to the north and west. The capital of Kuwait is Kuwait City. The country is divided to 6 administrative governorates; and the governorates are further subdivided into administrative areas. The country's topography is predominantly flat sandy desert, and is characterized by two distinct areas, as follows:

Figure 1-1: Satellite image of the State of Kuwait.
(Source: e- Misk, KEPA)

- *Northern zone.* This area includes Kuwait Bay and five islands: Boubyan, Warba, Maskan, Failaka, and Ouha. Kuwait Bay is a shallow but very important coastal and marine habitat with high productivity and diversity. Its coastal zone accounts for nearly half of the country's shoreline. The two largest islands (Boubyan, 863 km2 and Warba, 212 km2) remain in an undisturbed condition and are home to migratory birds and rich marine biodiversity. Boubyan is the second largest island in the Arabian Gulf and is home to pristine marine and terrestrial ecosystems of regional and international importance. The northern half of island is a designated marine protected area named the Mubarak Al Kabeer Marine Reserve (MKMMR) and was recently designated as a Ramsar Convention Site.1
- *Southern zone.* The area extends from Ras Al-Ardh to the border with Saudi Arabia. Its coastal stretches include sandy and mixed shores, as well as the coral reef islands of Kubbar, Qaruh and Um Al-Maradim. Many intertidal marshes, known as *sabkhas*, are also found in this zone; the largest is Al-Khiran Sabkha, which was transformed into a large waterfront city. The southern region of this zone is a monotonous plain covered by sand. Al-Ahmadi hill, 125-m high, is the sole exception to the flat terrain, Portions of Wadi Al- Batin and Ash-Shaqq the only major valleys in the zone of, lie within the western

[1] In 2015 Kuwait became the 169th Contracting Party of the Ramsar Convention on Wetlands; and on 17 May 2017 announced the designation of the MKMMR.

and southern reaches of the country, respectively. Rocks ranging in age from the early Miocene (less than 24 million years old) to recent times are exposed within the boundaries of Kuwait.

1.2. Climate

Kuwait has a hyper arid desert climate that is highly variable with recurrent extremes. Maximum daily temperatures can reach 45°C during the summer during which there is no rainfall (see Figure 1-2).

The climate is marked by four distinct seasons, with long, hot and dry summers and short winters, as briefly described in the bulleted list.

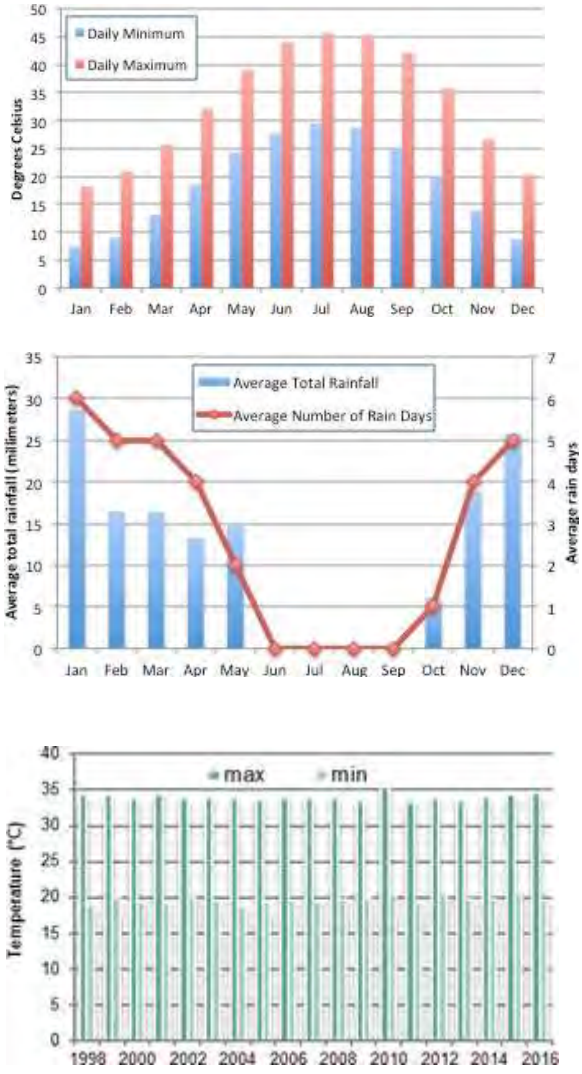

Figure 1-2: Top: Daily minimum and maximum temperatures in each month, averaged over 1962-2016; middle: total rainfall in each month, averaged over 1962-2016; bottom: highest and lowest average annual temperature recorded over the period 1998-2016.(Source: Kuwait Civil Aviation - Metrological Department)

- *Winter.* The winter season occurs over a 2-month period between 6 December and 15 February. These months are cold, and often experience a northwesterly wind. The lowest recorded temperature was −4°C recorded and was recorded at the Kuwait International Airport in January 1964. Low temperatures, clouds, rain and a cold northwesterly wind called (*Shamal*) characterize this season. Two distinct climatic periods within the winter season are evident, as described in Box 1-1.
- *Spring.* The spring season is a 3-month period from 16 February to 20 May and is characterized by moderate temperatures, rain, cloudy conditions and hot southerly winds. The climate during the spring is divided into two distinct climatic periods, as briefly described in the bulleted list. Two distinct climatic periods within the spring season are evident, as described in Box 1-1.
- *Summer.* The summer season occurs over an approximately 5-month period from 21 May to 4 November and is characterized by a significant increase in both humidity and temperature. Summer is typically hot, dry and humid, with daily maximum temperatures ranging from 43°C to 48°C. The highest-ever recorded temperature in summer was 54.0 °C at Mitribah in northwest Kuwait on July 21, 2016 (Kuwait Civil Aviation Metrological Department). I fact, this was the highest reliably recorded temperature on the planet in the last 76 years, as documented by the World Meteorological Organization (WMO). The prior highest temperature was 52.9°C, which was also recorded in Mitribah. The climate during the summer is divided into three distinct periods, as described in Box 1-1

- *Autumn.* The autumn season occurs over a single month- long period from 5 November through 5 December and is characterized by moderate temperatures, greater cloud cover, more frequent rain showers, and increasingly cold nights.

The climate of Kuwait is further characterized as follows:

- *Rainfall.* Figure 1-3 summarizes the annual rainfall from 1998 to 2016. Rainfall is concentrated in the winter and spring months. Rainfall totals are highly variable from year to year, and drought is a recurrent phenomenon. The average annual rainfall is typically approximately 112 millimeters (mm) per year and varies from 75 to 150 mm/yr. The annual recorded rainfall levels at Kuwait International Airport have been as low as 34.4 mm and as high as 218 mm, while a level of 319.5 mm was recorded in Umm Al-Maradim Island in October 2013.

- *Humidity:* from mid-August through September, humidity can exceed 95% in coastal areas. This is due to high seawater temperatures coinciding with tropospheric temperature inversions.

  Over the period 1987 through 2017, the average relative humidity was 57%.

- *Dust storms:* given the geographical location of Kuwait, dust storms are regular phenomena in the country. While they can occur in any season, dust storms are particularly frequent in summer and can reach speeds up to 150 km per hour (see Figure 1-4). Dust sources are in the Mesopotamian region which includes Syria, Iraq, western Iran, and the northeastern portion of the Arabian Peninsula.

  Dust activity in the Tigris-Euphrates basin begins around May, reaches a maximum in July and is much reduced by September–November. In spring, the region is affected by north-westerly Shamal winds that transport dust down to the Gulf.

  Dust storms are aggravated by overgrazing and camping practices. These storms are known to contribute to serious health impacts in Kuwait such as asthma attack incidence rates of 175 per day and have increased road traffic accident rates by up to three times the normal rates.

Box 1–1: Climatic sub-periods in Kuwait

Winter sub-periods:

- *Cold winter period (Murba'ania; 6 December to 15 January).* Temperatures can drop below 0°C, especially during the night or when northwesterly winds are strong. Warm intervals (>30°C) are common due to a humid southeasterly wind.
- *Mild winter period (16 January to 15 February).* Southeasterly winds lead to overcast/rainy conditions often followed by northwesterly winds that bring cold air, leading to dense fog and frost conditions.

Spring sub-periods:

- *Cold moderate spring period (*16 February to 8 April). Temperatures begin to increase due to a hot southerly wind (known as Al-Suhily) that lasts for several days at a time. Maximum temperatures may reach 41°C.
- *Warm spring period (*9 April to 20 May). Thunderstorms (known as Al-Sarayat) are common and typically develop in late afternoon or evening, accompanied by severe dust storms. Temperatures gradually increase from approximately 30°C to 47 °C by the end of the period.

Summer sub-periods:

- Transition period (21 May through 5 June). A transition period between late spring and actual summer conditions. Skies are generally clear, and winds are variable in direction and strength. Average maximum temperatures range from 40° to 44°C.
- Dry summer period (6 June through 19 July). Characterized by a consistent hot and dry northwesterly wind (*Semoom*) that contributes to strong dust storms with visibility of few meters, especially at noon. Average maximum temperatures range between 42° and 46°C.
- Wet summer period (20 July through 4 November). Characterized by light easterly and southeasterly winds that lead to high humidity. Cloud cover is minimal, and rainfall is less.

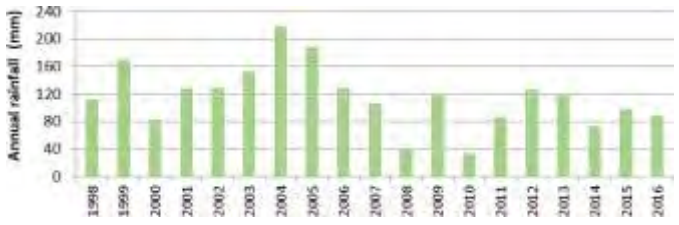

Figure 1-3: Average annual rainfall over the period 1998-2016.
(Source: Kuwait Civil Aviation - Metrological Department)

Figure 1-4: Recent severe dust storms over Kuwait City.
left storm on 17 June 2018. (Photo: Sarah Al-Sayegh); right: storm on 18 February 2018 (Photo: Kuwait Times, 19 February 2018)

1.3. Land and vegetation

Much of Kuwait is characterized by loose, mobile surface sediments. Soils are divided into ten groups, all of which have very low levels of nutrients and organic matter (see Figure 1-5). The soil moisture content is also very low because of high evaporation rates and hard pans (locally known as *gutch*) that reduce water permeability. Less than 1% of Kuwait's land area is considered arable.

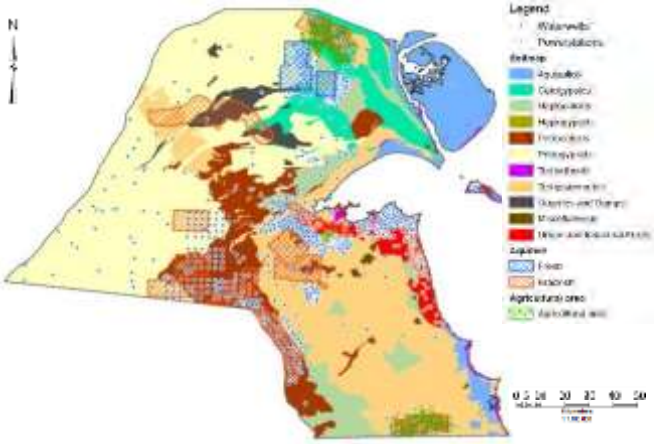

Figure 1-5: Soils, aquifers and groundwater-irrigated agricultural areas of Kuwait.
(Source: PAAF, KISR)

The vegetation of Kuwait is broadly classified as open scrub of the Saharo - Arabian floristic region, which is contiguous with the Northern Plains of eastern Saudi Arabia (Royal Botanical Gardens-Kew, 2010). Kuwait occupies part of the large, low-lying desert plain covering most of Eastern Arabia and is mostly characterized by desert and coastal plains (see Figure 1-6). Coastal areas comprise important marine habitats, many with high productivity and diversity, including salt marshes and tidal mudflats.

1.4. Desertification

Several studies have assessed desertification in parts of Kuwait (Shahid *et al.,* 1999; Al-Dousari *et al.,* 2000; Omar *et al.,* 2001; Misak *et al.,* 2002; Al-Awadhi *et al.*, 2005). Seven processes or indicators of land degradation have been recognized, with a general agreement that these processes affect approximately 70% of Kuwait's land area. These indicators are deterioration of vegetation cover; soil crusting and sealing; soil erosion by wind; soil erosion by water; soil compaction; soil contamination by oil; and soil salinization. And are mapped in Figure 1-7.

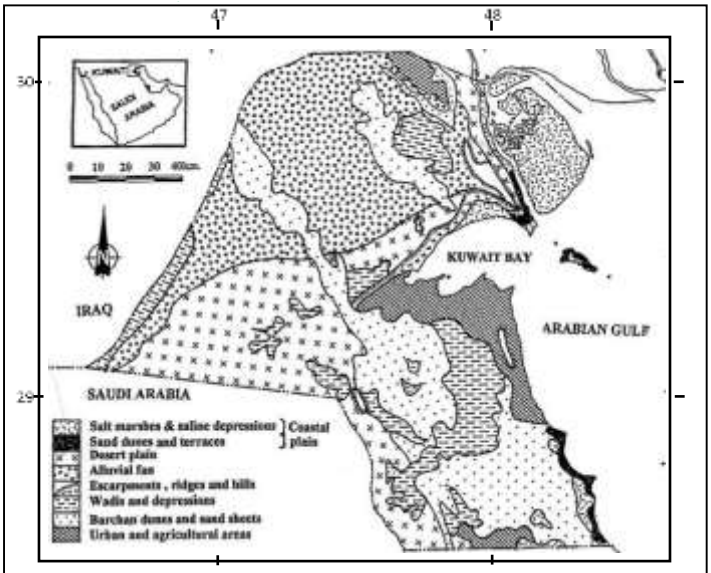

Figure 1-6: Ecosystems of Kuwait.
(Source: Samira AS Omar, Raafat Misak ;2007, KISR)

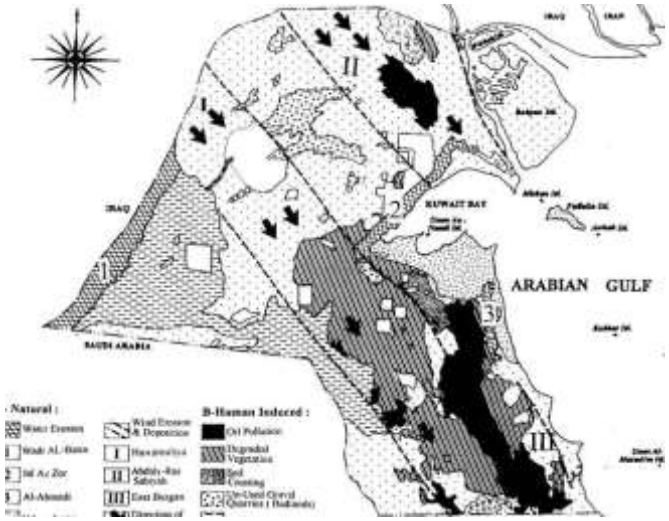

Figure 1-7: Preliminary land degradation map of Kuwait.
(Source: Al-Dousari et al., 2000)

The deterioration of vegetation cover, with a decline in the alpha diversity of plant species, is one the most obvious indicators of desertification in Kuwait's desert ecosystem. Overgrazing is considered the prime driver of vegetation degradation on rangelands, a conclusion supported by several studies that document much greater vegetation cover in areas fenced off and unavailable to livestock than in areas accessible to grazers (Omar, 1991; Zaman, 1997; Shahid *et al.*, 1999). This form of desertification is particularly severe around watering points where it is exacerbated by soil trampling and compaction due to the congregation of animals (Al-Awadhi et al., 2005).

Other important localized causes of vegetation deterioration are spring camping, the uprooting of woody shrubs used as fuel and military maneuvers. One survey indicates that at least 65% of Kuwaiti soils are affected by some degree of compaction, which inhibits the infiltration capacity of these soils by 40–100% and increases their bulk density by up to 50% (Misak, 2001).

Wind erosion occurs naturally on many of Kuwait's desert surfaces, particularly those consisting of active sand sheets and sand dune fields. Elsewhere, vegetated sand sheets have also been mobilized where the stabilizing cover of vegetation has suffered from degradation and trampling. These mobile sediments represent a serious hazard to human activities. The annual cost of clearing sand

encroachment from oil installations in Kuwait is more than US$1 million. The annual expenditure needed to remove sand from the Ali As-Salem airbase is similar (Ramadan & Al-Dousari, 2013). Local sources of fine particulates contribute to the numerous dust storms that affect Kuwait, although the country is also affected by desert dust transported from neighboring countries and further afield. Associated wind-erosion impacts include hazards to aircraft and maritime traffic, effects on oil operations and green energy production, and serious human health problems due to the low air quality.

1.5. Biodiversity

Kuwait is committed to its international obligations regarding the conservation of its native biodiversity. On 5 June 2017, Kuwait ratified the Nagoya Protocol, which is a supplementary agreement to the Convention on Biological Diversity, that sets forth obligations on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization. With this ratification Kuwait became the 100th party to such protocol. On the same date, Kuwait also ratified the Cartagena Protocol on Biosafety to the Convention on Biological Diversity and became the 171st party to the protocol.

The Worldwide Fund for Nature (WWF) classifies Kuwait's terrestrial ecosystem as a desert with xerophytic (Greek xero for dry, phuton for plant) scrub. This classification is based on the high variability in intra-annual annual rainfall (see earlier Figure 1-2), and the high evaporation rate which exceeding the rainfall.

Approximately 375 plant species have been recorded in Kuwait Approximately two thirds (256 species) of these species are annuals. Low shrub species and herbaceous perennials form the main constituents of the perennial vegetation with only a few large shrubs, and a single tree species present (Halwagy & Halwagy 1974, Halwagy et al. 1982, Mandaville 1990, Omar et al. 2001, Ghazanfar 2006).

Kuwait has colorful terrestrial and marine biodiversity (see Figure 1-8). This diversity is fragile and vulnerable to the impacts of climate change; desertification and other threats resulting from anthropogenic activities, including habitat destruction, overgrazing, pollution, and illegal hunting and overfishing. The last inventory of wild animal species in Kuwait documented the presence of more than 300 bird species, 20 mammal species and 40 reptile species.In Kuwait, 648 species of insects have, belonging to 414 genera and 22 orders.

Figure 1-8: Examples of biodiversity in Kuwait.
Top left: Lizard; top right: Al-Sheriab (shore Crab); bottom right: Arabian red fox (Vulpes arabica); bottom left: Black-winged Stilt (Credits: Faisal Al-Nomas; KEPA)

The largest order is that of beetles (Coleoptera) with 230 known species, followed by butterflies and moths (Lepidoptera) with 76 recorded species, bees, wasps and ants (Hymenoptera) with 71 species, flies (Diptera) with 69 species, and finally locusts (Orthoptera) with 34 known species (Al-Houty, 1989).

The native flora of Kuwait consists of 374 plants: dwarf perennial bushes, annual grasses, and herbs. These plants comprise 256 annuals, 83 herbaceous perennials, 34 under shrubs and 1 tree. Native plants have developed mechanisms to survive in the country's extreme environmental conditions. In practical the perennials must endure the harsh climate more than the annuals, which propagate only after the seasonal rainfall (Shamal Azzour: https://www.aznoula.com). Important plant communities in this floristic region in Kuwait are briefly described in the bulleted list (Halwagy & Halwagy, 1974; Halwagy *et al*., 1982; Mandaville, 1990; Omar *et al*., 2001; Ghazanfar, 2006).

- *Haloxylon salicornicum community*. Extends from Iraq in the northeast down to the northern edge of the Rub'al Khali in Saudi Arabia. Found predominantly on sandy and sandy-gravelly soils and composed of the dominant shrub *Haloxylon salicornicum*, this is the largest community in northeast Arabia. In Kuwait, the *Haloxylon salicornicum* community is present in the north and northeast. Associates are *Astragalus spinosus* and *Chrozophora spp*.
- *Rhanterium epapposum community.* Extends from eastern Saudi Arabia and the south to the United Arab Emirates. This community is present on deep and shallow sand. The dominant species is *Rhanterium epapposum* with associates *Convolvulus oxyphyllus* and *Moltkiopsis cilata*. Other species, such as *Gynandriris, Anthemis*, and *Cornulaca*, are associated with the community in specific soils and topographies. *Rhanterium epapposum* is very palatable to livestock, and overgrazing has greatly affected its occurrence. This species is not common in Kuwait and is presently found only in protected areas.
- *Stipagrostis plumosa community*. Found mostly in the west and southwest of Kuwait with dominant grass, the occurrence of *Stipagrostis plumosa* is a result of degradation and disturbances. Under proper management, this community develops into the *Rhanterium epapposum* community or, on saline soils, into the *Haloxylon salicornicum* community. In the southwest, *Centropodia forskalii*, a perennial grass, is dominant with *Stipagrostis plumosa* as the chief associate (recognized as a separate community by Omar *et al.* 2001).
- *Cyperus conglomeratus community*. Found throughout the Arabian Peninsula, this community is present on sand, occurring on both mobile and stable dunes and sand sheets, and forming hummocks. In Kuwait, the *Cyperus conglomeratus* community is found in the south. An excellent sand binder and not readily eaten by livestock, this species can thrive with moisture from dew. Associates are usually annual species (*Astragalus annularis*, *Brassica tournefortii*, *Plantago albicans*).
- *Halophytic communities*. Three halophytic communities, *Zygophyllum*, *Pennisetum* and *Halophyletum,* from the coastal inland region are composed primarily of halophytic shrubs. *Salicornia europaea* grows on low, frequently inundated mud banks or along creeks and is sometimes associated with *Aeluropus lagopoides* and *Bienertia cycloptera* or with *Juncus rigidus* on the fringes of creeks. The *Halocnemum strobilaceum* community occupies the lower marshes along the shoreline, where the seaward edge is very frequently inundated by tides. The *Seidlitzia rosmarinus* community occurs further inland than the *Halocnemum strobilaceum* community, while *Nitraria retusa* occurs above the high tide mark and dominates the middle marshes. Finally, the *Tetraena qatarensis* (syn. *Zygophyllum qatarense*) community occurs on elevated, coarse sandy sites on the landward edge of marshes. The salt marshes are fringed by nonhalophytic communities such as the *Cyperus conglomeratus* community, the *Rhanterium epapposum-Convolvulus oxyphyllus-Stipagrostis* plumose community and the *Haloxylon salicornicum* community; the latter covers most of the territory of Kuwait.

Kuwait has a rich profile of invertebrate and vertebrate fauna. The intertidal zone is colonized by many species of Ocypode crabs, including the endemic crab *Leptochryseus kuwaitnese*. The blue-spotted Mudskipper *Boleophthalmus boddarti* is another inhabitant of the intertidal zone. The most common scorpion is the black scorpion *Androctonus crassicayda*, while the most common spiders are the wolf spiders *Pardosa sp*., the crab spiders *Thomisus sp.*, the sun spiders *Galeodes sp*., the velvet mites *Dinothrombium sp.*, and *Tarantula sp.* (KEPA, Fifth National Report, 2014).

One of the most common insects in Kuwait is the ground beetle (*Tenebrionidae*). The most famous beetle species is probably *Trachyderma hispida*, which is omnipresent in houses and in the desert. Active during the day, this black beetle makes burrows for larvae and pupae beneath the soil cover.

The reptile fauna of Kuwait is depauperate, with no endemic species, although 40 species have been recorded. The common reptiles of Kuwait include the dhub *Urmastyx microlepis*, the Agma lizard and the wirral *Varanus griseus*. There are several species of snakes in Kuwait, such as the sand boa *Eryx jayakari*, the Arabian boa *Malpolon moilensis* and the sand viper *Cerastes cerastes*.

Twenty-eight mammalian species live in Kuwait. Sadly, four large mammals have been exterminated: the dorcas gazelle, the mountain gazelle (*Idmi*), the Arabian sand gazelle and the Asiatic cheetah (*fahd*). Other large carnivores, such as wolves, caracals, and jackals, are now extremely rare. Habitat destruction and extensive and unregulated hunting are driving endangered mammalian species, such the fennec fox, the red fox, the honey badger, the Indian gray mongoose and the wild cat, to extinction.

Due to ecological and anthropogenic activities, most large mammals that were native to Kuwait have been wiped out or have disappeared. (Kuwait Times, 11 March 2017). Over the past few decades, the desert of Kuwait has witnessed a dramatic decline in biodiversity, as many species, such as the Arabian oryx *Oryx leucoryx*, the Arabian wolf *Canis lupus arabs*, the striped hyena *Hyaena hyaena*, the golden jackal C*anis aureus*, *Mellivora capensis*, the dorcas gazelle *Gazella dorcas*, the sand gazelle *Gazella subgutturosa*, Ruppell's fox *Vulpes rueppellii*, have disappeared (https://www.aznoula.com). In addition, several species of birds, such as the houbara bustard *Chlamydotis undulate* and lanner falcon *Falco biarmicus feldeggi,* have been wiped out. Concerning reptiles, over 40 species of reptiles and amphibians have been recorded in the dry areas of Kuwait

Although no specific studies have investigated the current status of these reptiles, like other native fauna of Kuwait, their distribution has been minimized and is restricted to remote areas with minimal human interference. In general, the fate of desert reptiles is not expected to be better than the fate of extinct birds and other species. Habitat loss and fragmentation, human impacts and overcrowding are the main causes of extinction. Habitat fragmentation continues to threaten the wildlife in Kuwait.

Genetic clustering, species isolation, and the intensification of genetic mutations that may lead to population breakdown in isolated groups are some of the threats that habitat fragmentation poses. (https://www.aznoula.com).

The Kuwaiti government strives to preserve national biodiversity through several policies and procedures. Environmental police are enforcing the implementation of the Environmental Protection Law on violators hunting or polluting the environment or fishing in restricted areas. Article 100 of Kuwait's Environmental Act, which became effective in 2014, bans the hunting and collection of fauna or destruction of nests in areas where wild species live. The article states that native fauna, including all mammals, birds and reptiles, cannot be killed, collected, or hunted, cannot have their nests destroyed, and cannot be harmed by any activity.

Kuwait has also allocated 11.65% of its terrestrial and coastline as nature reserves and protected parks. At present, there are twelve reserve areas across the country (see Figure 1-9). The largest and most significant reserves are as follows:

- *Sabah Al-Ahmad Nature Reserve.* Located at the north- east part of Kuwait, this reserve covers 325 km^2 and is area where threatened animals and plants are reintroduced, and natural characteristics of the native ecosystem is preserved.
- *Mubarak Al-Kabeer Reserve.* Located in the north of Boubyan Island and the entire territory of Warba Island, this reserve covers 510.2 km^2 and consists of low sandy and muddy surfaces, and numerous channels and bays with rapid currents tides that are rich in food abundance, which contributes to a richness in marine organisms. The reserve accommodates dolphins during the summer and migratory birds, such as flamingos, watercress and small derricks in winter.

Figure 1-9: Protected Areas of Kuwait.
(Source: EPA e-Misk – Kuwait)

Migratory birds use Kuwait as transit base in different times of the year. The Al-Jahra Pool Nature Reserve located in northern Kuwait is a wet and green sanctuary area that attracts a wide variety of birds, both migratory and wintering species. To date, 220 bird species have been recorded in the reserve (Bird Life International, 2012). Another site for migratory birds is Kubbar Island, located roughly 30 kilometers off the southern coast of Kuwait, and a breeding ground for three migratory species of terns, nesting in Kubbar from early May to August.

However, the vegetation of Kuwait is under threat of extinction due to many factors including; setting up extensive recreational camps, gravel quarrying, oil exploration and the destructive activities during the 1990/1991 war; all of these factors have increased pressure on Kuwait's vegetation. Decades of low enforcement and compliance of ecosystem protection laws is another major cause of the destruction of the native biodiversity. A study conducted in protected and unprotected areas has shown that the plant cover in the unprotected areas is 80% less than that of the protected areas. (Shamal Azzour: https://www.aznoula.com).

1.6. Water Resources

Kuwait is one of the world's most water-stressed countries, with the lowest per capita renewable internal freshwater availability of any country.[2] Water supply consists of desalinated seawater, groundwater and treated wastewater. On a per capita basis, roughly 900 liters per day are consumed in Kuwait, one of the highest rates in the world (ESCWA, 2011).

[2] FAO AQUASTAT data accessed June 2016.

Desalinated water is produced in six multi-stage flash distillation plants and one reverse osmosis plant. These are large facilities located near the coast and co-produce electricity (see Figure 1-10). Desalination plants provide more than 90% of Kuwait's potable water needs.

Figure 1-10: Al-Zour North independent power station and desalination plant, installed in 2015.
(Source: engie.com)

Much of the available groundwater is brackish (total dissolved solids (TDS) ranging from 1,000 to 7,000 mg/l) and saline (TDS ranging between 7,000 to 20,000 mg/l) PAAF, 2006) Freshgroundwater (TDS less than 1,000 mg/l) is very limited and available in two freshwater lenses, Raudhatain and Umm Al Eish, of the transboundary Dammam aquifer. These freshwater lenses are formed due to a combination of unique conditions that include high intensity rainfall of short duration, and a geomorphology and lithology that enable rapid infiltration to the underlying groundwater. From historical pumping and water quality variation data acquired between 1963 and 1977, the sustainable extraction rate for Raudhatain and Umm Al Eish, which would avoid the uplift of deeper saline water, is estimated to be 3,500 and 5,500 m3/day, respectively (Kwarteng *et al*,, 2000). Fresh groundwater is considered a strategic reserve for drinking purposes only.

Brackish groundwater is used for agricultural and domestic purposes and as drinking water for cattle. This water is produced from the Al-Shigaya, Al-Qadeer, Sulaibiyah, Wafra and Abdally fields. The production capacity of these fields is about 545,000 m3/day. In general, groundwater quality and quantity are deteriorating due to the continuous pumping of water. In Wafra in the south, 50% of the wells pumped water had a salinity level higher than 7,500 ppm in 1989, reaching 75% and 85% in the years 1997 and 2002, respectively. In Abdally in the north, these figures were estimated at 55, 75 and 90%, respectively. For Wafra, reported monitored wells over a similar time period and results showed that salinity is increasing from 5-14,000 ppm to 8-14,000 ppm in wells (Akber, 2009).

A significant percentage of wastewater is being discarded and flows back into the Gulf sea water. Over 90% of the population is connected to a central sewerage system. This offers an important potential for treated wastewater (TWW) reuse that can contribute to alleviating high irrigation water demand for landscaping and agriculture. Planning is underway to distribute water from the Sulaibiyah treatment plant as follows: 40% to the south for the Wafra agricultural area, 40% to the north to the Abdally agricultural area, with 20% to remain in the Sulaibiyah area agricultural area. There are GCC guidelines allowing use of quaternary TWW for growing vegetables, fruits and other crops in times of crises.

Kuwait has recently implemented a vigorous campaign that aims to reclaim and reuse all treated wastewater. A recent paper by Al-Anzi, Abusam and Shahalam (2010) presents the current status of wastewater treatment, reclamation and reuse in Kuwait, and discusses the impact of wastewater reuse on the amounts of pollutants discharged into the sea. "Analysis of the historical records of the waste water treatment plants has indicated that the reuse of reclaimed wastewater in Kuwait has greatly reduced the amounts of pollutants discharged into the sea, from about 65% of treated wastewater in year 2000 to less than 30% in year 2010. However, the amounts of treated wastewater discharged into the sea were predicted to start increasing again by the year 2020, especially if the future plans of the Ministry of Public Works (MPW) are not implemented by that time."

A study undertaken by Alhumoud and Madzikanda, in 2010 also shows that "the overwhelming majority of the respondents (77.91%) objected to using reclaimed water for drinking and only 16.83% said they might consider drinking it. The majority of respondents (75.28%, 66.80% and 55.60%) did not object to using the reclaimed water for agricultural irrigation, car washing and house washing. In addition, data showed that most of the respondents, even the ones that possessed enough knowledge about the subject, strongly opposed using reclaimed wastewater for human use (showering/bathing: 60.03%, clothes washing: 52.40% and cooking: 78%), regardless of its quality and cost". Reasons and objections for not using treated wastewater were: health (69%), psychological (54%), religion beliefs (29%), mistrust of the workmanship at the plant (25%), fear of mechanical breakdown (19%), while seven% reject it for other reasons. People with high educational attainment showed a greater willingness, compared with other groups, to use treated wastewater for different purposes. This may be because they are more familiar with the different potential uses. Nearly 58% of the sample thought that fresh water supply would be a problem in the future. About 32% believed to some extent that it would be a problem and ten% said it would not be a problem. In the future there may be more acceptance of the use of tertiary or quaternary treated water in Kuwait.

1.7. Demography

Kuwait has an overwhelmingly urban population that has grown rapidly since the discovery of oil in the late 1930s, with over 98% of the population lives in urban areas. Between 1994 and 2016 the total population increased from 1.6 million to 4.8 million, at an average annual rate of 4.0% (see Figure 1-11). Over this time, the Kuwaiti population as a share of the overall population has declined from nearly 37.2% to nearly 30.4%. In contrast, the expatriate population has grown more rapidly over the same period - about 5% per year on average - while their ratio of total population rose from nearly 62.8% to 69.6% (PACI, 2018).

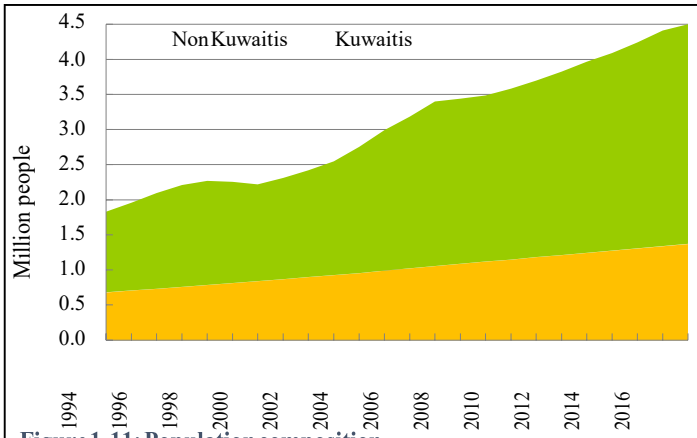

Figure 1-11: Population composition.

(Source: Public Authority for Civil Information, paci.gov.kw)

Kuwait's population is, like those of its Gulf neighbors, heavily skewed due to relative to age and gender (see Figure 1-12). By the end of 2017, most of total population (about 78%) was between 16 and 64 years of age and males roughly comprised 63%. This is in large part due to the presence of a large number of expatriate workers in the country in that age bracket (about 86%) that are mostly male (nearly 69%).

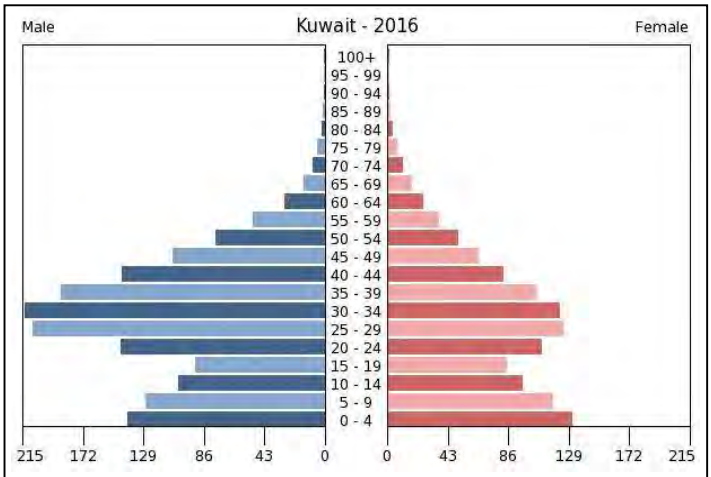

Figure 1-12: Population pyramid, 2016.

(Source: Public Authority for Civil Information, paci.gov.kw)

In contrast, Kuwaitis under the age of 20 accounted for the majority, about 45.2 percent, of the national population in 2016. On the other hand, the gender distribution in the case of Kuwaiti national population is modestly biased towards females (51%).

Regarding educational levels, illiteracy rate among population during the 10 years was confined to about 3 percent, while those who just read and write were 27 percent, holders of school certificates ranging from primary to secondary represented 45.4% of the population (see Figure 1-13).

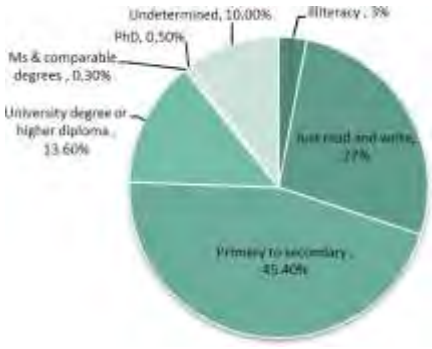

Figure 1-13: Educational profile.
(Source: Alghais and Pullar, 2016)

1.8. Urban Development

Since the first half of the twentieth century, Kuwait City has transformed itself from a small walled city to a metropolitan area experiencing rapid and unprecedented population growth with only a relatively small increase in the extent of its urban area. Most of the highly urbanized areas are located along the coast (see Figure 1-14). This has led to a number of lifestyle, economic and environmental challenges (Alghais and Pullar, 2016).

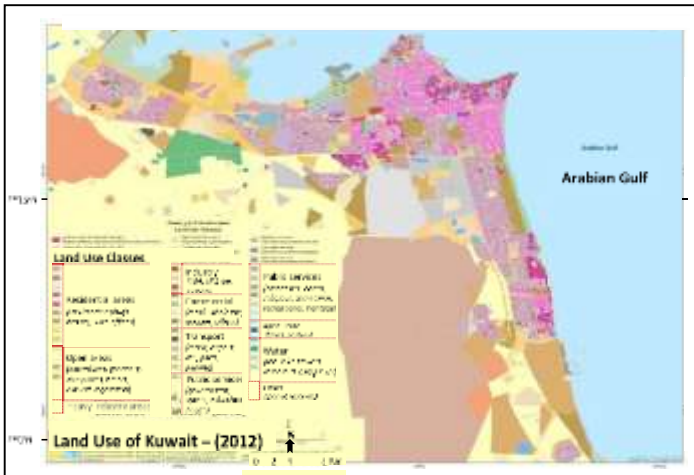

Figure 1-14 GIS map of land use in State of Kuwait.
(Source: e- Misk, KPA)

Future urban developments are planned for beyond the the periphery of existing urban centers. Two of the most prominent are briefly described in the bullets below.

- *Kuwait's Islands Project.* The initial phase of an ambitious project to transfer five of the Kuwaiti uninhabited islands (Boubyan, Failaka, Warba, Miskan and Ouha) into economically feasible areas was presented to His Highness the Amir who backed the initiative as part of the Kuwait future strategy and a corner stone of the vision to transform Kuwait into a regional and global trade and financial hub, while also boosting development of all other sectors of the economy. The project aims to support the country's development through various projects on these islands, which will turn them into free trade zones that link the East to the West. The Supreme Council of Planning is studying the benefits of adopting other international models to create a comprehensive and multi-purpose free trade zone in these islands to enhance Kuwait's regional and international competitiveness and attract foreign investment. Realization of the project will require new legislation, exceptional resolutions, and other governmental measures.
- *Madinat Al-Hareer (Silk City).* Madinat Al Hareer project (see Figure 1-15) was initially proposed by the Tamdeen Group, a private corporation before its approval by the government where it becomes part of the Kuwait future strategy. The project site is Al- Subiya in northern Kuwait and would cover about 250 km^2. The project is planned to be built in phases and be completed within 25 years at an estimated cost of US$ 132 billion.

The city will be connected to Kuwait City via the Jaber Causeway. It will accommodate at its center a one-kilometer high skyscraper tower (Burj Mubarak) that will be surrounded by mixed- use tall building. The proposed capability of the city housing is expected to reach 700,000 people. One of its four villages are the Ecological Village which will includes national parks and reservations for wild animals and rare planets as well as nature reserves for migrating birds from central Asia and Africa. The village will include a center for environmental studies and vast green spaces, as well as be surrounded by a green belt of gardens and vast green spaces. The Chinese government has shown interest in collaborating on the project along with others in the five Kuwaiti islands as part of the Chinese 'One Belt, One Road' initiative promoting economic prosperity of Eurasia countries.

Figure 1-15: Conceptual rendition of Silk City to be built at Subyia. (Source: Tamdeen Group)

1.9. Public Health

Due to a modern healthcare system, there has been a decrease in the incidence of communicable diseases and an increase in life expectancy over the recent past. Today, the burden of disease has shifted towards non-communicable diseases and injuries (see Figure 1-16). Trends are showing steady increases in the incidence of coronary heart disease, cancer and accidents and injuries (mainly road traffic accidents). In addition, the incidence of diabetes and obesity is on the rise. Various NGOs have begun to focus attention on these conditions.

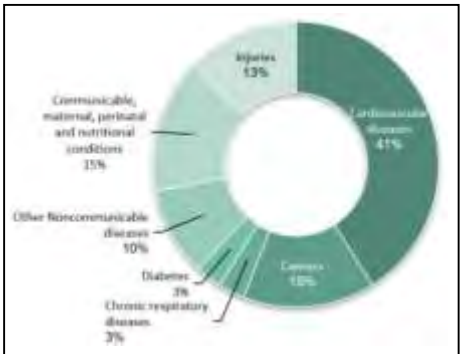

Figure 1-16: Premature mortality from Noncommunicable diseases, 2016. (Source: WHO Noncommunicable Diseases Kuwait Profile)

In recent decades, the number of motorized vehicles has grown significantly lead to increased air pollutant emissions (PM_{10}, CO, NO_x, O_3, SO_2 and VOCs) and poor urban air quality. Many studies have shown strong associations between particulate matter (PM) levels and a variety of adverse health outcomes, with PM levels are high enough in Kuwait to impose substantial health risks (Ward Brown et al., 2008).

1.10. Government structure

The State of Kuwait is a constitutional, hereditary emirate ruled by princes (Emirs) drawn from the Al-Sabah family. The Constitution of Kuwait, endorsed by the Constituent Council on 11 November 1962, has elements of a presidential and a parliamentary system of government. The country is administrated relative to six (6) governorates:Al- Kuwait (capital), Al-Jahra (largest), Al-Ahmadi (several major oil refineries), plus governorates located close to the capital: Al-Farwaniyah, Hawalli, and Mubarak Al-Kabeer.His Highness Sheikh Sabah Al-Ahmad Al-Jabir Al-Sabah is the Emir of Kuwait, head of state, and Commander-in-Chief of Kuwait's armed forces. The Emir, a member of al-Sabah dynasty that has been ruling since

approximately 1752, exercises his executive authority through the Prime Minister and the Council of Ministers. The Emir is constitutionally empowered to appoint the Prime Minister. Legislative power is vested in the Emir and the parliament which convenes in the National Assembly building (see Figure 1-17). Parliament consists of fifty members, who are chosen in direct elections that are held every four years. In accordance with the country's constitution, the fifteen cabinet ministers are also members of parliament. Kuwait's parliament is not only the oldest legislative assembly among in Gulf Cooperation Council (GCC) states but possesses the greatest political authority of any in the GCC. Since 2005, all Kuwaiti citizens, both male and female at least 21 years of age, are eligible to vote.

Figure 1-17: Kuwait National Assembly building.
(Source: KNA official website)

The Emir is empowered by the Constitution to dissolve the parliament and call for new elections, or in cases of national emergency can dismiss the parliament outright and/or suspend certain articles of the Constitution and assume supreme authority over the country. Either the Emir or the parliament can propose amendments to the constitution; a two-thirds majority of the members of the Assembly is required to adopt a change.

The nomination of a successor to the Emir is the prerogative of the ruling Al-Sabah family, and is subject to parliamentary approval under the Constitution. If the nominee does not win a majority of votes of the Assembly, the parliament must vote on and approve another candidate for the post.

The Constitution allows for the establishment of political parties. At the current time, a law has not yet been enacted to regulate them. As a result, no political parties are operational in Kuwait in a formal sense. Nevertheless, several members of parliament identify themselves and function as de facto political parties on the basis of religious sect/belief, social class or tribe.

Kuwait has an independent judiciary system. Civil laws are based on a combination of British common law, French civil law, and Islamic religious law, the latter having a considerable role in personal and family matters. In each of the country's six governorates there is a summary court. There is also a court of appeals; a Cassation Court, which is the highest level of judicial appeal; and a Constitutional Court.

1.11. Economy

Kuwait's economy is fairly small, comparatively rich, semi-open and highly dependent on oil exports. Petroleum accounts for the majority of gross domestic product (GDP), export revenues and government income. Crude oil & natural gas sector dominates the economy. On average, it represents nearly 50% of the country's real GDP.

Other sectors are not actually fully independent of the oil and gas sector as they are heavily dependent on oil and gas revenues. Social services, for example, are entirely funded by public oil revenues. The largest manufacturing industries are oil-based, and most other activities are heavily subsidized with oil income. Figure 1-18 (left) shows the percentage contribution of oil and non-oil sectors to real GDP (at constant prices of 2010) between 2006 and 2015. Figure 1-18 (right) shows the growth trend of these two sources of real GDP during the same period. Because of such a reliance on oil income, Kuwait's economy continues to be highly vulnerable to changes in global oil demand, as well as international oil market price volatility.

Over the period 2006–2015, nominal GDP per capita has shown a decline of 12.6% from nearly 30.7 thousand U.S. dollars in 2006 to nearly 26.7 thousand U.S. dollars in 2015. However, during the same period of time, real GDP per capita has shown a strong growth of 63.6% from 18.6 thousand U.S. dollars in 2006 to 30.2 thousand U.S. dollars in 2015 (see Figure 1-19, left). Over the same period of time, the GDP per capita using the purchasing power parity (PPP) basis has averaged 80.4 thousand U.S. dollars, which is one of the world highest levels. However, PPP-GDP per capita has declined by 6.4 percent. Figure 1-19 (right) shows the decline in GDP per capita at PPP basis over the period 2006 – 2015.

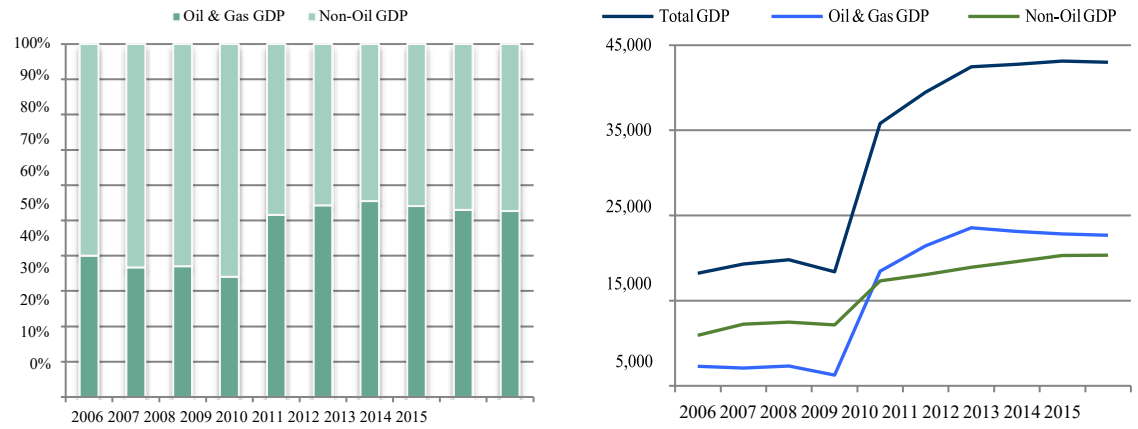

Figure 1-18: Shares of oil and gas sector and non-oil sectors of total real GDP, 2006–2015 (Left); Right: Trends in the contribution to total real GDP from oil and non-oil sectors, 2006 – 2015.
(Source A. Al-Mejren-2018)

In addition to the oil and gas sector, there are four other activities with large GDP shares. They include social services, financial services, transport and manufacturing. Together, these sectors account for about 90% of the non-oil sector's contribution to real GDP and 42% of the entire real GDP, with the remaining 5% of non-oil GDP accounted for by agriculture, utility, construction, and trade sectors. An overview of the major sectors is provided in the bullets below. Figure 1-20 presents their relative contribution to GDP in 2015.

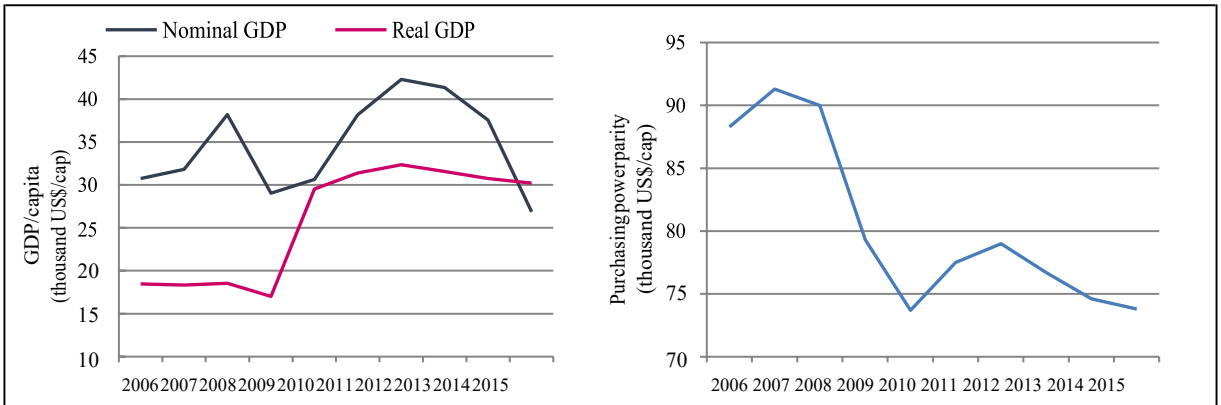

Figure 1-19: Nominal GDP per capita versus real GDP per capita, 2006 –2015 (Left); Right: GDP per capita at purchasing power parity, 2006 – 2015. (Source: A. Al-Mejren-2018)

- *Social services:* The contribution of this sector to real GDP is in the form of government expenditures on basic services (e.g., health care). The overall contribution to overall real GDP in 2015 was about 17%.
- *Financial services:* This sector, which includes banking, insurance, real estate and other financial and business services, plays a substantial role in the nation's economy where its contribution to real GDP was about 14%.
- *Transport:* This sector includes road and ports development, storage and communication services. Its contribution to real GDP in 2015 was about 6%.
- *Manufacturing:* This sector consists primarily of petrochemical industries, building materials, metal and steel production. Its overall contribution to real GDP was about 5%.

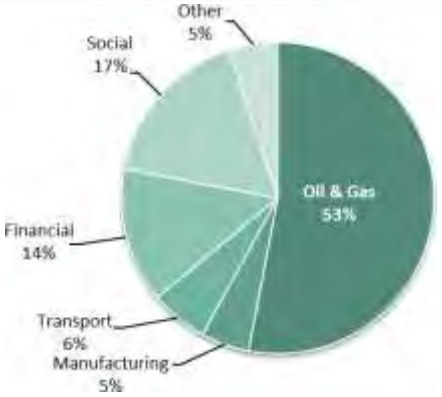

Figure 1-20: Sectoral contribution to Kuwait's real GDP, 2015.
(Source: Central Statistical Bureau, Kuwait)

1.12. Oil & gas

Kuwait is one of the world's leading oil producers. It has the world's fifth largest crude oil reserves and is one of the ten largest global exporters of crude oil and oil products. As result of Kuwait having a strong economy it had a per capita Gross Domestic Product (GDP) in 2015 of US$65,400.3 The country enjoys macroeconomic and financial stability and has a very solid financial position with accumulation of considerable public and external accounts surpluses.

Kuwait, a member of the Organization of Petroleum Exporting Countries (OPEC), has the world's fifth largest crude oil reserves and is one of the ten largest global exporters of crude oil and oil products. Kuwait Petroleum Corporation (KPC), the Ministry of Oil, and the Supreme Petroleum Council are the government institutions that are responsible for the petroleum sector in Kuwait. KPC is an umbrella establishment with multi subsidiaries including Kuwait Oil Company (KOC), which manages crude oil and natural gas production; Kuwait Gulf Oil Company, which manages offshore crude oil and natural

[3] Economist Intelligence Unit estimate (purchasing power parity).

gas operations in the Partitioned Neutral Zone between Kuwait and Saudi Arabia, the Petrochemical Industries, and Kuwait National Petroleum Company (KNPC), which operates the country's three oil refineries.

The Ministry of Oil estimates the country's proven oil reserves at 101.5 billion barrels, just over 7% of the world total. Additional reserves of about five billion barrels is held in the Partitioned Zone with Saudi Arabia. Much of Kuwait's reserves and production are concentrated in a few mature oil fields that were discovered in the early to middle decades of the past century. Figure 1-21 shows the distribution of Kuwait's oil fields.

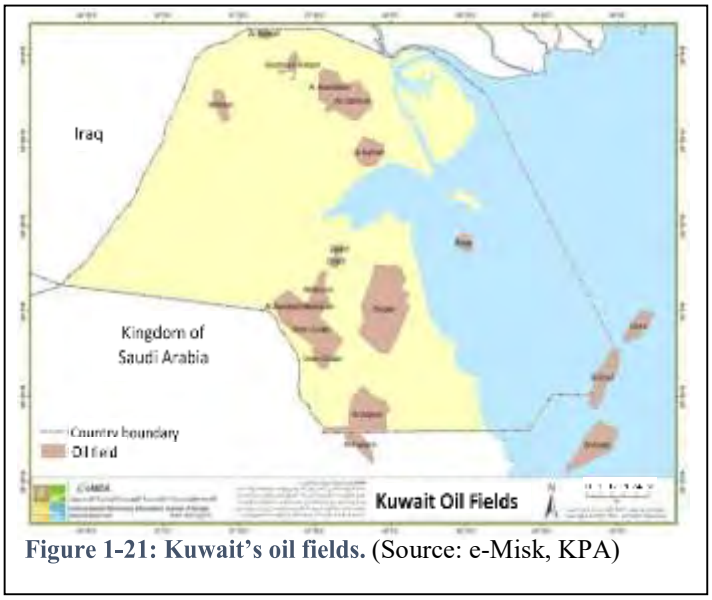

Figure 1-21: Kuwait's oil fields. (Source: e-Misk, KPA)

Gross crude oil production in Kuwait reached about 2.883 million barrels per day in 2016 while natural gas production exceeded 1,200 million cubic feet per day in that year (see Figure 1-22, left). In January 2018, KPC officials disclosed plans for the company to spend over $500 billion to boost its crude production capacity to 4.75 million barrels per day by 2040. Nearly $114 billion of this amount was allocated over the next five years. Kuwait's current crude oil production capacity is about 3.15 million barrels per day (bpd).

About one-sixth of Kuwait oil and gas production is consumed in the domestic market. According to estimates by KNPC, which produces and markets the refined products, half of the domestic consumption goes to power plants and seawater desalination units, while the rest is consumed mainly by the oil industry itself, followed by the transport sector. Only a small proportion is consumed by households. Figure 1-22 (right) shows the Kuwait's daily consumption of crude oil and oil Products in thousands of equivalent barrels of crude 1994 – 2016. The decline in oil consumption since 2009 was due, among other factors, to the shift toward the use of more natural gas in power stations and petrochemical industries. Finally, due to low natural gas production relative to consumption requirements, Kuwait has been a net importer of natural gas since 2009. In 2016, Kuwait's total imports of natural gas reached about 152.3 billion cubic feet, nearly 417 million cubic feet per day. (KNPC data).

1.13. Industry

In 2016, the industrial sector's contribution to GDP was 7.2% (current prices) and 5.7% (constant prices). Since 1994, nearly all manufacturing industries demonstrated some improvement in term of their contribution to the GDP (see Figure 1-23). Chemicals and chemical products exhibit an almost two-fold increase in the GDP through the years 2000-2016.

This alone gives chemical industries a special significance. Although growing, recycling has the lowest GDP contribution compared to other manufacturing activities.

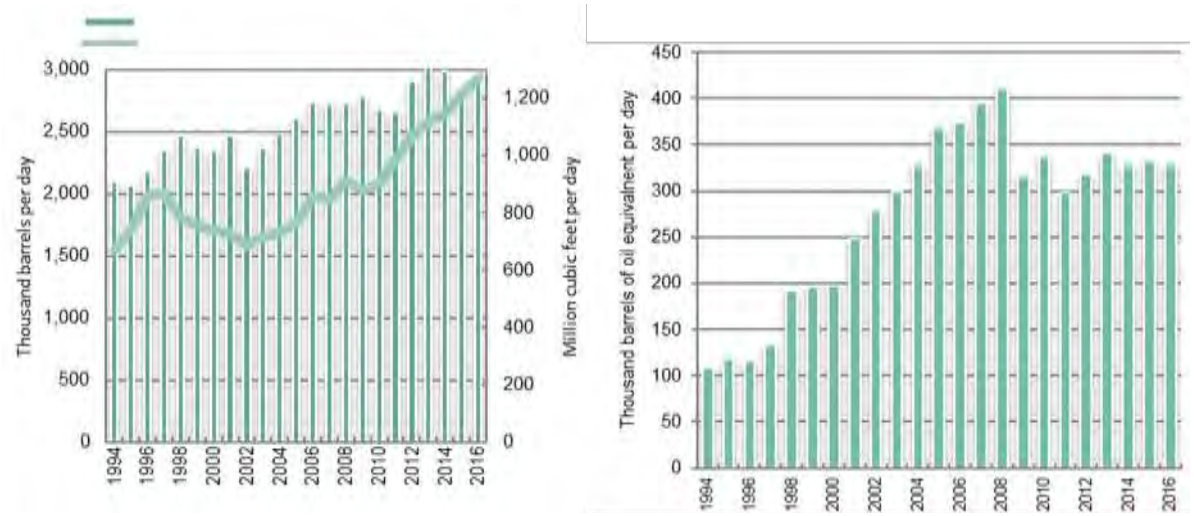

Figure 1-22: Kuwait's daily crude oil and dry natural gas production, 1994-2018 (Left).
(Source: Kuwait Petroleum Corporation);
Right: Kuwait's daily crude oil and oil by product consumption, 1994-2018.(Source: Organization of Arab Petroleum Exporting Countries (OAPEC) Data Base)

1.14. Agriculture, Livestock, Fisheries, and green areas

An arid climate and poor soils mean that Kuwait's arable area is limited. The Public Authority for Agriculture Affairs and Fish Resources (PAAF) records only 18,900 ha as being cropped, although crops provide 56% of the gross value of agricultural production in Kuwait (CBS data). In real terms, the agriculture sector's contribution to GDP is very small, 0.53% in 2016 (World Bank development indicators).

Farming systems are composed of small- and intermediate holders as well as specialized agribusinesses focused on growing date palms, greenhouses, open field vegetables, livestock production, and dairy/poultry production. Farms differ in size, productivity, profitability and marketing potential. Cropping systems are based on pure stand cultivation; monoculture and irrigation techniques vary from basin, furrow to micro-irrigation. Concerns related to yield limitation exist and are mainly caused by pests and poor crop management and systems optimization practices.

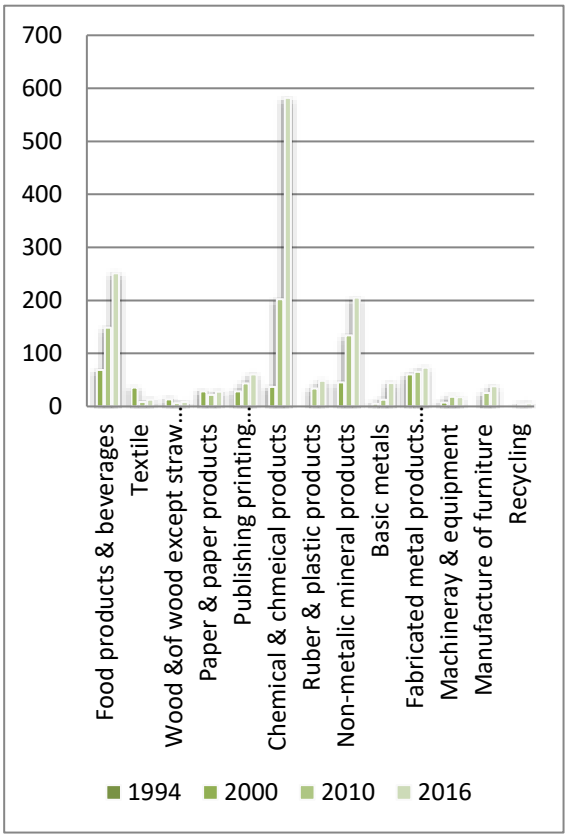

Figure 1-23: Contribution of manufacturing activities to GDP in million KD, 2016.
(Source: Central Statistical Bureau)

Livestock and animal production provide about 38% gross value of agricultural production in Kuwait (CBS data). Livestock production under Kuwait's harsh climatic conditions and shortage of good

quality fresh water at reasonable cost makes fodder production and livestock production in Kuwait difficult. All local livestock production is subsidized, particularly the dairy industry, and depends heavily on most animal feed being imported, which means higher costs of production, requiring subsidies for most local livestock products to compete pricewise with imported products. Grazing is widespread, with sheep, goats and camels the main livestock involved (see Table 1-1).

Table 1–1: Livestock population characteristics, 2013-2014 (Source: Kuwait Central Statistical Bureau, Annual Agricultural Statistics)

Livestock type	Total head (2013-2014)	Percent change over 2009-2010 levels
Sheep	628,041	+ 41%
Goats	153,391	+ 1%
Camels	9,192	+ 11%

The Public Authority for Agricultural Affairs and Fish Resources (PAAF), was established in 1983 to manage all type of activities in the agriculture sector and to formulate policies for developing plant, animal, and fishery resources, including land allocation. In order to support local agricultural production PAAF heavily subsidizes selected agricultural activities. Table 1-2 summarizes the various agricultural subsidies provided by the government during the fiscal year of 2015/2016. A portion of the subsidies is directed towards the expansion of protected agriculture production in greenhouses, encouraging water saving irrigation technology, and the utilizing treated wastewater in irrigation.

Table 1–2: Breakdown of agricultural subsidies, 2015-2016 (Source: Public Authority for Agricultural Affairs and Fish Resources)

Subsidy	Value of Subsidy (million US$)	Subsidy share (%)
Subsidy for plant productions	8.2	27%
Subsidy for fodders	15.7	51%
Subsidy for fisheries	0.5	2%
Subsidy for milk and cows	3.9	12%
Subsidy for palm trees	1.8	6%
Other Subsidies	0.5	2%
Total	30.6	100%

Over the years, Kuwait's food production has been growing substantially. Figure 1-24 reflects the growth of the value of such production for three years (1990, 2000 & 2014) using the index number of each type of food production (excluding cereals because of the sharp increase in its 2014's value). Kuwait's crops, which are mostly grown in greenhouses in Wafra, Abdally, Jahraa and Sulaibiya, include tomatoes, cucumber, pepper, okra, green beans, marrow, eggplant, strawberry, onion, mallow, coriander, peppermint, melon, parsley, cabbage, lettuce, snake cucumber, dill, cauliflower, purslane, watermelon and red radish. Roots and tubers include Potatoes, Radishes and Root Beets; while vegetables are varied including onions, and green leafy vegetables. Total value of crops products has increased threefold from 2006/2007 to 2016/2017.

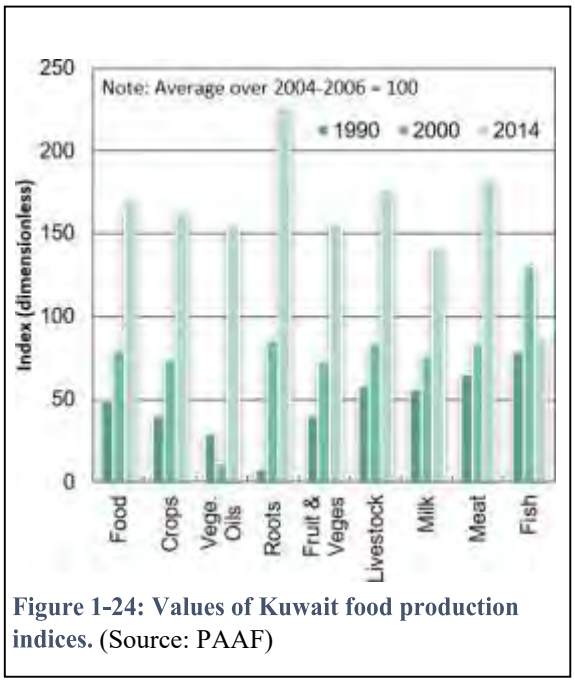

Figure 1-24: Values of Kuwait food production indices. (Source: PAAF)

The country's key policy objective in agriculture is to provide for some of the local needs. To enhance the locally available food, 500 plots of land (see Figure 1- 25), each with 50,000 square meters, were allocated by PAAF in Al-Abdali, the northeastern town, to support meat and poultry production in particular.

A sub-project of 200 integrated farms was also launched aiming to increase plants, crop production and to support other agricultural activities such as sheep farming, fish farming, poultry and other activities. However, 50 larger plots, each with 170,000 square meters for raising cattle and milk production are being removed as the current location obstructs a proposed railway route.

Figure 1-25: Agriculture areas in Kuwait.
(Source: e-Misk)

Since the 1990s overfishing and environment degradation caused 50% decline in the total local fisheries product (Al-Husaini *et al*., 2015). Fish products are actually the most important renewable food resource (fin-fishes and shrimps) with an annual production about 4,500 tonnes, representing only 16% of total demand. Most of the commercial important species are zobaidy (*Pampus argenteus*), harmoor (*Epinephelus coioides*), suboor (*Tenualosa ilisha*) and newaiby (*Otolithes ruber*). Total imported fish products including both fresh and frozen reached 23,285 tonnes in 2012.

Aquaculture practices have been growing in response to the emergence of protected coastal and marine areas. The reduced access to fishing has been partly offset by fish farming projects. These projects provide fish and shrimp to local market throughout the year at reasonable prices. Among these projects is a 10 km^2 pilot project of floating fish culture in the Al-Khiran area, with an expected productivity of nearly 2,000 to 3,000 tonnes of fish annually. The proposed Boubyan Island project has an expected yield of 3,000 tonnes of fish, 3000 tonnes of shrimp, and 60 tons of marine algae. Other proposed projects include the cultivation of wild fish in Al-Sulaibia, Al-Wafra and Al-Sabia, utilizing treated wastewater for fish farming. The proposed 8 km^2 Al-Sabia shrimp farm project will include 300 breeding ponds and two water pumping stations with an expected production capacity of 2,000 tonnes of shrimp annually. In addition, there is a shrimp reproduction plant with an annual capacity of six million shrimp larvae.

Aquaculture is relatively new and potential source of fish production in Kuwait. It is currently being expanded to supplement local depleted landings from capture fisheries. Two types of aquaculture systems are practiced in Kuwait: (i) culture of Nile tilapia (*Oreochromis niloticus*) in concrete tanks using brackish water in agricultural farms, and (ii) culture of marine species such as gilthead bream (*Sparus auratus*), European sea bass (*Dicentrarchus labrux*) and sobaity sea bream (*Sparidentex hasta*) in cages located in the Kuwait Bay. Two key events – the mass fish kills in 2001 in the Kuwait Bay and the Iraq war in 2003 – crippled production. Most of the cages were destroyed as nobody was allowed to go near the cages due to security reasons during the war.

As for green areas, PAAF is active in establishing parks and gardens as well as projects of planting trees and greenery on the sides of roads and in public squares. In this regard, there are 134 public parks, and 635 projects of side road planting extended to nearly 1,700 km long. The landscaping areas cover about 1.2 million square meters. The projects are divided into 12 sites with an area of 34 thousand acres, in addition to a number of parks such as Al-Salmiya Bolivar, Al-Wafra and Al-Abdali.

1.15. Food Security

Throughout its modern history, Kuwait has heavily relied on food imports since only a negligible fraction of food demand can be met by local agriculture. Kuwait produces roughly 1% of its crops from its arable land, using traditional agriculture practices (Analysis of Hydroponic Agriculture in Kuwait - Market trend, Growth and Opportunities (2015-2020), December 2017, Mordor intelligence). Almost all of its fruits and vegetable produce come from hydroponic or horticulture practices (see Figure 1-26).

Kuwait has always faced a unique set of food security challenges due to its climate, limited arable land and water scarcity. Full food self-sufficiency, meaning the country producing all its food requirements, is understood to be an impractical and unachievable goal with an expectation of continued reliance international food trade markets. The Council of Ministers established a Ministerial Committee to supervise the development of a Food Security Investment Strategy for Kuwait. The overwhelming conclusion of the evaluation was that Kuwait currently enjoys a high level of food security.

Figure 1-26: Hydroponics farming in Kuwait.
(Source: Kuwait News Agency website)

Food is readily available and accessible to all residents and Kuwait ranks internationally as one of the most food secure countries thanks to its economic circumstances and government policy.

Kuwait is resource rich, has a large international wealth reserve, easy access to the global food markets, a generous government food subsidy program and significant strategic reserves of basic food commodities. Nevertheless, opportunities have been identified for improving efficiency through the use of incentives and reforms, including the reforms to the system of subsidies, reduction in food waste and encouraging greater efficiency through competition within the supply chain.

1.16. Energy

Regarding natural gas, Kuwait had an estimated 1.8 trillion cubic meters of proven natural gas reserves as of 2015. Kuwait's reserves are not considered significant relative to global reserves and this has spurred an extensive drive in natural gas exploration. The utilization of the discovery of large non-associated gas reserves, which was discovered in the northern area of the country had been delayed by parliamentary opposition since 2006. However, in September 2016, Kuwait awarded contracts to international companies to enable the start-up of production of gas from these reserves by 2018. Yet, the $3.6 billion second phase plan of the project is on hold after tenders were unexpectedly cancelled in late 2017.

Total daily average production of associated and non-associated natural gas increased during 2016 to 1,737 million standard cubic feet per day (MMSCFD) against a target of 1,530 MMSCFD, i.e. higher by about 14%. In addition, average production of dry (non-associated) gas reached 1272 million cubic feet per day, i.e. nearly 464.4 billion cubic feet in 2016. In addition, average gas exported to the LPG unit in KNPC amounted to 1625 million standard cubic feet per day

(MMSCFD), exceeding the target of 1465 MMSCFD. On the other hand, KOC has succeeded in reducing gas flaring to 1%, and strive to achieve less than 1% in line with its strategy. However, despite its efforts, repeated closure of KNPC Acid Gas Removal Plant had pushed KOC's gas flaring rate to 1.31%, higher than the tolerance level of 1.15%.

Regarding electricity, given Kuwait's harsh climate, high population growth rate, and rapid socio- economic growth, demand for electricity is steadily increasing to keep pace, particularly during the hot summer periods. For Kuwait, coping with such multidimensional growth in electricity demand has proved to be a major challenge with repeated power outages experienced in 7 residential areas during the hottest month of July 2016 when temperatures exceeded 50°C.

Total installed electric capacity in 2016 was about 18,850 megawatts (MW). Small (18-42 MW) and medium (100-200 MW) gas turbines account for about 40% of total installed capacity and are usually used in emergencies or during the time of peak load. Due to the high operational costs and low thermal efficiency of gas turbines, they are usually kept as standby with a high level of availability.

The remaining electric capacity consists of steam turbines ranging in size from 120 to 300 MW and combined cycle units (185-280 MW). Natural gas, heavy fuel oil, crude oil and gas oil, are all used as primary fuels for electric generation depending on boiler design, with priority given to natural gas relative to its availability. Figure 1-27 presents the development of total power installed capacity in MW between 1994 and 2016.

Over the period from 2000 to 2015, electricity generation has been increasing by 5.1% on average per year. (Ali and Alsabbagh, 2018). The Ministry of Electricity and Water (MEW) is solely responsible for generation, transmission and distribution of power and water in Kuwait. Although the country has been slow to reform such avital sector, progress is taking place as the government looks to attract foreign investors. Three major Public-Private Partnership projects are expected to be launched soon: the 2.7 GW Al-Zour North Second and third Project, the three phases of 5.4 GW Al- Khiran Project and the 3.6 GW Al- Nwaiseeb Project. Within the vision of New Kuwait, Kuwait started a three- phase process, with the goal of generating a total of 3,070 MW of renewable energy (15% of the country total annual consumption) by 2030. The first phase is comprised of 70 MW energy park built on a 100-square- kilometre area in Al-Shigaya, a desert zone about 100 km west of Kuwait City.

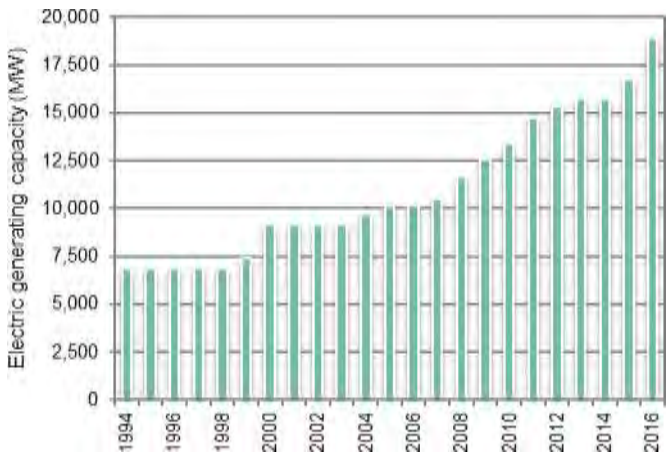

Figure 1-27: Total installed electric capacity, 1994-2016. (Source: Ministry of Electricity and Water, Statistical Yearbook 2017: Electrical Energy)

The second and third phases are projected each to produce 1,500 MW individually. The country determination to increase investments in the renewable sources of energy, mainly solar and wind has intensified after its decision to abandon its plan to construct a nuclear plant.

Kuwait ranks fifth in the world in terms of per capita electricity consumption. Between 1971 and 2014, Kuwait's per capita electricity consumption has been growing by an average annual rate of

3.8% (from 3,011.95 kWh in 1971 to 15,213 kWh/cap/year in 2014). The residential sector accounts for 64% of the country's total electricity consumption, a much higher share the OECD countries (31%) . While the country's harsh weather is a key factor behind this level of demand, the highly subsidized energy tariffs is believed to be the biggest driver behind such extraordinary electricity consumption in Kuwait. The cost of electricity is subsidized by more than 90%. Electricity cost of production is about $0.130 per KWh but is priced to consumers about $0.007 per KWh. (https://oxfordbusinessgroup: Rising Cost Growing Demand has Prompted Drive Boost Generating Capacity and Explore Alternatives).

Table 1–3: Municipal solid waste generation, 2016 (Source: KM)

Landfill	Area size (km^2)	Solid waste (thousand tonnes)
Mina Abdullah	2.42	478.3
South of 7th ring road	5.35	1,381.8
Al-Jahra	1,67	465.
Total	9.44	2,325.2

Over the past decade, Kuwait has adopted policies aimed at reducing per capita electricity consumption and has organized several public awareness campaigns to specify the urgency of energy conservation. Policies attempt to reduce electricity consumption in the building sector in general in Kuwait. These policies include the update of the Energy Conservation Program in 2014, the use of renewable energy to generate electricity and the setting of renewable energy penetration targets. Within the government energy reform initiative of 2016, electricity and water rates have been revised and adjusted to encourage consumers to rationalize consumption. The new tariffs became effective on 22 November 2017.

1.17. Waste

Despite the small geographical area of the country and the relatively small population, Kuwait has one of the highest per capita rates of municipal solid waste (MSW) generation in the world, 1.32kg/capita/day. Kuwait produces more than 1.9 million tons of municipal solid waste annually. Figure 1- 28 summarizes the typical composition of MSW, with the largest share being organic food wastes at 45%. Paper and plastics, prime candidates for recycling and reuse, together make up 40% of total solid waste generation.

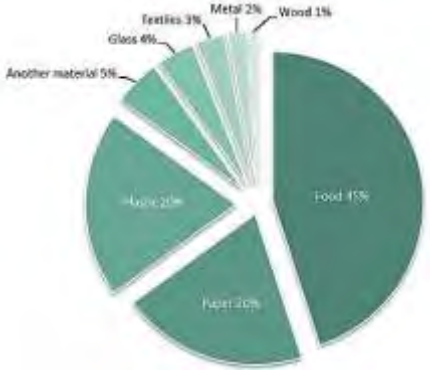

Figure 1-28: Weighted averages of all waste composition.
(Source: KM, Fichtner ; 2013)

Until recently, the dominant MSW disposal method has been landfills. In contrast to its limited area, Kuwait used to have a relatively large number of landfills sites (14 in total), of which 11 have been closed prior to achieving their capacity, because of improper disposal methods and concerns related to public health and environment. Such dumpsites generate huge amount of toxic gases (methane, carbon dioxide etc.) and are plagued by spontaneous fires. Characteristics of the three remaining landfills - Mina Abdullah, Al-Jahra and South of 7th Ring Road - are summarized in Table 1-3. The total area of these landfills is estimated at 9.44 km^2.

The management of domestic wastewater is the responsibility of the Ministry of Public Works. In 1965, the first sewer system was established in Kuwait, and the first domestic wastewater treatment plant was commissioned in the 1970, with a capacity of 100,000 m^3/day. By 1994, there were 3 established domestic wastewater treatment plants; and to meet the further increase in the rate of water consumption per person (275 liter/day) more domestic wastewater treatment plants were built, which make the number reach on total of 7 treatment plants. Table 1-4 lists the domestic wastewater treatment plants, along with the treatment type, design values and daily inflow.

There are 7 industrial areas, as presented in Figure 1-29, where the majority of industrial units are located. In the past, most of these industrial areas were not connected to the sewer system, resulting in the industrial wastewater effluents discharged directly to the environment without treatment.

Table 1–4: Domestic wastewater treatment plant characteristics (Source:MPW)

Treatment plant	Treatment type	Design inflow (thousand m^3/day)
Sulibiyah (Al-Ardeiah)	Reverse Osmosis	425
Kabd (Al-Jahra)	Tertiary treatment	180
Al-Reqah	Tertiary treatment	180
Um-Alhaiman	Tertiary treatment	27
Wafrah (not working)	Tertiary treatment	4,500
Subah Al-Ahmad Marine city	Tertiary treatment	5,000
Khiran City (not functional yet)	Tertiary treatment	1,500

In 2010, an industrial wastewater treatment plant was established in Al-Wafra area with a capacity of 8,500 cubic meters per day, with the possibility of increasing the capacity to about 15 thousand cubic meters per day. With the passing of Environment Law No. 42 in 2014, as amended by Law No. 99 in 2015; Article 35 committed all government agencies and the private sector to treat industrial wastewaters produced by their facilities. Accordingly, the Central Station was designated to receive the industrial treated wastewater from the different sectors.

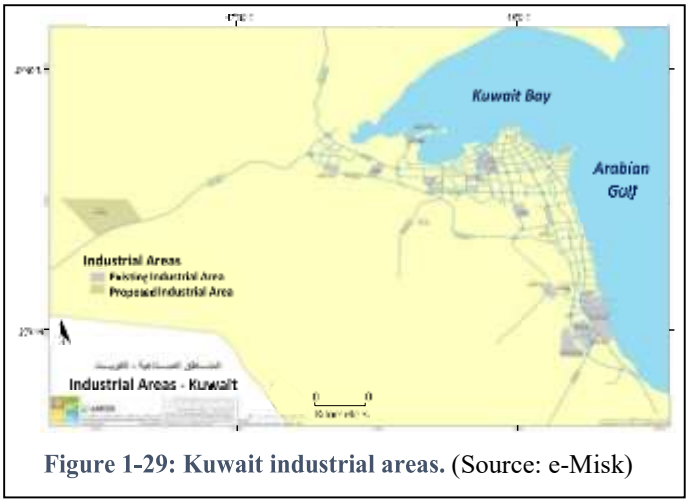

Figure 1-29: Kuwait industrial areas. (Source: e-Misk)

The Ministry of Health is responsible for the disposal of medical wastes, the treatment of such wastes through sterilization by autoclave and final backfilling in the Kuwait Municipality landfill sites. Most medical wastes are sent to incinerators. Currently, the Ministry of Health manages three incinerators as listed in the Table 1-5.

1.18. Transport

Kuwait has an extensive, modern and well-maintained network of road infrastructure. In addition, Kuwait's most recent Midrange Development Plan includes several ambitious projects that expand and upgrade the country's major highways and other means of transport. In fact, the development of transport infrastructure in general is an essential part of the "New Kuwait" vision. Various transport key projects are in progress including the expansion of

Table 1–5: Incinerators of Kuwaiti Ministry of Health (Source:MOH)

Incinerator name	Online year	Capacity (kg/hour)
Shuaiba-1	2002	500
Kabd-1	2009	500
Shuaiba-2	2014	500

airport facilities, a railway, a metro, bridges and seaports. In light of the ongoing technological advancement in the telecommunications industry which has become a basic part of all contemporary infrastructure, Kuwait also recognizes that the term "infrastructure" goes beyond the traditional concept of land, sea and air transportation.

To achieve a "sophisticated modern transport and communication infrastructure", the government is striving to realize five targets: (1) increasing the capacity of Kuwait's International Airport; (2) addressing the domestic traffic problem; (3) developing new economic and urban center at the Northern part of the country, (4) maximizing the capacity of ports to support the transition of Kuwait to a financial and commercial hub; and (5) modernizing the technologies of the telecommunications sector and keeping abreast of the continuous advancement in this field.

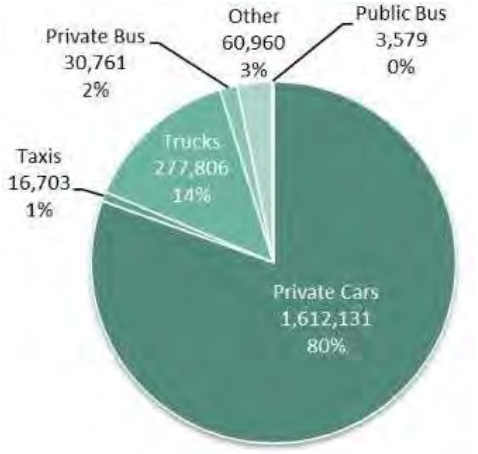

Figure 1-30: Vehicle stock profile, 2016.
(Source: CSB, the annual statistical abstract 2015/2016)

Kuwait has an extensive, modern and well-maintained network of road infrastructure. By 2016, the total length of paved roads exceeded 7,100 km. Yet, despite such great expansion in road capacity, the pace of increase in the number of vehicles in Kuwait outperforms such expansion. In the same year, the number of vehicles number had exceeded 2 million, of which 80% were private. The rest consists of public and private trucks, buses and taxis. (Figure 1-30) presents the distribution of vehicles by type in Kuwait in 2016.

The second pillar of the Mid-Range Plan which deals with the domestic traffic problem includes the development of new roads and ports that link the Northern part of Kuwait with neighboring countries, limiting traffic congestion and involving the private sector in the construction of the needed infrastructure. This program includes the 37-km long Sheikh Jaber Al-Ahmad Sea-Bridge terminals (Figure 1-31), which seeks the efficiency of the transport network reduce the traffic congestion and shorten the distance between Kuwait City and Sabiya at the Northern part of Kuwait Bay. The Bridge which entered its pre-final completion phase includes the construction of two artificial islands containing buildings for traffic and emergency services, the authority which monitors the maintains the bridge, a fuel station and a marina, as well as a main navigation bridge with a height of 23 meters and an opening of 120 meters for the passage of ships.

Figure 1-31: Sheikh Jaber Al-Ahmad cross-sea bridge.
(Source: e-Misk)

In addition, the 570 km long railway network project, which aims to increase trade volume and to facilitate the movement of passengers among GCC countries, will have a positive impact on the domestic traffic by reducing the need for road transport and reducing pollution resulting from the use of vehicles and trucks.

The project also aims to encourage the private sector to participate in the construction and development of the national projects and to benefit from its practical experience, which has a positive impact on the local economy, especially through the transfer of technology and knowledge, thus enhancing the efficiency of employees and raising the level of services provided as well as creating more career opportunities.

The Metro Transport Systems Project (Metro Kuwait) aims to link local suburbs and commercial centers, with a view of reducing the use of private means of transport and thus reducing traffic congestion, number of car accidents, passenger casualties, and air pollution resulting from car exhausts; and creating more than 1,500 job opportunities.

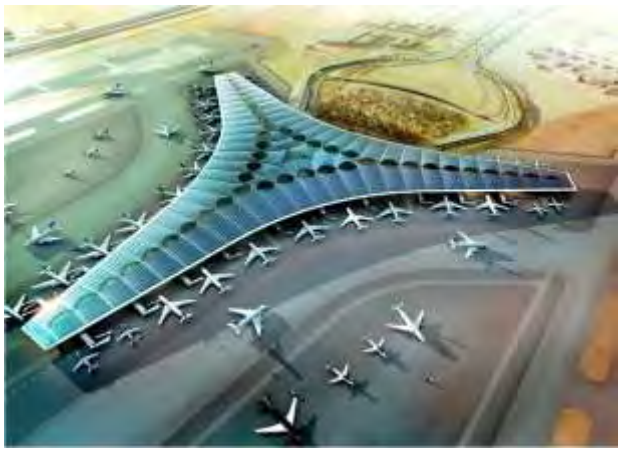

Figure 1-32: Kuwait international airport new terminal
(Source: Ministry of Public Works website)

Air Transport. The development of air transport system includes the increase of the capacity of the country's international airport to 25 million passengers through the construction of new passengers' facilities using the highest world specifications, adding new terminals (Figure 1-32), increasing the efficiency and the capacity of the runway to enable it to receive modern aircraft and the Airbus A380, adapting the world latest technologies of air navigation and the latest international standards, and adding a new air control tower serving the third runway and the middle corridor.

Maritime Transport. There are further plans to develop the maritime transport system to maximize the capacity of the ports to enable it to support the transformation of Kuwait into a regional financial and commercial hub. At the top of the maritime transport program is the project of Mubarak Al-Kabeer Port, which seeks to increase trade exchange activities, boost the volume of regional trade, increase the volume of investments, increase economic resources, raise economic growth rates, develop the services provided by sea ports, increase their absorptive capacity and contribute to the reconstruction and development of the new northern urban area. Mubarak Al-Kabeer port will have a capacity of 24 berths, an ability of receiving outsized ships and a capability to handle nearly eight million containers. The project will help in the creation of an industrial zone and providing thousands of new job opportunities.

The development of Shuwaikh seaport (see Figure 1-33) is an essential part of the program. It aims to increase the efficiency of the navigation channel in the port to accommodate larger number of up-to- date container vessels with deeper depths, in addition to the enhancement of safety factor.

Figure 1-33: Shuwaikh seaport.
(Source: Kuwait Ports Authority website)

1.19. Impact of Response Measures

In the implementation of the commitments of the United Nations Framework Convention on Climate Change (UNFCCC), the signed international parties have agreed to consider the specific needs and concerns of developing countries arising from the impact of the execution of response measures taken by these international parties in combating the climate change. Therefore, parties of the convention, when addressing climate change concerns, shall strive to minimize adverse economic, social and environmental impacts on other parties, especially developing countries and parties with special circumstances, and to ensure that their development programs are not affected by the response measures. This special treatment has been endorsed to the concerned developing countries in the Paris Agreement (UNFCC, 2015). In fact, Kuwait is among the designated group of developing countries to be affected by the adverse impacts of these measures. Kuwait also suffering from a wide range of climate change consequences including a rapid increase in temperature, desertification, rising sea level, and loss of biodiversity. Some of the response measures relevant to Kuwait's oil and energy sector that are in the process of exploration or actual implementation are outlined below.

Carbon Taxes

Kuwait economy relies heavily on its oil exports, which virtually represent the only source of government income, and contribute to more than half of the country's GDP. Since the linkages between climate change and greenhouse gas emissions was established in the 1980s, crude oil and its derivatives, as key sources of emissions became under tough pressures from environmental concerned policies and procedures in many developed countries. The idea of carbon taxes has been embraced by these countries. Such taxes would eventually reduce oil consumption and encourage the use of clean renewable resources, a trend that would ultimately reduce the income of oil-exporting countries, including Kuwait.

New Sources of Energy

Additionally, the world has witnessed a shift in the nature and pattern of its dependence on oil products since the unprecedented rise in oil prices in the first half of the 1970s, where it becomes less dependent on oil in power generation which has shifted toward the use of alternative fuel such as nuclear, natural gas and renewable sources. With this shift, most of the world oil consumption goes now to the transport sector. However, this sector is also threatened by the shift from the use of oil-based fuels to other substitutes, especially with the recent development of hybrid and electric cars. Many advanced countries support the spread of such alternative means of transport which would eventually leads to lower demand on oil.

Investment in Clean Fuels

In response to tightening environmental standards on oil products by developed countries, Kuwait has been quick to invest in the production of environmentally friendly oil products through the largest project in Kuwait's history - the Clean Fuel Project (15.5 billion U.S. dollar) which includes the modernization of Mina Al-Ahmadi and Mina Abdullah refineries. Kuwait also retired its Shuaiba refinery and decided to replace it with Al-Zour refinery, which is specialized in producing fuel that is compatible with emerging environmental standards in developed countries.

Investment in Other Clean Products

Kuwait has also committed itself to upgrade its petrochemical products by updating the specifications of these products in order to ensure that they meet the newly required specifications in advanced markets. Likewise, the Ministry of Commerce and Industry has committed the local manufacturing sectors to comply with the new international standards in the production of their products.

Fuel switching and demand side efficiency

In order to reduce harmful emissions caused by the fuel mix in electricity production in Kuwait, the Ministry of Electricity and Water has shifted most of its power generation plants from the use of oil to natural gas. Kuwait has also launched several programs to use renewable energy sources, especially solar energy. Through intensive media campaigns, Kuwait is encouraging consumers to rationalize consumption of electricity, water and fuel. Besides, since 2016, the country has moved towards changing the energy pricing structure.

Investment in Indoor Activities

Climate change forces countries with harsh weather, such as Kuwait, to invest heavily in sheltered buildings for indoor activities. Examples of such buildings include covered sport areas, gymnasium halls, schools, public facilities and markets. In addition to the high construction costs, these buildings also require high operating costs, efficient air-conditioning systems and greater consumption of electricity and fuel.

Promotion of occupational safety

Rising temperatures, in the relatively long summer period of Kuwait, that approach or exceed 50 degrees Celsius in many days of July and August. Kuwait has taken steps to stop outdoor labor activities under such conditions in an effort to ensure the health and safety of its labor worker. Such disruption of work increases the cost of production and delays the completion of projects.

New Development Projects

In compliance with world effort towards lower greenhouse gas emissions, Kuwait has been adhering to environmentally friendly standards in its various new development projects, such as Sheikh Jaber Causeway project, the new urbanization projects, the new power plants project, etc. In addition to such impact of response measures on Kuwait's oil and energy sector, the economy of Kuwait might be affected by response measures on area like: Consumer goods subject to eco-labelling and standards; Energy-intensive trade-exposed goods (such as aluminum, iron and steel, cement, chemicals, and pulp and paper); Air-freighted goods; Tourism; Marine-transported goods; and Agriculture.

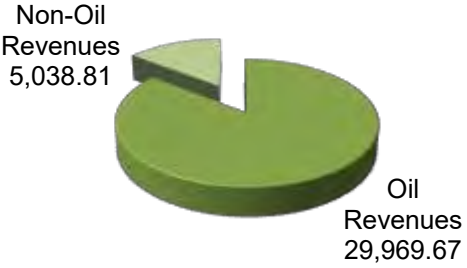

Figure 1-34 Gross domestic product by economic activity (b) for the years 2012-2013 (Million KD).

Source: Central Statistical Bureau, National Accounts Statistics of 2016.

Kuwait also might be influenced by decision and measures taken several relevant international organizations as: The World Trade Organization (WTO); International originations for standardizations (ISO); International Civil Aviation Organization (ICAO); International Maritime Organization (IMO); and the General Agreement on Tariffs and Trade (GATT).

Diversification of Economy

Kuwait has a relatively open economy dominated by the oil industry and government sector. It is one of strongest economies in the GCC with per capita GDP of around US$85,659.55 (IMF, 2012). The country enjoys macroeconomic and financial stability and has very solid financial position with accumulation of considerable public and external accounts surpluses. The latest published National Accounts Statistics of 2011 indicated that oil and gas sectors were still the dominant natural resource form shaping the economic activities in Kuwait, composing 57% of the general output, whereas fisheries, agriculture and livestock collectively compromised only 1%.

1.20. Implementation arrangements

The preparation of the Second National Communication (SNC) was participatory in nature and has in its core objective the establishment of foundational national capacities to prepare subsequent NCs and other reporting obligations such as the BUR. The national team was selected primarily from relevant ministries and institutions and with the senior management of the Climate Change section from KEPA for coordinating the team, some of those experts were members of the negotiating team who's familiar of climate change and the convention obligations.

The Kuwait Environment Public Authority (KEPA) is the focal point of the United Nation Framework Convention of Climate Change UNFCCC. The Climate Change Section is a unit of Air Quality Monitoring Department and is the implementing entity of the UNFCCC in the State of Kuwait. The two major responsibilities of the Climate Change Section are as follows:

- Leading the negotiating team, which includes the all the state agencies and other stakeholders concerned with climate change; and
- Managing the reporting system such as Nationally Determined Contributions (NDC's), National Communications (NC's) & Biennial Update Reports (BUR's).

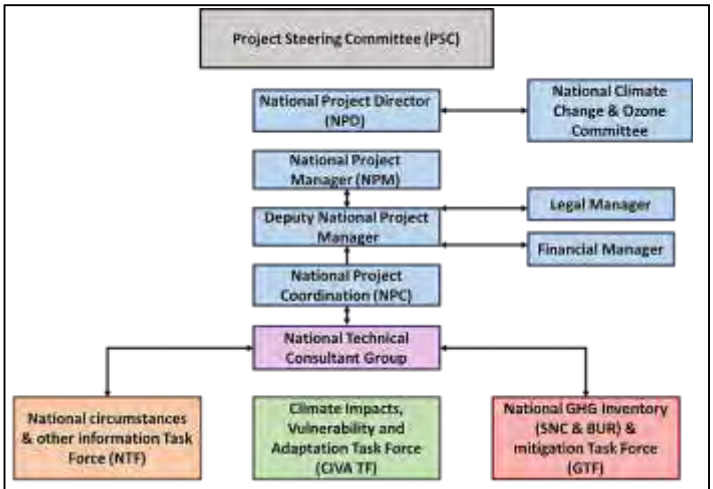

Figure 1-35: Organizations structure for the development of the SNC.

The knowledge developed during the preparing Kuwait's Initial National Communication (INC) was utilized to build up the organizational and technical structure of the SNC & biennial updated reports (BUR). The capacity was built up by engaging and training key stakeholders, namely KEPA technical staff, public sector staff, and civil society stakeholders. Key organizations participating in the development of the SNC are indicated throughout the Acknowledgements section.

A Project Steering Committee (PSC) oversaw the overall coordination and implementation of the SNC, while the National Climate Change & Ozone Committee provided overall policy and cross-sectoral guidance. The KEPA executed project activities at the national level and appointed a National Project Coordination (NPC) who worked under the supervision of a National Project Director (NPD). A small project management support team was established at KEPA to facilitate implementation and reporting. Three Task Forces (TF) were established as follows:

- *National circumstances & other information Task Force (NTF).* This task force developed SNC contents regarding national circumstances, technology needs assessments, research and systematic observation, and capacity building and institutional framework sector.

- *National GHG Inventory (SNC & BUR) & mitigation Task Force (GTF).* This task force developed SNC contents regarding emissions associated with all sectors of the Kuwaiti economy (i.e., oil and gas, energy, transport, waste sector, industry, and agriculture sector. This task force also addressed domestic measurement, reporting and verification (MRV).
- *Climate Impacts, Vulnerability and Adaptation Task Force (CIVA TF*). This task force developed SNC contents regarding vulnerability of sectors and systems in Kuwait, namely, water resources, public health, coastal zones, and marine ecosystems. This task force also focused on climate, dust storms, and Arabian Gulf waters.

Memberships of the various TFs from government institutions and stakeholders were established based on the technical dictates and expertise requirements of the scopes of work. Each Task Force Head submitted a report to the NPC, which was followed up by a technical review process, with subsequent revisions as needed. Figure 1-34 illustrates the organizational structure of the project.

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2. Greenhouse Gas Inventory

This chapter presents estimates of national anthropogenic greenhouse gas emissions and sinks for the year 2000. The inventory includes four categories: energy; industrial processes and product use (IPPU); agriculture, forestry and other land use (AFOLU); and waste. The results presented below are based on an inventory assessment prepared by KEPA, (2018).

2.1. Methodology

The methodology used to develop the inventory is based on the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* and the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (Good Practice Guidance) prepared by the Intergovernmental Panel on Climate Change (IPCC).

References and sectoral approaches were implemented to estimate GHG emissions in each emission category. Emissions up to the year 2016 were estimated using the inventory results for the year 2000 using IPCC's Inventory Software (Version 2.54). The Tier-1 approach of the IPCC guidelines was utilized in the calculations for all reporting categories.

In the subsections that follow, GHG emissions are reported both in absolute units of carbon dioxide, methane and nitrogen oxide emissions, as well as in units of CO_2-equivalent by applying 100-year GWPs of 1 for CO_2, 21 for CH_4, and 310 for nitrogen oxide, as recommended by the IPCC in its Second Assessment Report. Unless, as noted, default emission factors from the IPCC guidelines have been used.

2.2. Total GHG Emissions

Table 2-1 presents total GHG emissions and sinks for the year 2000. Total and net GHG emissions in 2000 were 48,683 Gg CO_2-equivalent, which includes 46,535 Gg from energy; 873 Gg from industrial processes and product use; 102 Gg of emissions from agriculture, forestry and other land use and 1,170 Gg from waste. CO_2 sequestration in 2000 amounted to 9.2 Gg. Emissions from perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF6) in Kuwait are negligible as the products containing these gases are not produced in the country.

Table 2- 1: presents total GHG emissions and sinks for the year 2000.

	GHG Sources & Sinks	CO_2-eq	CO_2	CH_4	N_2O
1	Energy	46,535	46,192	7.5	0.61
2	Industrial processes and product use	873	873	0.0	0.0
2	Agriculture, forestry and other land use	102	-9.2	5.0	0.019
4	Waste	1170	0	54.12	0.11
	Total National Emissions	48,683	47,065	66.6	0.74
	Net National Emissions	48,683	47,056	66.6	0.74

Energy-related activities accounted for the dominant portion of GHG emissions in Kuwait in 2000. Approximately 95.6% of all GHG emissions are associated with the combustion of fossil fuels for electricity production and transport, as well as the release of fugitive emissions from oil and gas operations. Emissions from waste management accounted for 2.4% of all GHG emissions, followed by IPPU and AFOLU categories which accounted for about 1.8% and 0.2% of total emissions, respectively.

2.3. GHG Emission Trends

Figure 2-1 presents the trend in total GHG emissions for the previous 1994 inventory and the GHG inventory for the year 2000. In addition, projected GHG emissions for 2016 are also plotted. Over the 1994-2000 period, total emissions have increased by about 50%; from 32,351 Gg CO2-equivalent in 1994 to about 48,683 Gg CO2-equivalent in 2000, or roughly 7%/year. By 2016, national emissions are projected to reach about 86,020 Gg CO2-equivalent. Figure 2-2 compares GHG emissions for each sector for the years 1994, 2000, and a projection to 2016 and highlights the fact that energy is the main component responsible for the overall increasing trend in GHG emission levels in Kuwait. Over the 1994-2000 period, CO2-equivalent emissions from energy use have increased by 51%, or about 7.1% per year, due primarily to increased energy use for electricity generation, desalinated water production, and process heat in manufacturing. Notably over the 1994-2000 period, CO2-equivalent emissions from AFOLU, though small in absolute terms, increased by 131%, or about 15% per year. For the forecast period from 2000 to 2016, total GHG emissions are projected to increase by 77%, or about 3.6% per year. While energy related GHG emissions growth continues to represent the overwhelming majority of Kuwait's emissions, the growth rate is projected to slow to 3.6% per year, or roughly half the 1994-2000 rate. This trend holds true for AFOLU- and waste-related GHG emissions, which are projected to slow to 2.0% and 2.4% per year, respectively, and are well below their 1994-2000 growth rates. On the other hand, IPPU-related emissions are projected to grow by 5.1% per year, or roughly 0.5% per year more than the 1994-2000 growth rate.

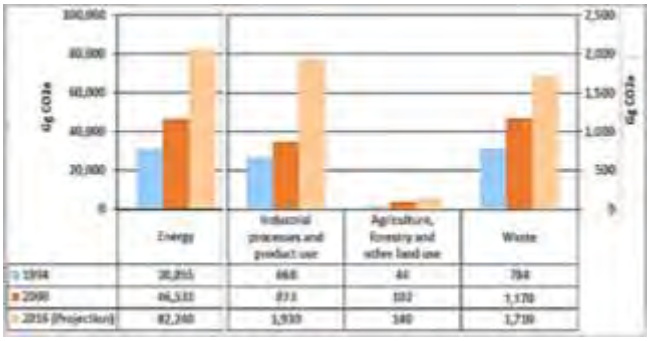

Figure 2- 1: Breakdown in total GHG emission trend, 1994 - 2000, and projection through 2016.

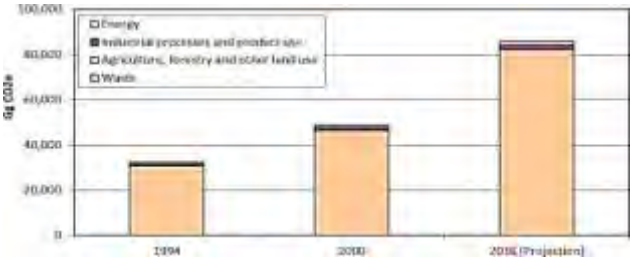

Figure 2- 2: Total GHG emission trend, 1994 - 2000, and projection through 2016.

2.4. Energy

The energy sector includes electricity generation, water desalination, Oil and gas combustion activities, manufacturing industries and construction, other fossil fuel combustion activities, and fugitive emissions from oil & gas operations. Table 2-2 provides a breakdown in energy sector GHG emissions for the year 2000 for these source categories. Relative to overall anthropogenic GHG emissions in Kuwait, the 46,533 Gg CO2-equivalent represents about 96% of total national emissions.

Table 2- 2: Breakdown in energy sector GHG emissions for the year 2000.

GHG Sources & Sinks	CO_2-eq	CO_2	CH_4	N_2O
Electricity & water	25,652	25581	0.89	0.17
Oil & Gas	7,225	7219	0.13	0.01
Manufacturing & construction	824	823	0.01	0.00
Transport	6,890	6,749	2.00	0.32
Other combustion activities	236	235	0.02	0.00
Fugitive emissions (oil & gas)	5,707	5,586	4.50	0.08
Total National Emissions	**46,533**	**46,192**	**7.53**	**0.59**

Figure 2-3 illustrates the breakdown in energy related GHG emissions in 2000 by activity. Emissions from electricity and desalinated water production are primarily associated with the combustion of natural gas and oil products showed the highest share of GHG emissions, about 55%. Transport activities are based overwhelmingly on the use of gasoline and diesel oil and accounted for about 15% of total emissions from energy-consuming activities. Fugitive emissions of methane, a gas that has a high global warming potential, accounted for about 12% of
all GHG emissions in the energy industries sector Other combustion activities and manufacturing/ construction accounted for the remaining 3%.

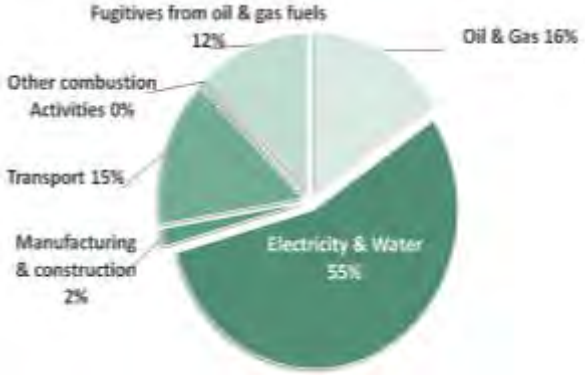

Figure 2- 3: Breakdown of GHG emissions associated with energy activities, 2000.

2.5. Industrial Processes and Product Use

Table 2-3 summarizes GHG emissions associated with industrial processes and product use in 2000. Industrial processes are the third largest emitter of anthropogenic GHG emissions in Kuwait, accounting for 873 Gg of CO_2– equivalent, or about 2.2% of national CO_2–equivalent emissions in 2000.

The mineral and chemical industries represent the sole source of emissions from industrial processes and product use. For the mineral industry, GHG emissions are associated with cement, lime and glass production and account for about 75% of total sectoral GHG emissions. For the chemical industry, emissions are solely associated with ammonia production.

Table 2- 3: GHG emissions associated with industrial processes and product use in 2000.

GHG Sources & Sinks	CO_2-eq	CO_2	CH_4	N_2O
Mineral industry	653	653	0.00	0.00
Chemical industry	220	220	0.00	0.00
Total National Emissions	**873**	**873**	**0.00**	**0.00**

2.6. Agriculture, forestry, and other land use

Table 2-4 summarizes GHG emissions associated with agriculture, forestry, and other land use in 2000. Agricultural practices are the smallest source of anthropogenic GHG emissions in Kuwait, accounting for net national emissions on only 102 Gg of CO_2–equivalent, or about 0.2% of net national CO_2–equivalent emissions in 2000. Most of the emissions from AFOLU activities are associated with methane production from livestock. Kuwait's extensive managed green areas acted as a CO_2 that resulted in a sequestration of 11 Gg CO_2-equivalent.

Table 2- 4: GHG emissions associated with agriculture, forestry, and other land use in 2000.

GHG Sources & Sinks	CO_2-eq	CO_2	CH_4	N_2O
Livestock	107	0	5.0	0.01
Land	-11	-11	0.0	0.00
Aggregate & non-CO_2 sources on land	5	2	0.0	0.01
Total National Emissions	**112**	**2**	**5.0**	**0.02**
Total Net Emissions	**102**	**-9**	**5.0**	**0.02**

2.7. Waste

Table 2-5 summarizes GHG emissions associated with waste management activity in 2000. Relative to overall anthropogenic GHG emissions, the 1,170 Gg CO2-equivalent represented about 2.4% of total national emissions. Waste-related GHG emissions are associated with solid waste disposal, and wastewater treatment and discharge.

Table 2- 5: GHG emissions associated with waste management activity in 2000.

GHG Sources & Sinks	CO2-eq	CO2	CH4	N2O
Solid waste disposal	1,136.5	0	54.121	0.0
Wastewater treatment & discharge	34.121	0	0.001	0.11
Total National Emissions	1170.6	0	54.122	0.11

2.8. Emissions by Greenhouse Gas Type

The following bullets provide an overview of GHG emission totals by all GHG types for the year 2000.

- *CO2:* Net CO2 emissions were estimated to be 47,056 Gg, or 96.6% of Kuwait's total greenhouse emissions in the year 2000. Figure 2-4a summarizes the contribution associated with CO2 emissions at both the sector and activity levels.
- *CH4:* Methane had the second largest share of greenhouse gas emissions. Total CH4 emissions were estimated to be about 66.6 Gg, or about 2.9% of Kuwait's total greenhouse emissions on a CO2-equivalent basis. Figure 2-4b summarizes the contribution associated with CH4 emissions at both the sector and activity levels.
- *N2O:* Nitrous oxide emissions were very small compared to other GHGs. Total N2O emissions were estimated to be only about 0.74 Gg, or about 0.5% of Kuwait's total greenhouse emissions on a CO2-equivalent basis. Figure 2-4c summarizes the contribution associated with N2O emissions at both the sector and activity levels.

2.9. Uncertainty assessment

Emissions/removals estimates are based on three key factors: methodology, modeling, and input data and assumptions, While each of these three contribute to uncertainty levels, they were kept to low levels as possible. There is minimal uncertainty associated with methodology as appropriate QA/QC procedures and the IPCC Software was used as the main tool in the inventory. On the other hand, there is uncertainty associated with input data and assumptions (i.e., emission factors and activity data). Default emission factors provided in the 2006 IPCC Guideline were adopted, thus reflecting the uncertainty embedded in these estimates.

For Kuwait, CO2 represents about 97% of GHG emissions and are associated with the categories listed previously in table 2-2. Hence, the overwhelming majority of any uncertainty in the inventory will be associated with these categories. Using the results from Table 7a – Uncertainties generated as part of the IPCC Software Report, all of the combined uncertainty levels are below 10%. This suggests a high level of confidence in the inventory results.

2.10. Quality Control

QC/QA Program was implemented in this inventory according to IPCC good practice guidance. Specifically, the 12 QC activities called for in Table 8.1 of the guidance document were followed without exception where applicable.

2.11. Key Category Analysis

The analysis was performed using Approach 1 recommended in 2006 IPCC Guidelines for National Greenhouse Gas Inventories Vol.4 Ch.4. Key categories were identified using a pre-determined cumulative emissions threshold and were those that, when summed together in descending order of magnitude, add up to 95% of the total level. Given Kuwait's circumstances as major oil producing and exporting country which leads to uniformity of emissions in Kuwait over the years (energy sector was always the leading sector in economy and therefore in GHG emissions), the analysis was limited to level assessment excluding trend assessment. Analysis was also limited to CO2 since the latter represents 97% of total GHG emissions. Table 2-6 summarizes the results of key category analysis.

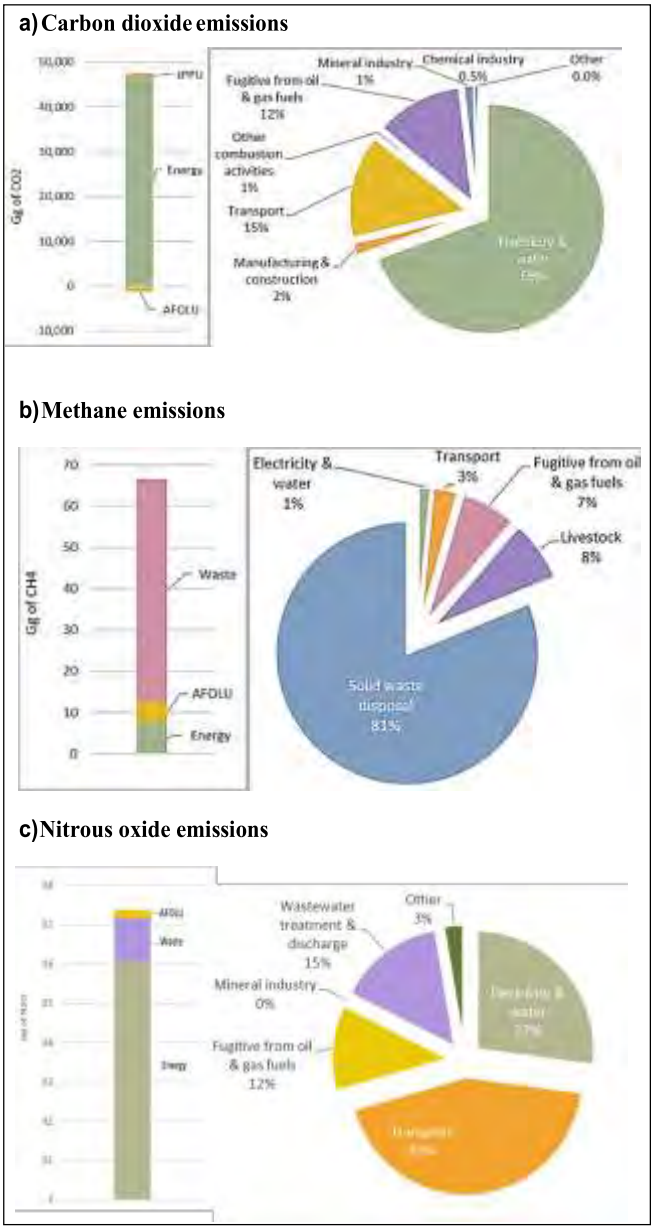

Figure 2-4: Breakdown in GHG emissions, 2000 (Gg).

Table 2- 6: Key category analysis results.

IPCC Category	GHG	Emissions in 2000 (Gg)	Level assessment (%)	Cumulative Total of level assessment (%)
Electricity & Water	CO2 - eq	25,652	53	-
Oil & Gas		7,225	15	68
Transport		6,890	14	82
Fugitives from Oil & Gas		5707	12	94
Waste		1170	2.4	96.4
Total National Emissions		46644	1	96.4

2.12. Challenges and Recommendations

The primary challenge to the development of the current GHG inventory is data-related, namely availability, accuracy, and consistency. These challenges are rooted in administrative and institutional barriers that impede the application of locally available technical capacity to collect, manage, and analyze pertinent data. Addressing these challenges should address the following:

- Establish and enforce a national statistical data system, which logs operational and production data and information, in governmental and private organizations.
- Establish strategic collaboration agreements between KEPA and public organizations to ensure a sustainable supply of related data.
- Given the above two points, a national emissions inventory system is to be developed with key sectors in the country.
- Hold periodic workshops for public organizations for training and educating critical authorities with the IPCC emissions inventory system.
- Call for and support the conduction of a national project to determine local emission factors related to the indigenous resources.
- Establish a GHG inventory committee with high-level representation from key ministries/institutions, having clear oversight and coordination authority.
- Develop an integrated database of relevant information including annual statistical abstracts and annual reports from specific entities.

2.13. List of references

Kuwait Environment Public Authority, Kuwait, 2018." greenhouse gas inventory report for Kuwait second national communications under the UNFCCC, assorted sectoral reports and spreadsheets.

IPCC, 2000. "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories".

IPCC, 2006. "Guidelines for National Greenhouse Gas Inventories"

3. Vulnerability and Adaptation

This chapter presents an overview of key sectors that are highly vulnerable to climate change in Kuwait, namely water resources, coastal zones, and agriculture. Coupled with the assessment of vulnerability in each of these sectors are a set of recommended adaptation strategies for which international support will be critical.

3.1 Climate

Outputs of regional climate experiments undertaken as part of the COordinated Regional Climate Downscaling EXperiment (CORDEX) were used as the basis for projecting Kuwait's future climate. The aim of the CORDEX initiative is to better understand relevant regional and local climate phenomena, their variability and future changes, through downscaling of coarse resolution General Circulation Models (GCMs) that were part of the Coupled Model Intercomparison Project - Phase 5 (CMIP5), as well as to evaluate and improve regional climate models and dynamical downscaling techniques. CORDEX is a global initiative where scientists from 14 distinct regions of the world work together to downscale climate data to high resolution spatial scales that better capture local topographical features and meteorological characteristics.

3.1.1. Approach

One of the regions in this framework is the CORDEX-MENA domain which includes the whole Arabian Peninsula as well as North Africa and southern Europe (see Figure 3-1). Outputs from the CORDEX-MENA domain were obtained to develop an understanding of Kuwait's future climate, with a focus on the change in annual average temperature and rainfall the period 2071-2100 relative to the historical climate. Information was available for an ensemble of GCMs that were downscaled using a set of Regional Climate Models (RCMs) from which average values were computed. Two Representative Concentration Pathways (RCPs), RCP4.5 and RCP8.5 were considered for projections up through the year 2100. The spatial resolution of the RCMs was about 50 km. A total of 11 GCM-RCM combinations were considered. Table 3-1 provides a list of the GCMs and RCMs whose outputs were used in establishing Kuwait's future climate.

Figure 3-1: Spatial domain for the CORDEX-MENA region

3.1.2. Results

The change is average annual temperature for Kuwait over the period 2071-2100 is shown in Figure 3-2 for RCP4.5 (left) and RCP8.5 (right). Temperature increases are projected to be evenly distributed across the inner portions of Kuwait, on the order of about 2.5° to 2.7°C higher than the historical average under RCP4.5 and on the order of about 4.3° to 4.5°C higher than the historical average under RCP8.5. Future increases are slightly smaller over coastal areas, ranging from roughly 1.7° to 1.9°C higher than the historical average under RCP4.5 and on the order of about 3.5° to 3.7°C higher under RCP8.5.

Table 3-1: List of GCMs/RCMs in the CORDEX-MENA initiative

GCM name (acronym)	RCM name (acronym)						
	Aire Limitée Adaptation dynamique Développement InterNational (ALADIN)	Consortium for Small Scale Modeling - Climate Limited-area Modelling-Community (CCLM4-21)	Rossby Centre regional Atmospheric model (RCA4)	Regional Climate Model (RegCM4-4)	REgional MOdel (REMO2009)	Weather Research Forecasting model (WRF351)	Weather Research Forecasting model (WRF36)
Community Earth System Model, Version 1.0 (CESM1)						✓	✓
Centro Euro-Mediterraneo sui Cambiamenti Climatici Climate Model (CMCC-CM)		✓					
Centre National de Recherches Météorologiques (CNRM-CM5)	✓		✓				
National Oceanic and Atmospheric Administration Geophysical Fluid Dynamics Laboratory model (GFDL-ESM2M)			✓	✓			
Coupled earth system model being used by the Met Office Hadley Centre for the CMIP5 Centennial simulation (HadGEM2-ES)				✓			
Max Planck Institute for Meteorology Earth System Model, LR-r1 configuration (MPI-ESM-LR-r1)					✓		
Max Planck Institute for Meteorology Earth System Model, LR configuration (MPI-ESM-LR)				✓	✓		

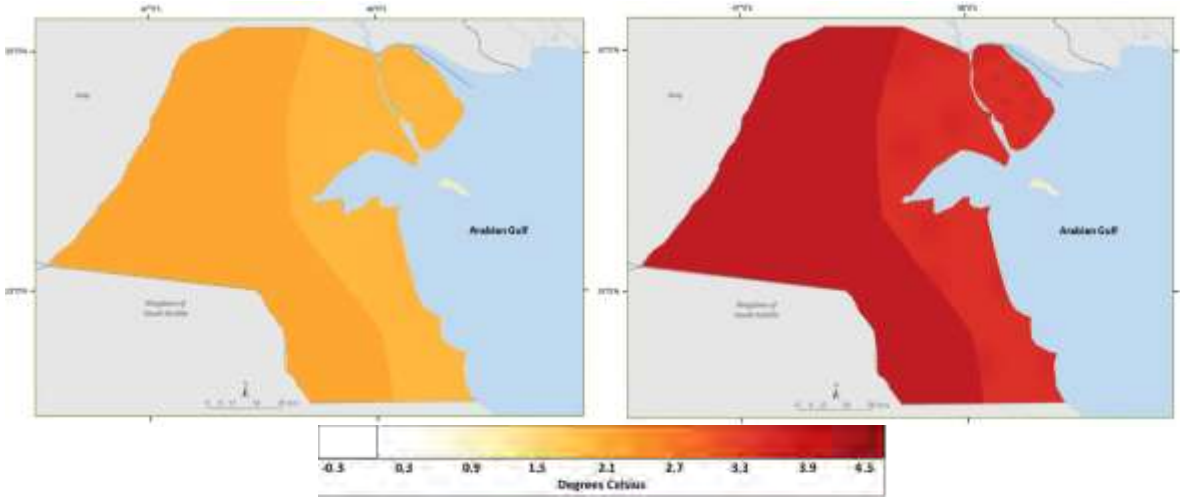

Figure 3-2: Annual average projected change in temperature under RCP4.5 (left) and RCP8.5 (right) for the 2071-2100 period (Sources: CORDEX-MENA; ICBA)

Average future rainfall change for Kuwait over the period 2071-2100 is shown in Figure 3-3 for RCP4.5 (left) and RCP8.5 (right). Under RCP4.5, rainfall decreases are projected to be evenly distributed over the northern portions of Kuwait, on the order of about 3% to 6% lower than the historical average, while the southern portions of the country are projected to experience even steeper reductions, roughly between 15% and 18% lower than the historical average. Under RCP8.5, rainfall decreases are projected to be evenly distributed over the eastern portions of Kuwait, on the order of about 6% to 9% lower than the historical average, while the western portions of the country

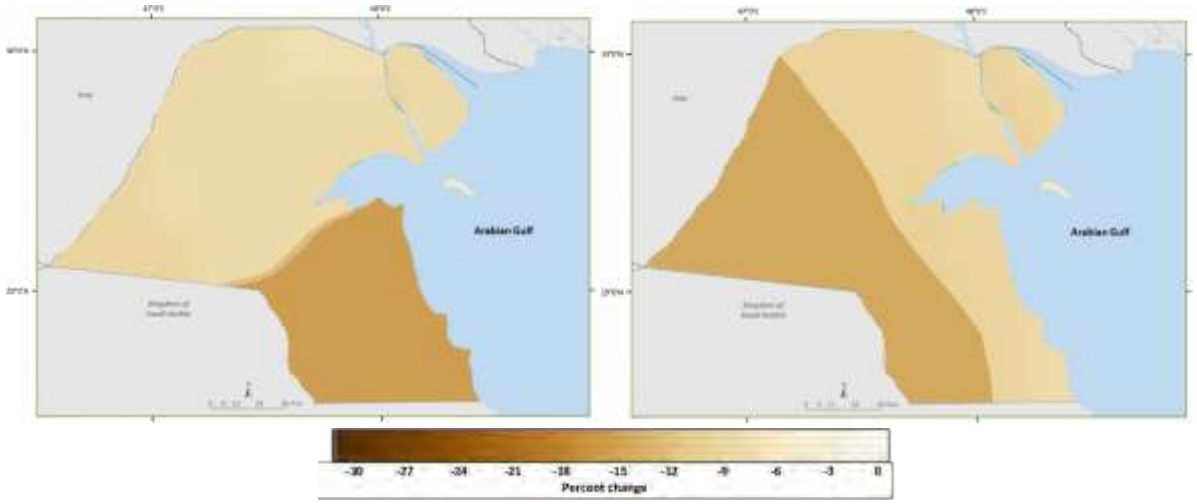

Figure 3-3: Annual average projected change in rainfall under RCP4.5 (left) and RCP8.5 (right) for the 2071- 2100 period (Sources: CORDEX-MENA; ICBA)

are projected to experience even steeper reductions, roughly between 15% and 18% lower than the historical average.

3.1.3. Climate policy implications

The above findings point to several promising areas of future activity. Specifically, the following research areas are considered high priorities that could be pursued within the CORDEX-MENA initiative or independently within Kuwait.

- *Narrowing the spatial domain.* The current CORDEX-MENA spatial domain is quite extensive. A new domain focused solely on the Arabian Peninsula, pursued in coordination with relevant organizations in the region, would be preferable;
- *Projecting tropical storm frequency.* Given the potential for changes in the frequency, intensity, and pathway of tropical storms originating in the Indian Ocean, additional model runs should seek to capture impacts of sea surface temperatures on cyclones.
- *Sandstorm/dust modeling.* Given the importance of dust, it would be valuable to explore how a changing climate might impact dust formation, transport and deposition in the region.

3.2. Changes in the Arabian Gulf

Observed changes in the physical and chemical properties of Arabian Gulf waters adjacent to Kuwait were reviewed and synthesized in order to develop a baseline understanding of recent changes in the Gulf due to increasing GHG concentrations (Alhazeem, *et al.,* 2018).

3.2.1. Background

The Arabian Gulf is surrounded by a hyper-arid environment characterized by high air and sea temperatures, high evaporation rates, and low annual rainfall (Alhazeem, 2007; Riegl and Purkis, 2012). Aside from the Shatt Al-Arab waterway in Iraq and some small Iranian rivers, there is no freshwater inflow to the Gulf. This contributes to naturally high salinity levels which are further exacerbated by highly saline brine discharges associated with many seawater desalination plants in the region.

3.2.2. *Approach*

Trends in seawater temperature, salinity, and pH were examined based on local marine station data as well as publicly available satellite data. Available local marine data covering the period since 2011 were obtained from the Meteorological Department within the Directorate General of Civil Aviation, which oversees marine data gathering at eight marine stations in Arabian Gulf waters. Satellite data from 1985 are from NOAA's Advanced Very High Resolution Radiometric (AVHRR) satellite. Locations of Kuwait Bay, Kubbar Island, Qaru Island, and Umm Mudayrah Island for which seawater trends are reported are shown in Figure 3-4. Brief descriptions of these areas are provided in the bullets below.

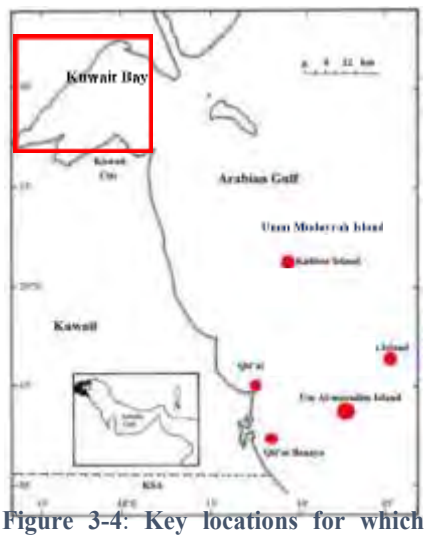

Figure 3-4: Key locations for which physical properties of Arabian Gulf water are reported (Source: adapted from Mahmoud and Jose, 2017)

- *Kuwait Bay.* This is a sheltered and a highly productive marine ecosystem where water temperature and salinity are higher than in open waters (Al-Yamani et al., 2004). Water depth is shallow, around 5 meters. The Bay is high in turbidity and has a very slow counter-clockwise current due to the nature of semi-closed system (Al-Rashidi et al., 2009; Al-Mutairi et al., 2014).
- *Open waters of northern Arabian Gulf.* The marine environment surrounding Kubbar Island, Qaro Island, Umm Mudrayah Island and other northern Gulf areas displays very strong seasonal oscillations, characterized by a strong stratification of temperature and salinity during summer and a fairly mixed vertical profile during winter months (Thoppil & Hogan, 2010). This area is characterized by intense evaporation rates and complex circulation processes.

3.2.3. *Results*

Historical monthly sea surface temperatures (SST) in the Arabian Gulf show a wide range. Average SSTs are highest in August and lowest in January, as illustrated in Figure 3-5 (left) for Kubar and Qaru islands for the period 2010 through 2017. Annually, the average SST for these locations is about 26.3°C. While similar seasonal trends prevail for Kuwait Bay, there has been a statistically significant increase in SST over the period 1985-2002 (see Figure 3-5, right), as derived from satellite data. SST has steadily increased at a rate of 0.6 (±0.3)°C/decade, a trend three times greater than the concurrent global average (Al-Rashidi, *et al.*, 2009).

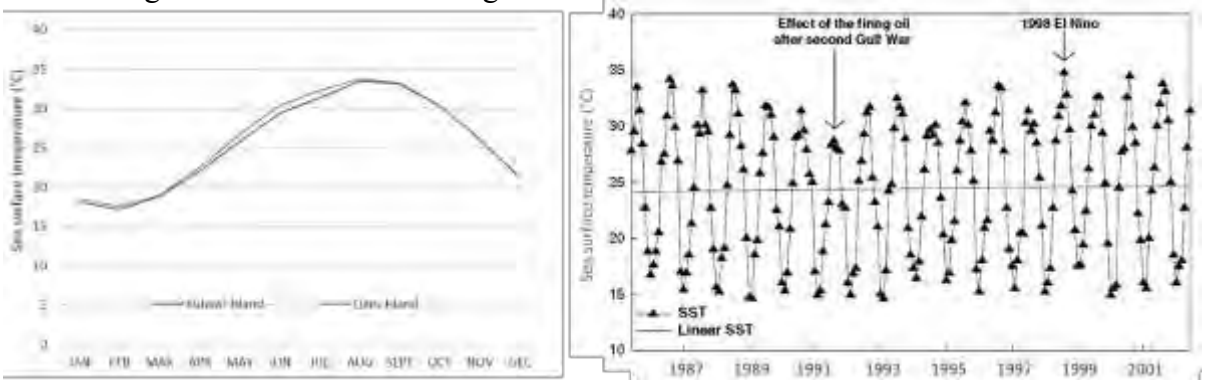

Figure 3-5: Left: Average monthly sea surface temperature at Kubbar and Qaru Islands, 2010-2017 (Source: Kuwait Meteorological Department); Right: Average annual sea surface temperature in Kuwait Bay, 1985- 2002 (Source: Al-Rashidi, et al., 2009)

It is estimated that about half of this increase can be attributed to factors that are global in nature, rather than regional or local.

Historical monthly sea surface salinity (SSS) in Arabian Gulf waters around Kuwait show little variation throughout the year. Average SSS levels are illustrated in Figure 3-6 for Umm Mudrayah Island for the period 2014 through 2016, based on marine station data. Average recorded salinity levels are about 40 parts per thousand (ppt) for each month. This is roughly the midpoint of average salinity levels for Kuwait's Arabian Gulf waters which range from about 38.6 to 42.4 ppt (Alhazeem, *et al.,* 2018).

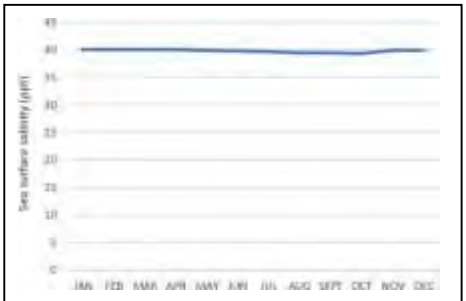

Figure 3-6: Average monthly sea surface salinity at Mudrayah Island, 2014-2016 (Source: Al-Rashidi, *et al.*, 2009)

The Arabian Gulf is a major aquatic sink in the region for sequestering atmospheric CO_2. This has led to acidification of the marine environment, with average pH levels over the 2006-2016 period ranging from 8.3 to 8.5. There are notable interannual pH trends for various marine locations around the southern end of Kuwait Bay, as illustrated in Figure 3-7.

3.2.4. Climate policy implications

The above findings point to several challenges inherent to of climate change policymaking in Kuwait. While historical trends in sea surface temperature, sea surface salinity, and pH have been established, the actual response of these physical and chemical parameters to future increases in atmospheric CO_2 concentrations remains poorly understood at this time. The next step is to undertake regional ocean modeling of the northern Arabian Gulf system to better understand how these waters will be affected under future climate change.

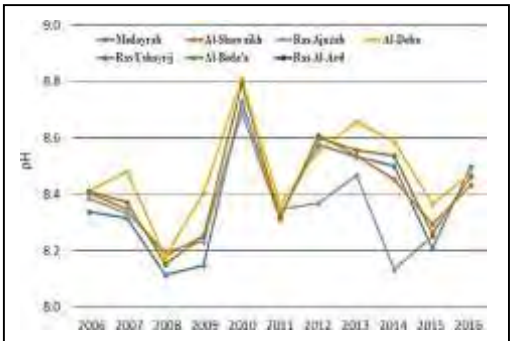

Figure 3-7: Average monthly sea surface salinity at Mudrayah Island, 2004-2016 (Source: Al-Rashidi, *et al.*, 2009)

3.3. Coastal zones

Rising sea levels pose threats of wetland flooding, aquifer and agricultural soil contamination, destructive erosion and lost habitat for fish, birds, and plants. Sea level rise also poses a threat to the built environment in the form of Arabian Gulf waters reaching further inland, particularly under high tide conditions and especially when combined with storm surge associated with extreme storm events. This section summaries the results of a study to assess the risks to urban livelihoods and infrastructure from sea level rise along the entire coastline (Al-Sahli, *et al.*, 2018).

3.3.1. Background

Kuwait's coastal zone consists of two distinct regions (see Figure 3-8). The northern region extends from the Kuwait-Iraq border to the northern coast of Kuwait Bay. This area is largely devoid of infrastructure, although some large projects have recently started, such as Mubarak Al-Kabeer Port on Boubyan Island (Al-Gabandi, 2011; Baby, 2014). The southern region extends from the western and southern coast of Kuwait Bay to the Kuwait-Saudi Arabia border. This area is highly urbanized and is where most of Kuwait's economic activity and infrastructure are concentrated, mostly within 20 km of the coastline.

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The total length of the Kuwait coastline is about 500 km including the islands (Baby, 2014). The southern coastal area of Kuwait Bay hosts Kuwait City, the capital, and the main commercial port, Shuwaikh Port. The southern coast includes residential, commercial and recreational areas, power plants, and desalination stations (Al Bakri and Kittaneh, 1998). Artificial sandy beaches, accounting for about 5% of the shoreline, have been developed in recreational areas. Other key features of Kuwait's coastal zones are summarized in the bullets below.

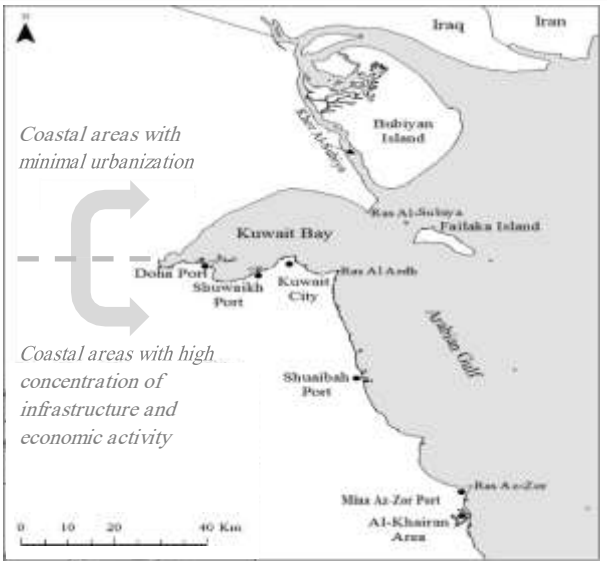


Figure 3-8: Kuwait's main zones along shoreline

- *Geomorphology:* Kuwait's coastal zones overlie an isostatically stable region (Förster et al. 2009; Lokier et al.2015; Stevens et al. 2014). Shorelines can be grouped into six classes based on morphosedimentary patterns: Soft mud tidal flats, sandy-rocky tidal flats, coral reefs, artificial sandy beaches, and oolitic limestone beaches. The soft mud tidal flats are found around Boubyan Island, Ras Al-Subiya tidal channel, Kuwait Bay, and the Al-Khairan area. Sand beaches extend on the south coast from Ras Al Ardh to Ras Az-Zor, while oolitic limestone beaches are found south of Ras Az-Zor (Abou-Seida and Al-Sarawi, 1990). Sandy-rocky tidal flats are found on the southwestern coast of Kuwait Bay, the southern coast of Boubyan Island, and the Ras Al-Subiya headland.
- *Biodiversity:* Kuwait's coastal zones are rich in biodiversity. Subkhas (i.e., coastal salt marshes) along the northern coast are productive ecosystems supporting numerous plant species and other organisms (El-Ghareeb et al., 2006). Coral reefs in southern offshore islands of Kuwait are unique environments that support various trophic levels. Various migrating bird species are found on the islands during winter and summer seasons, supported by rich foraging areas within the intertidal zones, while other bird species inhabit the islands for breeding (Al-Yamani et al. 2004). Many marine organisms ranging from autotrophic species, such as flagellates and diatoms, to higher trophic level species, such as mollusks and demersal fishes in habit the intertidal ecosystem.
- *Tides and waves:* Kuwait's Tides are generally mixed semi-diurnal with a mean range of approximately 3 meters. The tidal range along the north coast varies from 3.5 to 4.0 meters, whereas the average tidal range along the south coast is about 1.8 m. The tidal range height significantly depends on wind direction and coast orientation

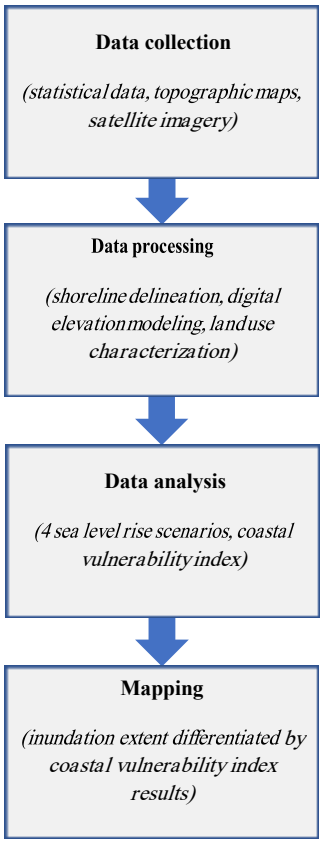


Figure 3-9: Main elements of the coastal zone vulnerability assessment

(Batista, et al. 2004; Paul & Ismail, 2012; Quinn et al. 2012). The dominant northwesterly winds contribute in decreasing tidal heights while secondary southeasterly winds rise the tidal height (Al-Hasem, 2002). Waves and longshore currents have generally limited influence on north coast and relatively strong influence on south coast (Abou-Seida & Al- Sarawi, 1990).

- *Intertidal zones:* The intertidal zone along Kuwait coast exhibits two distinct geographic patterns. The intertidal zone in the north extends gently seaward from 200 to 1,500 m and is characterized by low-energy waves, whereas the intertidal zone in the south is steep and narrow, less than 500 m wide, characterizing by moderate to high-energy waves (El-Ghareeb et al. 2006; Khalaf 1988).

3.3.2. *Approach*

The main objective of the coastal zone study was to characterize the vulnerability of Kuwait's entire shoreline to sea level rise (SLR). Extensive data collection and processing activities were undertaken from local and publicly available international sources. GIS techniques were employed to calculate a coastal vulnerability index (CVI) and establish the horizontal extent of seawater inundation into vulnerable areas. The major elements of the study are illustrated in Figure 3-9. A brief overview of the methodology applied is provided in the bullets below.

- *Coastal vulnerability index (CVI):* A CVI was calculated for all segments of the Kuwait shoreline, including the islands, using widely used methods (Gornitz, *et al.,* 1991; McLaughlin and Cooper, 2010; Palmer *et al.,* 2011; and Mohamad, *et al*., 2014). Four physical parameters (i.e., elevation, coastal slope, geomorphology, distance to 20-meter isobath) and two socio-economic parameters (i.e., population, and land-use/land-cover) were incorporated into the CVI calculations. The six parameters were ranked on a scale of one to four: the value of one represents the lowest vulnerability; and the value of four is very high vulnerability and manipulated in GIS using map algebra analysis. All layers were given the same weight. (see Table 3-2).

- *Inundation extent:* Four sea level rise scenarios were considered above mean high tide: 0.5 meters, 1.0 meters, 1.5 meters, and 2.0 meters by the end of this century. Northern shorelines were delineated using georeferenced topographic maps; shorelines not covered by the topographic maps, such as the south eastern part of Boubyan Island and southern areas of Kuwait, were delineated using satellite imagery. As LiDAR elevation data was unavailable, the USGS' Global Digital Elevation Model was calibrated to Kuwaiti conditions and used to create an elevation layer of coastal areas. The extent of inundated area under each scenario was estimated using GIS spatial analysis tools following the method used by Bhadra *et al*. (2011). Areas with elevations below the projected SLR and connected with seawater were considered to be inundated.

3.3.3. *Results*

Total inundated coastal area under the four scenarios are summarized in Table 3-3 relative to the CVI scores. Under the lowest SLR scenario, a total of 185 km^2 of land is projected to become inundated, absent any coastal protection measures. This inundated land area increases to 454 km^2 in the highest SLR scenario. Notably, very little of the very highly vulnerable land, as reckoned by the CVI score, is inundated under any scenario; ranging from less than 1 km^2 in the lowest SLR scenario to only 1.8 km^2 in the highest SLR scenario. In fact, coastal areas that are classified as having only moderate vulnerability shows the highest share of inundated land, ranging from 78% in the Mean high tide + 1.0 meters scenario to 81% in the lowest SLR scenario.

Figure 3-10 shows that spatial distribution of inundated areas for Boubyan Island (left) and the southern area of Kuwait Bay (right) under each of the seal level rise scenarios. Boubyan Island would be highly impacted under all sea level rise scenarios. Roughly half of the island would be inundated in the highest SLR scenario. Only the relatively higher land in the interior of the island would be visible by the end of this century. Coastal areas along Kuwait Bay are also projected to be adversely impacts by rising seas, especially the western coast near Doha Port and densely populated neighborhoods around Kuwait City where there are many areas for which CVI scores showed high or very high vulnerability. Notably, while much of this coastal area currently has hard coastal protection structures such as seawalls and bulkheads to protect roads, buildings and other infrastructure, such installations were based on pre-SLR design criteria and would likely need to be replaced or retrofitted to offer the same level of protection service.

Table 3–2: Parameter characterizations for coastal areas together with vulnerability rankings

Type	Parameters	Vulnerability Rank			
		1 (low)	2 (moderate)	3 (high)	4 (very high)
Physical	Elevation (m)	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5
	Coastal Slope (%)	> 3	1.5 – 3	0.5 – 1.5	≤ 0.5
	Geomorphology	Rocky Coast	Sand and rocks	Sand	Mudflats, clay/rocks, or sand
	Distance to 20m	> 4km	2 – 4km	1 – 2km	< 1km
Socio-economic	Population	≤ 1,116	1,117 – 3,789	3,790 – 8,836	8,837 – 23,200
	Land-use	Mudflats, vacant areas, bare soil, environmental reserves, green areas	Other types of land use	Recreational Areas, and sport complexes/ fields	Urban and industrial Areas

Table 3–3: Inundation results, by coastal vulnerability index bin

Extent of inundation (km²) and share of land inundated (%), mapped onto coastal vulnerability bins:					
Parameters	1 (low) 1.00 ≤ CVI ≤	2 (moderate) 1.50 < CVI ≤	3 (high) 2.50 ≤ CVI ≤	4 (very high) 3.50 ≤ CVI ≤	Total
Mean high tide + 0.5 meters	0.2 (0.1%)	150 (81%)	34 (18%)	0.9 (0.5%)	185.203 (100%)
Mean high tide + 1.0 meters	0.04 (0.02%)	180 (78%)	47 (21%)	1.3 (0.6%)	228.670 (100%)
Mean high tide + 1.5 meters	0.04 (0.01%)	298 (78%)	83 (22%)	1.5 (0.4%)	382.160 (100%)
Mean high tide + 2.0 meters	0.04 (0.01%)	359 (79%)	93 (21%)	1.8 (0.4%)	453.622 (100%)

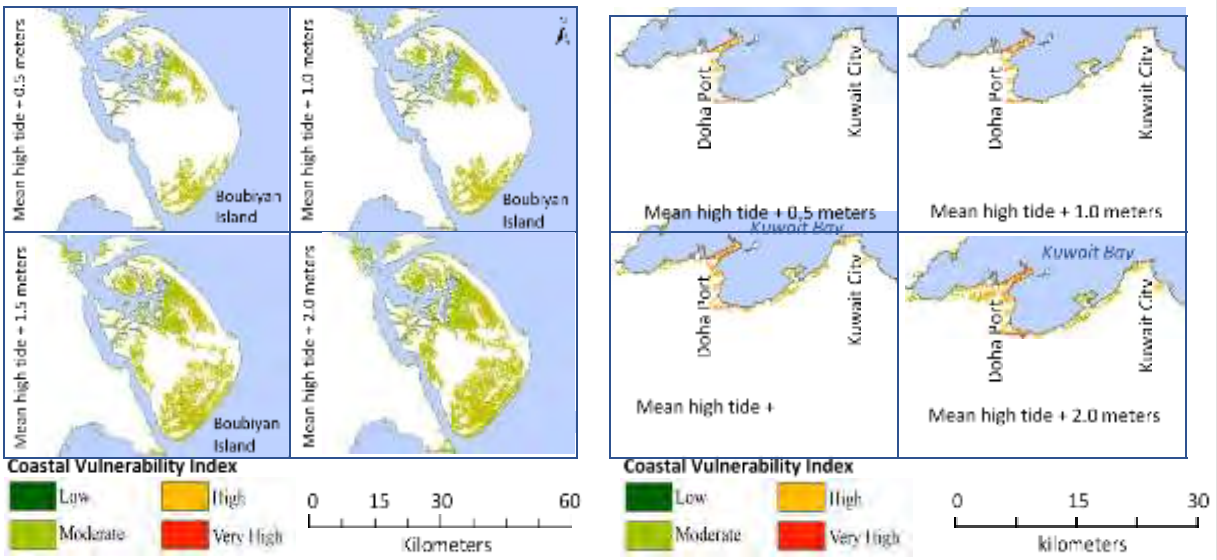


Figure 3-10: Inundated areas for Boubyan Island (left) and the southern area of Kuwait Bay (right)

Figure 3-11 shows the spatial distribution of inundated areas for Shuaibah Port and the Al-Khairan recreational area. These are the only other major areas in Kuwait where there exists significant infrastructure and population density. Unlike Kuwait City, the CVI scores showed mostly moderate vulnerability, with very few locations in the Al-Khairan Recreational Area showing high vulnerability, and no areas with very high vulnerability in either Shuaibah Port or the Al-Khairan Recreational Area.

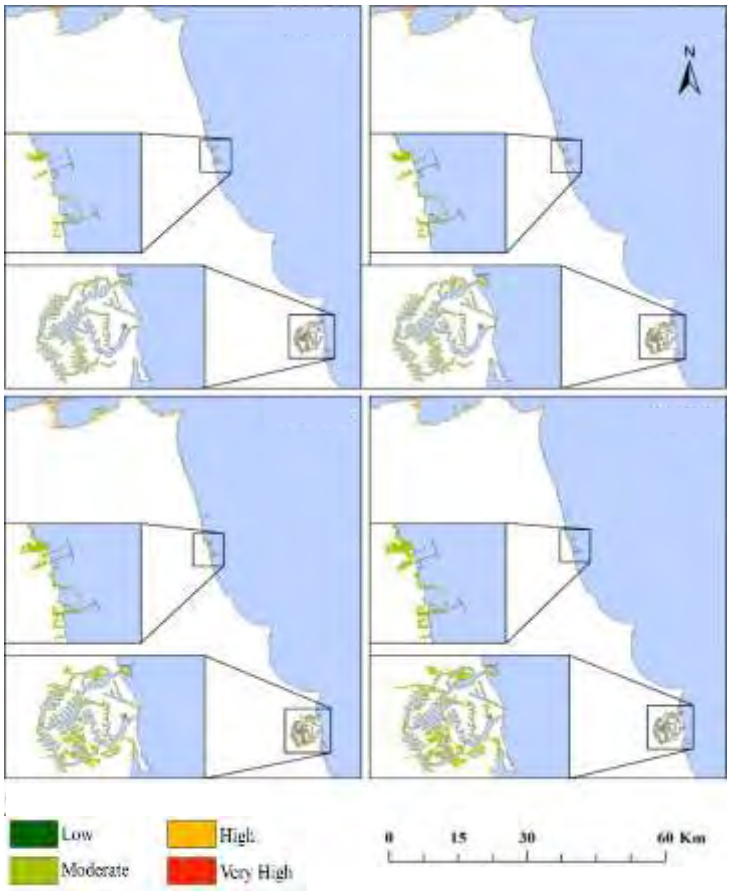


Figure 3-11: Inundated areas for Shuaibah Port and Al-Khairan recreational area

3.3.4. *Climate policy implications*

The above findings confirm that risings seas pose a critical challenge to risk management for Kuwait's coastal zones. These areas have experienced rapid population growth accompanied by the installation of long-lived infrastructure assets, trends that are expected to continue in the near- to mid-term. Assessingcoastal vulnerability to SLR is a fundamental step in understanding the scope of the challenge that confronts decisionmakers regarding the design of viable adaptation strategies. This is further exacerbated by the fact that the current version of GCMs do not represent the air-land-water-ice

system well, making actual projections of sea level rise can integrate factors such as accelerating deglaciation impossible. Nevertheless, two recommendations have emerged from the study that are premised on the precautionary principle. These are briefly discussed in the bullets below are considered strategic next steps in the face of uncertainty.

- *Avoid new infrastructure installation in areas classified as highly to very highly vulnerable.* New major development projects, such as power plants, desalination stations, and main ports, should not be established on such vulnerable coasts. Such installations are costly and long-lived and would likely face enormous upgrade costs if sea level rise was not fully considered in design specifications. Raising the awareness among decision makers to incorporate SLR scenarios into development plans is very important, especially now that construction has begun on Murabak Al-Kabeer Port on Boubyan island.
- *Strengthen the protection of coastal biodiversity.* SLR is expected to adversely impact coastal ecosystems, likely leading to a loss of some of Kuwait's rich coastal biodiversity. Protecting these environments through legislative action that restricts development activities is critical important for mitigating SLR consequences and promoting ecosystem resiliency to SLR. Extensive anthropogenic activities along the coast could significantly threat the coastal wildlife and consequently increase the vulnerability of the coasts of Kuwait to SLR. Recently established recreational sites along Kuwait coast, for instance, did not only destroy coastal habitats but also significantly changed the coastline of Kuwait. The continued expansion of recreational sites along Kuwait's coasts without due consideration of it environmental consequences would likely sharply diminish the tolerance of the coastal wildlife of Kuwait to rising seas.

Going forward, enhancing coastal information systems is an important priority for Kuwait. Data collection and information development are prerequisites for effective coastal adaptation. The more relevant, accurate, and up-to-date the data and information available to coastal planners, the more targeted and effective adaptation strategies can be. Enhanced information systems should include data and information on coastal characteristics and dynamics and patterns of human behavior, as well as improving stakeholder understanding of climate change impacts. It is also essential that there be a general awareness among the public, coastal managers and decision makers of these consequences and of the possible need to take appropriate action.

3.4. Water resources

Population growth, urbanization, industrial growth, agricultural development are key drivers underlying Kuwait's high per capita water consumption. Coupled with a hyper-arid environment, low annual rainfall, no permanent lakes or rivers, and limited fresh groundwater resources, sustainable water resource management is a key national priority. This section provides an overview of a study to quantify the costs and benefits of specific strategies to promote sustainable water management strategies in Kuwait (AlHarbi, *et al*., 2018)

3.4.1. Background

Kuwait depends on three water resources; desalinated water, brackish groundwater, renewable groundwater, and treated wastewater. Figure 3-12 shows the relative shares of current water

consumption associated with these sources. The bullets below details regarding water supply and demand trends.

- *Brackish and fresh groundwater.* Groundwater is extracted from the Ummer Radhuma-Dammam aquifer, a transboundary groundwater system underlying all of Kuwait. The lithology of the aquifer consists of 200 – 300 meters of soft, porous, chalky limestone and hardy crystalline dolomitic limestone with unmelodic and green shale at the base. Most of the groundwater is brackish with total dissolved solids (TDS) ranging from 3,000–10,000 mg/liter (MEW; Al-Rashed,2010).

  Renewable fresh groundwater, with TDS ranging from 600 to 1,000 mg/liter, is only available in low quantities through deep subsurface lenses at Al-Rawdatain and Umm Al-Aish in the Northern part of Kuwait and represents typically less than 5% of annual consumption. Brackish groundwater is used for oil depressurization by the Kuwait Oil Company as well as irrigation for green areas and private farms in Al-Wafra and Al-Abdalli. Over the period 2006-2016, brackish groundwater use has been increasing by about 8.7% per year, with current consumption levels of about 1,238 liters per person per day (see Figure 3-13).

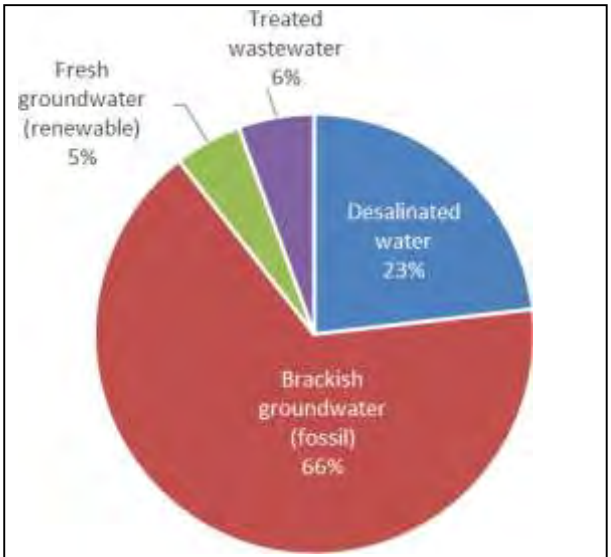


Figure 3-12: Water consumption profile in Kuwait (Source: MEW)

- *Desalinated water.* Desalinated waterproduced from Arabian Gulf seawater has been an important source since 1950. Kuwait relies on six desalination plants using multi-stage flash (MSF) technology (i.e., Shuaiba North, Shuaiba South, Doha East, Doha West, Al-Zour South, Sabiya) that account for 92% of total capacity and one plant using reverse osmosis (RO) technology (i.e., Shuwaikh). Additional RO capacity totaling 0.5 MM^3 per day are planned to come online in the near future (MEW, 2015). Over the period 2005-2015, desalinated water production increased by about 3.6% per year, with current consumption levels of about 417 liters per capita per day (l/cap/day) (see Figure 3-14). As a water security measure, there are currently 84 water.

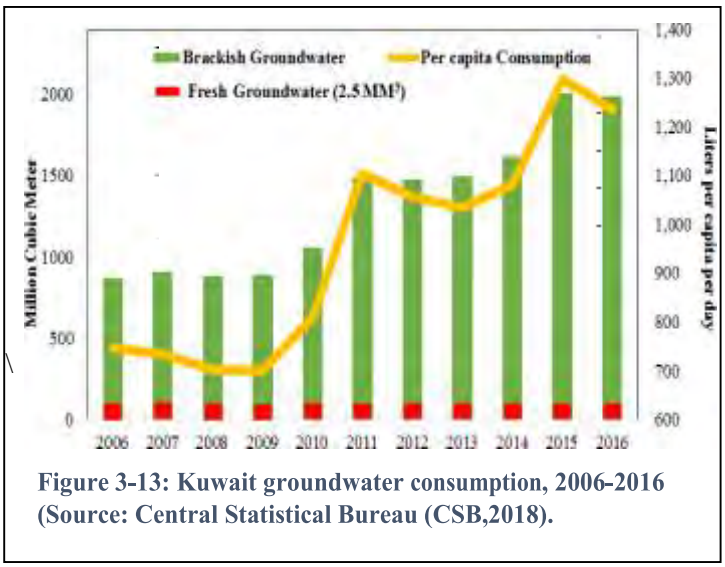


Figure 3-13: Kuwait groundwater consumption, 2006-2016 (Source: Central Statistical Bureau (CSB,2018).

- *Treated wastewater.* Treated Wastewater (TWW) has become a substantial and strategic water resource in Kuwait due to the high cost of desalination. The Ministry of Public Works (MPW)manages wastewater collection from all parts of Kuwait City and its suburbs through 4,700 km of gravity sewers,17 major pumping stations, 57 secondary pumping stations, and 1,600 km of pressure mains (Al-Essa, 2000). Six wastewater treatment facilities are located in the Kuwait City vicinity. Five of these plants use rapid sand filtration and chlorination treatment (i.e., Riqqa, Um Alhaiman, Kabd, Al-wafra, Kheran) and one uses using RO and ultra-filtration technology (i.e., Sulaibiya). These facilities process about nearly 90% of all wastewater generated, with the balance discharged into the Arabian Gulf. Over the period 2001-2014, wastewater generation has increased by about 3.7% per year (see Figure 3- 15). Between 50% and 60% of TWW is typically reused for irrigation of highway landscapes, households' greening, public parks, and artificial wetlands, with the rest discharged into the Arabian Gulf (MPW, 2010).

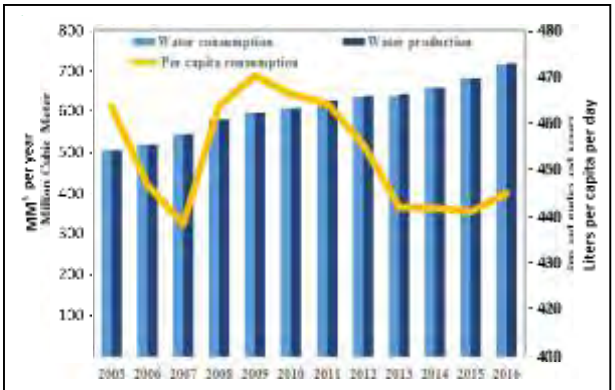


Figure 3-14: Kuwait desalinated water production and consumption, 2005-2016 (Source: MEW, 2015)

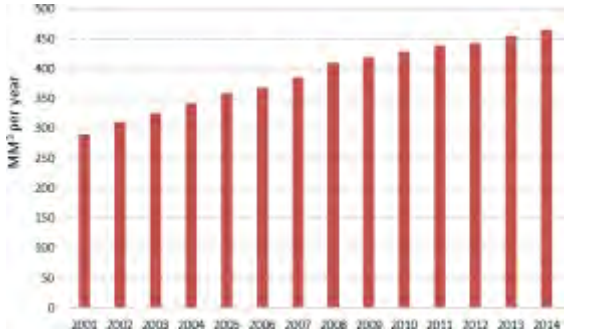


Figure 3-15: Kuwait wastewater generation,2001-2014 (Source: Analysis on Reclamation and Reuse of Wastewater in Kuwait, Aleisa and Shayji,KU,2017)

3.4.2. *Approach*

Climate change is not projected to adversely impact Kuwait's brackish/fossil groundwater and desalinated water supplies which together account for about 90% of total supply. Nevertheless, there are likely to be indirect impacts of a changing climate water on water resource management. Therefore, the main objective of the water resource vulnerability assessment was to explore the direct costs and benefits of strategies that promote sustainable water resource management, as well as the co-benefits resulting in lower CO2 emissions. Extensive data collection and analysis activities were undertaken from local sources. The Water Evaluation and Planning (WEAP) model was used to evaluate water supply and demand in Kuwait under two economic growth scenarios over the 2006-2035 period. The major elements of the study are illustrated in Figure 3-16. A brief overview of the methodology applied is provided in the bullets below.

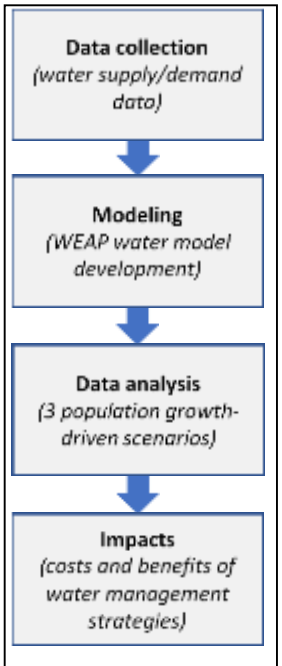


Figure 3-16: Main elements of the water resource vulnerability assessment

- *Scenario construction.* Three scenarios were developed. The Baseline Scenario assumes an average annual population growth rate of 3.2% for the entire planning period. Historical average per capita water consumption was assumed to apply throughout the planning period (i.e., 419 l/cap/day). For the industrial and agricultural sectors, an average annual water uses growth rate of 1.0% was assumed. The Normal Growth Scenario assumes a higher per capita water consumption of 427 l/cap/day, with the population growth rate and the industrial/agricultural water use growth rate remaining the same as in the baseline scenario. The High Growth Scenario assumes an even higher per capita water consumption of 430 l/cap/day, with the population growth rate and the industrial/agricultural water use growth rate remaining the same as in the baseline scenario.

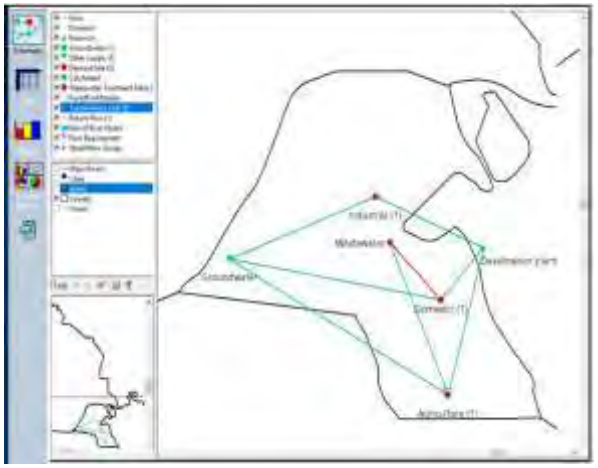


Figure 3-17: Kuwait's water supply/demand system, as modeled in WEAP (Source: AlHarbi, et al., 2018)

- *WEAP Model development.* Water supply/demand was modeled within WEAP by representing its key elements in a spatial schematic (see Figure 3-17). WEAP is a water supply/demand accounting model capable of quantifying the impacts of water policies on supply, demand, and implementation costs. The three main input elements represented within WEAP were water supply, water demand, and water transmission. Water supply elements include groundwater aquifers both fresh and brackish, rainfall, desalination plants and wastewater plants. Water demand sectors correspond to the domestic, agricultural and industrial sectors. Water transmission include links between supply sources and demand sectors, between rainfall and groundwater, and between demand sectors and either treatment or the sea. The water model was calibrated to match historical trends in Kuwait.

Table 3–4: Policies considered in the analysis

Policy name	Description
Water tariffs	Block-tariffs would replace the current flat rate of \$0.59 per m^3 by \$0.6/m^3 for the first 36 m^3; \$0.88/m^3 for the next 18 m^3; and \$1.1/m^3 above 55 m^3. Water demand elasticity in the residential sector from the application of these block rates was assumed to be approximately 7%, after Bushehri (2007).
Improved water efficiency	Installation of efficient water devices in households and businesses (e.g., low-flow showerheads, faucet aerators). This would lead to water use reductions of 20 - 40% after Aboaba and Alhaji (2001) and Al-Rumikhani (2001).
Leak reduction	Reduction of leaks from the pipe network system would result in 10% to 15% water saving.
Improved irrigation efficiency	Increasing irrigation efficiency of agriculture field from its current value of about 25% to 70% by 2035 through more efficient irrigation scheduling. Improving Irrigation efficiency would reduce agggregate water consumption by 30%.

Table 3–5: Summary of Costs and benefits associated with the implementation of the policies

Policy	Annual benefits (2035)		Cumulative benefits (2019-2035)		Costs		
	Water savings (BCM)	CO2 reductions (million tonnes)	Water savings (BCM)	CO2 reductions (million tonnes)	Net costs (billion 2016$)	Cost of water savings ($ per MM³)	Cost of avoided CO2e emissions ($ per tonne)
Water tariffs	436	4.36	2.9	29	14.2	4.9	488
Improved water efficiency	623	6.23	4.1	41	13.2	3.2	318
Leak reduction	1,247	12.47	8.3	83	9.9	1.2	119
Improved irrigation efficiency	1,870	18.70	12.4	124	6.6	0.5	53

- *Policy analysis.* Four water resource management policies (i.e., water block tariff rates, Improved water efficiency, leak reduction, and improved irrigation efficiency) were evaluated individually (rather than in combination) within the WEAP modeling representation of the Kuwait water system. All policies were assumed to be phased in starting in 2019 and reaching full implementation by 2035. Table 3-4 provides a brief overview of the design of each policy. Key assumptions were 5% for the real discount rate; an average of 10 kg of CO_2 emissions for each cubic meter of water delivered; and the use of local capital and operations & maintenance costs for water efficiency devices.

3.4.3. *Results*

Table 3-5 summarizes the costs and benefits associated with the implementation of the policies individually in Kuwait under the High Growth Scenario. Net costs (i.e., costs of new technologies less savings from reduced water use) are incremental in nature. That is, they result from shifting the development pathway from the High Growth Scenario to a scenario that reflects the integration of each of the individual policies. Moreover, net costs represent the incremental costs to society from the implementation of the policies, rather than any segment of society. Benefits from the policies relative to the High Growth Scenario are presented in physical units for water savings and greenhouse gas emission reductions and are reported in annual terms for the year 2035 and in cumulative terms for the 2019-2035 period. Highlights are briefly described in the bullets below.

- Under the water tariff policy, there are cumulative water savings and CO_2 reductions (i.e., 2.9 billion cubic meters (BCM) and 29 million tonnes, respectively) that come at a net cost of $14.2 billion. This is equivalent to spending $4.9 for each cubic meter of water saved and $488 for each tonne of CO_2 avoided.
- Under the Improved water efficiency policy, there are significant cumulative water savings and CO_2 reductions (i.e., 4.1 BCM and 41 million tonnes, respectively) that come at a net cost of $13.2 billion. This is equivalent to spending $3.2 for each cubic meter of water saved and $318 for each tonne of CO_2 avoided.

- Under the leak reduction policy, there are high cumulative water savings and CO_2 reductions (i.e., 8.3 BCM and 83 million tonnes, respectively) that come at a net cost of $9.9 billion. This is equivalent to spending $1.2 for each cubic meter of water saved and $119 for each tonne of CO_2 avoided.
- Under the improved irrigation efficiency policy, there are the highest cumulative water savings and CO_2 reductions of all the policies (i.e., 12.4 BCM and 124 million tonnes, respectively) that come at a comparatively low net cost of $6.6 billion. This is equivalent to spending $0.5 for each cubic meter of water saved and $53 for each tonne of CO_2 avoided.

3.4.4. Climate policy implications

The above findings confirm that there are viable policies that could be implemented in Kuwait to reduce long-term water demand associated with high population and economic growth. These policies are particularly relevant given Kuwait's acutely limited natural limited water resources and high costs of desalinated water. Several efforts are recommended in support of these measures as briefly described in the bullets below.

- *Education and training:* These activities involve the introduction of climate change issues at different levels of the educational system, which can assist to build capacity among stakeholders to support adaptation in the future and can help to develop appropriate research activities and a greater awareness among citizens.
- *Awareness campaigns*: increase decision makers' and public awareness about impacts of climate change on water resources and the environment. This more effective if pertinent stakeholder or environmental NGOs are involved in the development and the role out of the strategy. Awareness campaigns can be performed via different forms include television, internet, and newspapers.
- *Strengthening/changes in the fiscal sector:* Public policies may inspire and backing adaptation of individuals and the private sector, mostly through the establishment of fiscal incentives or subsidies.
- *Science, research and development (R&D) and technological innovations:* R&D and innovation are necessary to allow responses to climate change in general, and to permit definite reactions to climate change vulnerability, including economic valuation of adaptations, technological adaptations (salt-resistant crop varieties), and surveys of new foundations of groundwater and better resource management.

3.5. Marine ecosystems

Kuwait's marine waters and coastal areas includes highly productive habitats, including intertidal mudflats, seagrass, algal beds, mangroves, and coral reefs. These habitats support important commercial fisheries, marine biodiversity as well as endangered species such as the green turtle. This section summarizes the results of an assessment of potential climate change impacts on a subset of these vulnerable ecosystems, namely coral reef ecosystems and commercial fisheries (Alhazeem, *et al.,* 2018).

3.5.1. Background

Coral reef ecosystems play an important role in maintaining marine biodiversity and a genetic library for future generations (Moberg and Folke, 1999). In Kuwait, they function as an essential spawning ground, nursery, and breeding and feeding ground for many kinds of marine species such as commercial fish, marine turtles, worms, molluscs, crustaceans and sponges. Healthy coral reefs depend on a delicate balance between sea surface temperature, salinity and water column clarity, which affects the amount of sunlight reaching coral.

Other factors affecting coral growth are hydrodynamic in nature (e.g. currents, waves and storm frequency) and biologic such as larval sources, species diversity and disease occurrence (Done, 2011).

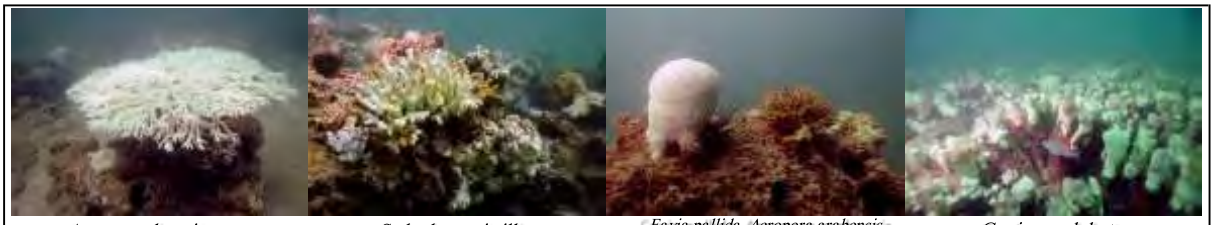
Kuwait has three well-developed offshore coral reef islands: Kubbar, Qaro, and Umm Al-Maradem (see earlier Figure 3-4). Coral cover diversity in Kuwait has reported low coral diversity with 24 Scleractinian species in 17 genera (Downing 1985). Some local coral species such as *Acropora* and *Stylophora* species are particularly sensitive to environmental stressors (e.g., increased sea surface temperature) have experienced bleaching events in recent years (see Figure 3-18). Coral communities around these islands already exist in extreme environmental conditions that are near tolerance limits for survival and reef development (Downing, 1985). With climate change, maximum sea surface temperatures are projected to rise in northern Arabian Gulf waters and likely adversely affecting the delicate balance among these factors.

Kuwait's commercial fisheries are subject to Decree Law Number 46 of 1980 (Concerning the protection of fish wealth) and have been regulated by the Public Authority for Agriculture Affairs and Fish Resources (PAAFR) since 1983. They are the second most important natural resource in Kuwait after oil and gas. In addition to being a renewable source of income, they contribute to Kuwait's food security and cultural heritage, while also providing recreational opportunities.

With its shallow intertidal waters, Kuwait Bay is a highly productive fish nursery habitat and supports a thriving fishing industry, with a range of species typically harvested (Wright, 1988, 1989). Of the over 345 fish and shrimp species found in Kuwait's waters (Al-Baz *et al*., 2013), there are 2 commercially important shrimp species - green tiger prawn *(penaeus semisulcatus)* and jinga shrimp *(Metapenaeus affinis)* - and 21 commercially important fish species (see Table 3-8). These 23 species typically account for about 41% of total annual catch. Despite their historical importance, fisheries in Kuwait and the surrounding region remain understudied and fish catch data remain inaccurate

Table 3–6: Major commercial fish species in Kuwait. (Source: Al-Hussaini, et al., 2015)

Family	Species	Common name
Carangidae	Parastromateus niger	Black pomfret
Cynoglossidae	Cynoglossus arel	Largescale tongue sole
Haemulidae	Plectorhinchus pictus	Trout sweetlips
	Pomadasys kaakan	Javelin grunter
Hemipteridae	Nemipterus peronii	Notched threadfin
Lethrinidae	Lethrinus nebulosus	Spangled emperor
Lutjanidae	Lutjanus malabaricus	Malabar blood snapper
Mugilidae	Liza klunzingeri	Klunzinger's mullet
	Mugil cephalus	Flathead mullet
Paralichthyidae	Pseudorhombus arsius	Largetooth flounder
Platycephalidae	Platycephalus indicus	Bartail flathead
Polynemidae	Eleutheronemaa	Fourfinger threadfin
Sciaenidae	Otolithes ruber	Tigertooth croaker
	Protonibea diacantha	Spotted croaker
Scombridae	Scomberomorus	Kingfish
	Scomberomorus guttatus	Indo-Pacific king
Serranidae	Epinephelus coioides	Orange-spotted
Sparidae	Acanthopagrus latus	Yellowfin seabream
	Argyrops spinifer	King soldier bream
Stromateidae	Tenualosa ilisha	Hilsa shad
	Pampus argenteus	Silver pomfret



Acropora dawning | *Stylophora pistillata* | *Favia pallida, Acropora arabensis and Favites pentagona* | *Goniopora lobata*

Figure 3-18: Examples of bleached coral species from Kuwait's coral reefs (Source: Alhazeem, et al., 2018)

(Al-Abdulrazzak and Pauly, 2013a, 2013b). While human activities have led to habitat destruction and degradation (Al-Husaini, *et al.*, 2018), climatic factors such as elevated sea surface temperatures have led to fish kills of massive proportion (Al-Marzouk, *et. al.*, 2005).

3.5.2. *Approach*

Two distinct methodological approaches were applied to assess the impact of climate change on marine ecosystems. For coral reefs, the methodological approach consisted of estimating the change in coral reef coverage surrounding 3 islands - Kubbar, Um Al Maradim, and Qaru - for the period 2003 through 2017.

These islands are located 40 km, 25 km, and 60 km away from the Kuwaiti coastline, respectively (see earlier Figure 3-19). Both satellite and aerial images were acquired and analyzed using GIS techniques to define the change in spatial extent of the coral reefs surrounding the islands. The change in coral reef coverage over time was used as a proxy to establish the degree of impact of climatic and other factors on coral reef health.

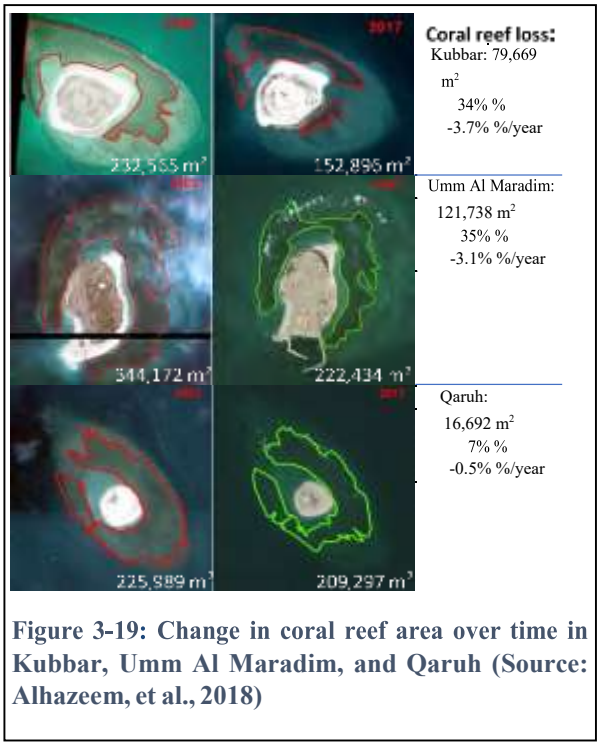


Figure 3-19: Change in coral reef area over time in Kubbar, Umm Al Maradim, and Qaruh (Source: Alhazeem, et al., 2018)

For commercial fisheries, the methodological approach consisted of estimating the impact on fish landings (or fish catches) in Kuwait Bay associated by exploring the relationship between fish landings and changes in sea surface temperature and pH. The period for the assessment was 2006 through 2016. Daily data for marine parameters were obtained from monitoring stations in Kuwait Bay (see Figure 3-5). Data for fish landing statistics were collected from Kuwait's central statistical bureau and focused on the 23 main commercial shrimp and fish species. Data on fish kills were also collected to explore potential relationship with sea surface temperature. Relationships between fish landings and fish kills relative to elevated sea surface temperatures and pH levels were used as an indicator of the impact of these parameters on fish productivity.

3.5.3. *Results*

Coral reef coverage loss over time is illustrated in Figure 3-19. The total loss of area is greatest in Umm Al Maradim island, with nearly 122 thousand square meters of coral reef coverage lost. The annual average rate of loss is highest for Kubbar island at 3.7% per year. Coral reefs around Qaruh Island are the most robust with only 7% of the area lost in absolute terms and a much lower annual rate of loss.

It is noteworthy that these losses have occurred during a period when sea surface temperatures have been increasing at a rate of 0.6 (±0.3) °C per decade. This suggests a potential association between temperature increases and regional bleaching events that occurred in 2010, 2015, and 2016, an association that has been documented in other marine environments (Schoepf *et al.,* 2015; Done, 2011; Hennige *et al.*, 2010). On the other hand, Arabian Gulf coral reefs have shown a high tolerance to heat stress, rendering them uniquely resilient under extreme environmental conditions

(Riegl and Purkis, 2012b; Coles and Riegl, 2013; Hume *et al.*, 2013; Benzoni et al., 2006; and Alhazeem, 2007).

In addition, there has been several events of fish kills. The most severe cases were reported in 1999 when up to 30 tonnes of *Liza macrolepis* deaths occurred in Kuwait Bay from September to October. More than 80,000 fish of other species were killed in October (Heil, et. al.; 2001). Another massive fish kill occurred in Kuwait Bay during August and September of 2001, with over 2,500 tonnes of *Liza klunzingeri*, followed by several smaller scale fish kills. Notably, unusually high levels of algae were observed coupled with high temperatures (up to 35°C) and calm conditions (Gilbert, *et al.*, 2002).

Numerous other fish kill incidents have occurred in Kuwait Bay, although at smaller scales. Such experiences are consistent with documentation of warming water temperatures leading to increases in the frequency and severity of fish kills associated with plankton blooms (e.g., Sheppard *et al.*, 2010).

3.5.4. *Climate policy implications*

Kuwait's marine ecosystems may be vulnerable to climate change impacts. Multiple human stressors, such as habitat destruction and overfishing, are likely to exacerbate this vulnerability. Effective management of activities in the Arabian Gulf under climate change will help increase the resilience of marine ecosystems and the adaptive capacity of policy-making systems, for example by reducing other human perturbations, to ensure the sustainable flow of ecosystem services into the future. Effective implementation of ecosystem-based management that considers a much wider range of environmental and human stressors is fundamental to increasing the adaptive capacity of marine social-ecological systems to climate change. This includes strengthening the implementation and enforcement of current regulations and agreements to protect marine resources in the Arabian Gulf.

3.6. Public health

Climatic conditions can profoundly affect human health in Kuwait. Prevailing conditions of very high temperatures and frequent dust storms impose major health risks that can lead to premature mortality and health care facility visits, particularly among the elderly and very young. This section summarizes key health risks associated with climate change; reviews actions already taken to address climate/health linkages; and outlines a strategic approach to strengthen Kuwait's capacity to address climate change risks to public health (Alshatti, *et al.,* 2018).

3.6.1. *Background*

With climate change, increased heat stress from higher temperatures and increased cardiovascular and respiratory diseases associated with more frequent dust storms, represent looming health threats to the population. These additional risks could exacerbate current major health problems such as ischemic heart disease, stroke, road injury and lower respiratory infections, whilst potentially undermining Kuwait's social protection systems.

Average and maximum temperatures in Kuwait under a changed climate are projected to rise considerably. Numerous studies confirm that extreme heat leads to increased heat stress which adversely affects health, increasing the risk of morbidity and premature mortality through heat stroke, heat exhaustion and the exacerbation of chronic diseases (Basu, 2009; Xu, 2012; Turner et al., 2013; Basu, 2013; Xiang, 2014). The most severe heat-related illness is stroke and occurs when a person's temperature exceeds a critical threshold and is accompanied by a weak pulse, nausea, and fainting. Moreover, increased heat stress is associated with psychological distress, anxiety and mental health disorders (Wang et al. 2014; Tawatsupa et al. 2010). These potential health outcomes also apply to Kuwait's population, with outdoor workers (e.g., construction,

green space maintenance), the elderly, and very young likely to be exposed to the greatest risks.

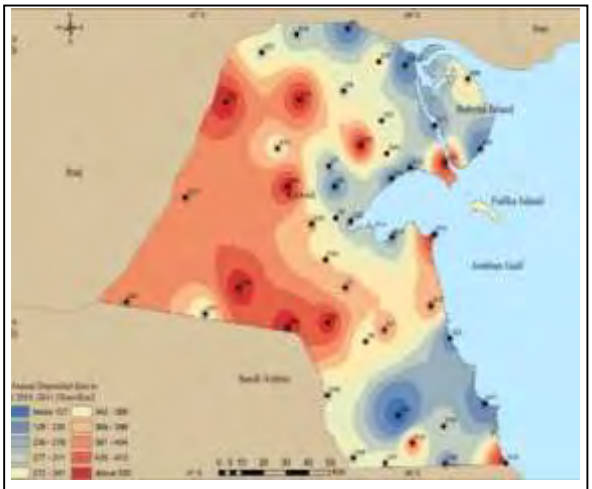


Figure 3-20: Annual dust fallout in Kuwait, 2010- 2011 (UNEP, et al., 2016)

Dust storms already have large depositional rates, particularly across the northern Arabian Peninsula region. The highest annual depositional rates over Kuwait exceed 500 tonnes per square kilometer and are found in the western part of the country (see Figure 3-X), while annual dust deposition in the Arabian Gulf averages over 10 thousand tonnes for each cubic kilometer of seawater (Al-Dousari, et al., 2017). Severe dust storms result from strong winds that can exceed 45 km/hour, leading to high concentrations of coarse particulates (PM_{10}, particles greater than 10 microns in diameter) that can lead to cardiovascular impacts (stroke, heart attack) and respiratory ailments (asthma attacks). Notably, the frequency of dust storms in the region has increased drastically in the last decade (Sissakiam, et al., 2013) and could potentially increase further under climate change. Some epidemiological studies in Kuwait show a strong association between dust storms and increased asthma and respiratory hospital admissions (Qasem *et al*., 2008; Thalib and Al-Taiar, 2012; Alshatti, *et al*., 2018), with other studies in Iran (Ebrahimi, et al., 2014) and Turkey (Al, et al., 2018) offering corroborating evidence, with yet other studies unable to affirm a direct relationship between dust storms and increased asthmatic attacks (Sabah, *et al*., 2014). In any event, since there is already a high prevalence of asthma in Kuwait - 15% of adults and 18% of children are affected (Khadadah, 2012) – any aggravating factor such as increased dust storm frequency represents a critical health security issue.

3.6.2. *Current coping strategies*

In response to clear indications of a changing climate in Kuwait, several measures have already been put into place in recent years to cope with health impacts. These governmental actions have been taken as a proactive step to protect public health and maintain work productivity (see Table 3-7).

Table 3–7: **Actions implemented to mitigate health impacts of climate change**

Coping strategy	Actions
Adjust the official working hours	▪ The Ministry of Social Affairs and Labor of Kuwait issued a national law in 2005 for bidding any outdoor work from 11:00AM to 16:00PM from June to August as these are the times when the day temperature reaches its maximum level
Awareness campaigns on how to respond to dust and thunderstorms	▪ The Ministry of health of Kuwait launched several awareness campaigns through social media channels and health care centers advising individuals on how to react to dust events. It provided infographics and general advices that are applicable, easily comprehendible. ▪ Annual awareness campaigns on how to deal with the summer in Kuwait: The Ministry also launches annual media campaigns advising individuals on how to deal with Kuwait's hot summer days and how to avoid heat stress and its effects.
National health alerts for dust storms	▪ Whenever a dust event in expected, a national disaster alert is released through media channels to alert individuals about the event and what measures to be taken. All emergency rooms in Kuwait are notified to be well-prepared to expected increase in emergency visits due to such dust events. However, this system needs to enforce further to be activated during every event in collaboration with other public agencies. People in Kuwait themselves have adopted responsive measures to climate change impacts and effects. During the hot summer days, people tend to avoid walking in the streets at noon unless it's needed. Many cover their heads or even use an umbrella to decrease the effect of heat during the day.

3.6.3. Climate policy implications

While the country may not be able to influence climate change directly, an adaptation plan is needed to reduce such detrimental health impacts in Kuwait. These include:

- Inclusion health outcomes into Kuwait's national climate change adaptation plans and programs,
- Specific adaptation plans targeting vulnerable groups is needed to create and implement prevention measures toward climate health impacts such as heat-related conditions,
- It was noted that there is a lack of research and scientific studies toward local climate health impacts in Kuwait. Future studies are greatly needed to assess further public health impacts at local levels in relation to heat waves, extreme temperatures, ambient air pollution, humidity, droughts and sea level rise,
- Enhance data collection system through electronic filing systems at health care centers to correctly measures the climate health impacts,
- Equip health care workers with the right skills and knowledge on how to identify, assess and treat such health effects such as heat stress and heat exhaustion. This needs to be coupled with sufficient resources in terms of medical equipment and human resources given the estimated increase in number of admissions and emergency presentations,
- Since climate change is a cross-sectoral issue involving several areas including environment, health, agriculture, and more, a multi-sectoral and multidisciplinary collaboration is essential to the development of a national health adaptation strategy,
- Due to the health effects of dust events and extreme temperature as highlighted in the report, a review of national working conditions should be made to adjust to the current and future climate change impacts. Additionally, a nation-wide early warning system must be developed further in case of extreme weather events such as heat waves or sand and dust storms

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4. Greenhouse Gas Mitigation

Kuwait is committed to efforts that harmonize economic growth with a low-carbon, climate-resilient development. Domestically, it has already undertaken several strategic projects to reduce its carbon footprint. Internationally, it has expressed through its Nationally Intended Contribution a commitment to explore future GHG emission reduction policies and measures in the energy sector (State of Kuwait, 2015).

Such actions will reflect practical ways to promote clean energy initiatives, introduce new low-carbon technologies, and develop long-term partnerships to exploit sustainable energy opportunities. Progress toward such actions is already underway, and when fully implemented, will eventually lead to substantive greenhouse gas mitigation in an increasingly carbon-constrained world.

The rest of this section is based on an analysis of potential GHG reductions in the energy sector by KEPA (2018). The energy sector was selected at it represents the largest share of GHG emissions in Kuwait. The section concludes with a proposed set of strategic mitigation actions for achieving deeper GHG reductions in the future.

4.1. Goal, scope, methodology, and data sources

The goal of the GHG mitigation assessment was to establish annual and cumulative GHG emission reductions due to the implementation of several promising GHG mitigation options. The scope of the assessment focused on fugitive emissions from oil & gas operations and combustion-related emissions associated with electricity and desalinated water production. Together, these activities accounted for between 76% and 81% of emissions over the 1994-2016 period (see Figure 4-1).

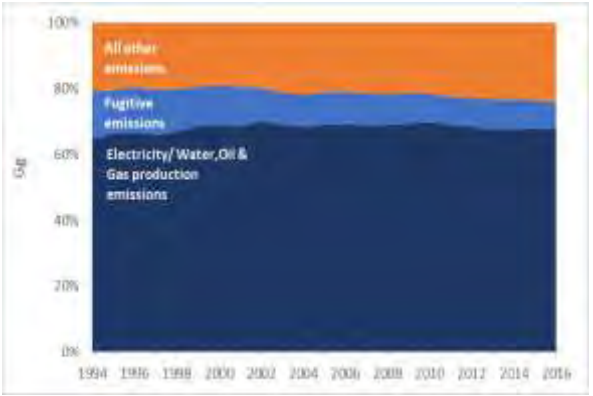

Figure 4-1: Share of oil & gas and electricity water production emissions, 1994-2016

While there are other GHG reduction opportunities in the next largest-emitting sector, transportation, which accounted for roughly 18% of emissions in 2016, a tactical decision during initial mitigation planning was made to limit the scope of the assessment solely to the way that electricity is produced and efficiency improvement in upstream oil & gas operations.

Two emission scenarios were considered; a Baseline Scenario which assumed the continuation of historical trends in energy supply and demand and a Mitigation Scenario which assumes the implementation of measures to reduce fugitive emissions, enhance supply side efficiency in electricity production and introduce renewable energy. Due to resource and time constraints, the assessment was limited to GHG reductions only (i.e., costs were not considered). The Baseline scenario incorporated activities that have taken place to date to reduce emissions. A 19-year planning horizon was considered, from 2016 through 2035.

A linear regression model was developed to project Baseline Scenario emissions to 2035. Population and GDP data over the 1994-2016 were used to establish trends between these variables and national CO_2e emissions. The model was developed using simple regression and analysis of variance (ANOVA) techniques. Box 4-1 provides details of the final form of the model. Most of the data required to undertake the assessment was acquired from governmental sources.

Average annual growth rates of 2.65%, 1.8%, and 2.0% were used for population, GDP, and inflation, respectively. Physical properties of fuels (e.g., GHG emission factors, energy densities) are based on IPCC default factors used in the development of the GHG inventory.

Box 4–1: Regression model used to project Baseline Scenario emissions through 2035 The final form of the econometric model for year t is as described below. All regressions statistics confirm that the model adequately produces actual GHG emissions over the 1994-2016 period (e.g., R^2 over 0.96).

$$CO_2e_t = 6.3E+03 + 0.018178*(P)_t + 3.17E-08*(GDP)_t$$

Where:

CO_2e_t = national GHG emissions in year t P

= national population in year t

GDP = Gross domestic product in nominal US dollars in yeart

4.2. Baseline scenario

The Baseline Scenario incorporates emission reductions associated with several recent projects that have been implemented as part of the Clean Development Mechanism (CDM) to stimulate sustainable development and emission reduction targets under the Kyoto protocol. A brief overview of these projects is provided in the bullets below.

- *Flare gas recovery at the Mina Al Ahmadi Refinery.* This project aims to recover gases that are currently flared at one of the refineries operated by the Kuwait National Petroleum Company. The project involves the installation of a Flare Gas Recovery Unit (FGRU) to recover gases for subsequent commercial uses. Annual GHG emission reductions are about 54.4 Gg.
- *Flare gas recovery at the Mina Abdullah Refinery:* This project aims to recover gases that are currently flared at another of the refineries operated by the Kuwait National Petroleum Company. The project involves the installation of an FGRU to first cool and then compress the recovered gases. After the cooling and compression steps, the gases are treated in an amine absorber to remove hydrogen sulfide and then reused for thermal heat generation. Annual GHG emission reductions are about 89.5 Gg.
- *Solar photovoltaics.* This project introduces a 10 MW solar photovoltaic farm in western Kuwait partially meet electricity demand at 29 oil wells and related infrastructure in the region. The major electrical load at oil wells consists of electric submersible pumps which would otherwise be met by the central grid. Annual GHG emission reductions are about 13.7 Gg.
- *Improved electric distribution efficiency*. This project introduces capacitor bank technologies at various 11/0.433 KV substations to improve the power factor in the electric distribution system. Capacitor banks were implemented in 632 transformers around Kuwait City and showed substantial improvement in the average power factor, leading to a reduction in distribution losses. Annual GHG emission reductions are about 112.7 Gg.

Baseline scenario trajectories of GHG emissions, CO_2e emissions per capita and CO_2e emissions per$ of GDP are illustrated in Figure 4-2. The left side of the figure shows that GHG emissions are projected to grow from about 86,000 Gg in 2016 to over 142,00 Gg by 2035, an average annual increase of about 2.67% per year. The right side of the figure shows historical and projected trends for CO_2e emissions as a function of population and GDP. Notably, per capita emissions showed sharp increases over the 1994-2002 period and declining per capita emissions over the 2002-2016 period, suggesting that efficiency and co to conservation measures have been effective in counteracting steady population growth. Additionally, while CO_2e emissions as a function of GDP show inter-year volatility, there is a noticeable downward trend from 3.6 in 1994 to about 1.0 in 2016 - suggesting that the economy is becoming more efficient from a carbon footprint perspective.

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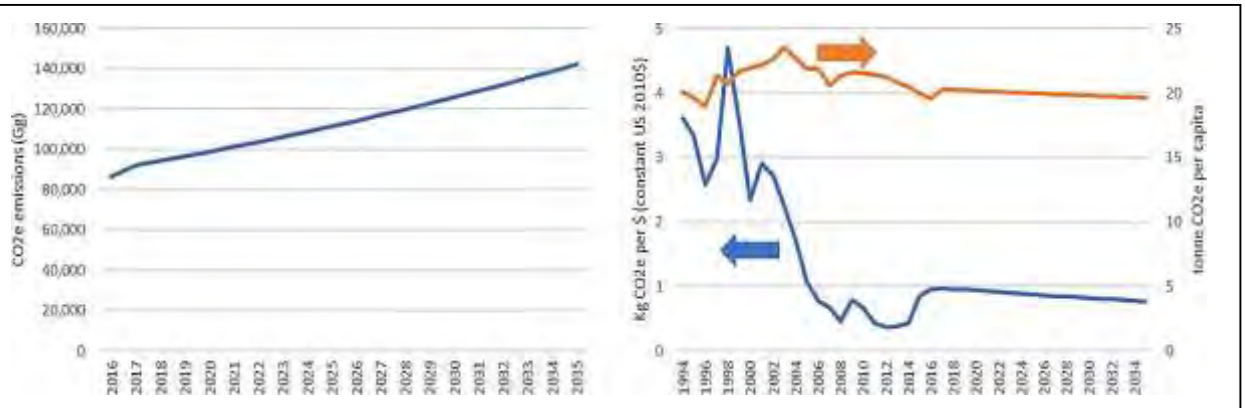

Figure 4-2: Left: Projected CO2e emissions in the Baseline Scenario; Right: Historical trends and projections for CO2e emissions per capita and per constant US$ of GDP

4.3. GHG Mitigation scenario

The GHG Mitigation Scenario incorporates emission reductions associated with several projects that have been proposed as expansions to the distribution efficiency and solar photovoltaic projects described above. A brief overview of these projects is provided in the bullets below.

- *Expansion of improved electric distribution efficiency.* This project expands the introduction of capacitor bank technologies at additional outdoor and indoor 11/0.433 KV substations to improve the power factor in the electric distribution system. Online years are 2019 and 2020 for outdoor and indoor substations, respectively. Annual GHG emission reductions are about 219.8 Gg for outdoor substations and 351.8 Gg for indoor substations, or total annual reductions of 571.6 Gg.
- *Expansion of renewable-based electricity production.* The Shagaya Renewable Energy Master Plan represents a 3-phase national vision to meet 15% of electricity requirements by renewable energy by 2030. The Plan incorporates solar thermal, solar photovoltaic and wind technologies. Phase I of the Plan introduces 50 MW of concentrated solar power, 10 MW of solar photovoltaics and 10 MW of wind in 2018. Phase II introduces an additional 1,500 MW of solar photovoltaics by 2022. Phase III of the Plan introduces an additional 200 MW of concentrated solar power, 1,200 MW of solar photovoltaics and 100 MW of wind by 2030. By its completion, the Plan will have introduced a total renewable energy capacity of 3,070 MW. Annual GHG emission reductions are about 5,000 Gg, equivalent to a displacement of 12.5 million barrels of oil equivalent.

The results of the GHG Mitigation scenario are illustrated in Figure 4-3. The left side of the figure shows projected CO_2e emission reductions by measure. The right side of the figure shows the resulting annual GHG emissions in the Baseline and GHG Mitigation scenarios. By 2030, total annual emission reductions are about 5,600 Gg, representing a reduction of about 4% of Baseline scenario emissions in that year. Cumulatively, nearly 60,000 Gg of CO2e is avoided over the entire planning period by the measures.

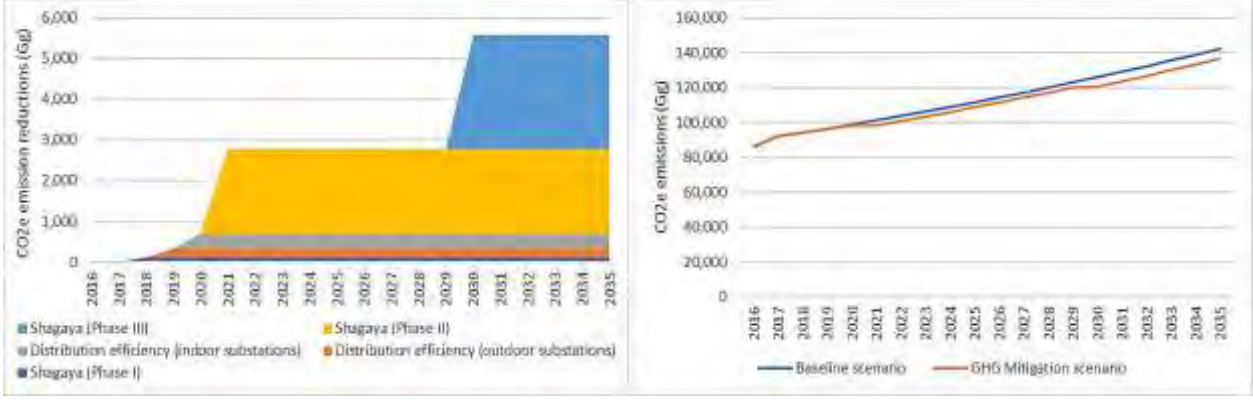

Figure 4-3: Left: Projected CO2e emission reductions in the GHG Mitigation Scenario; Right: Projected CO2e emissions in the Baseline and GHG Mitigation Scenarios

4.4. Future GHG mitigation opportunities

Going forward, there are several priority strategies that are being considered for achieving additional reductions, as outline in the bullets below.

- *Power supply.* Supply side combustion efficiency can be increased by shifting from current technologies to combined cycle gas turbines and maximizing the use of reverse osmosis over multi-stage flash technology in seawater desalination. Moreover, emissions can be further decreased by fuel switching (i.e., replacing liquid fuels in existing thermal power plants with natural gas) and
- *Transport.* There are several promising mitigation options for transport sector that are strategic for Kuwait. These include fuel efficiency improvements for vehicles, alternative clean fuel, transportation infrastructure improvement, as well as tariff and subsidy redistribution.
- *Industry.* The industrial sector in Kuwait covers chemicals, manufacturing fertilizers, cement industry, metallic products and food processing. Waste heat recovery from industrial processes is an important GHG reduction measure. Furthermore, adoption of more advanced plants, technologies, and processes are effective mitigation options leading to reduced electricity demand.
- *Waste.* Mitigation options in waste sector are based on the objectives of the National Development Plan in improving the efficiency of waste management by developing a safe waste management system for Solid, liquid and hazardous waste (Ensures the reduction of pollution levels resulting from traditional waste handling). Encourage the rehabilitation of landfill and gas utilization. Utilization of biogas from waste-water treatment. And, encourage waste recycling (Through providing all scientific consultations and provide incentives for investors to carry out recycling activities).

Going forward, Kuwait plans to build up its mitigation assessment capacities especially those related to human resources. Additionally, in order to improve the quality of future mitigation assessments, there is an urgent need to develop a national database for monitoring and reporting information related to GHG emissions and mitigation projects.

4.5. List of references

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5 . Technology Needs Assessment

This chapter provides an overview of a technology needs assessment for climate change. Both mitigation and adaptation technologies were considered. The technologies considered encompass “hard” technologies, such as equipment and infrastructure, as well as “soft” technologies, such as management practices and institutional arrangements.

According to the regulations of the UNFCCC, parties are supposed to submit an assessment of their country’s technological needs. In 2012, the State of Kuwait submitted the Initial National Communications under the UNFCCC, which included initial technological needs assessment. In 2018, Kuwait developed the second Technology Needs Assessment (TNA) report, which is part of the Second National Communications (SNC) Report.

5. 1. Methodology

UNDP’s Technology Needs Assessment (TNA) methodology was used to develop an understanding of the range of technology options that could be harnessed to address the challenge of climate change in Kuwait (UNDP, 2010). The TNA methodology essentially involved the development of a set of multi-criteria evaluation matrices for potential technologies to either reduce future GHG emissions or reduce Kuwait’s vulnerability to the impacts of climate change.

Enhancing technology development, transfer, deployment and dissemination is a key pillar of the international response to climate change. As a result, and to support the implementation of the UNFCCC Paris Agreement, Parties to the UNFCCC initiated the elaboration of the technology framework to further promote and facilitate enhanced action on technology development and transfer. The work on technology needs assessment (TNA) will play a key role in the implementation of climate technologies.

With reference to the aforementioned, the UNFCCC executed the Technology Needs Assessment (TNA) project. The Technology Needs Assessment (TNA) project assists developing country Parties to the UNFCCC determine their technology priorities for the mitigation of greenhouse gas emissions and adaptation to climate change. TNA is a set of country-driven activities leading to the identification, prioritization and diffusion of environmentally sound technologies for mitigation and adaptation to climate change.

In early 2017, Kuwait Environment Public Authority (KEPA) signed an agreement with the Regional Office for West Asia of the United Nations Environment Program (UNEP) to supervise the preparation of technical tasks implementation of the SNC project and the first periodic report of the State of Kuwait on the UNFCCC. To achieve main objective of this project, KEPA executed the SNC project in cooperation with several governmental organizations involving oil, power, industry, transportation, agriculture, waste, and research and education fields. All the efforts that has been taken by KEPA were to serve all the SNC aspects; in addition, a sure a successful completion of the report.

This report introduces an updated assessment of Kuwait's technological needs by referring to nationally active different sectors in the country. Priority given to the tools and technologies that will serve the sectors with the highest share in Green House Gases (GHG) emissions. The ultimate goal of the United Nation Framework Convention on Climate Change (UNFCCC) is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [i.e., human-induced] interference with the climate system". UNFCCC is the main international treaty on climate change.

TNA is important part of all country's national communications and so Kuwait's SNC. The TNA team of experts worked on a process that identifies the country's development priorities. Surveying ongoing policies, programs and projects as well as strategies that work for the favor of climate change mitigation and adaptation was part of the process. Figure (5-1) represents the TNA process that parties has to apply follow during the path of the assessment. This TNA report will bring to light the specific technologies that are the most appropriate to Kuwait, which will facilitate achieving its targets for the mitigation of greenhouse gases and adaptation to climate change.

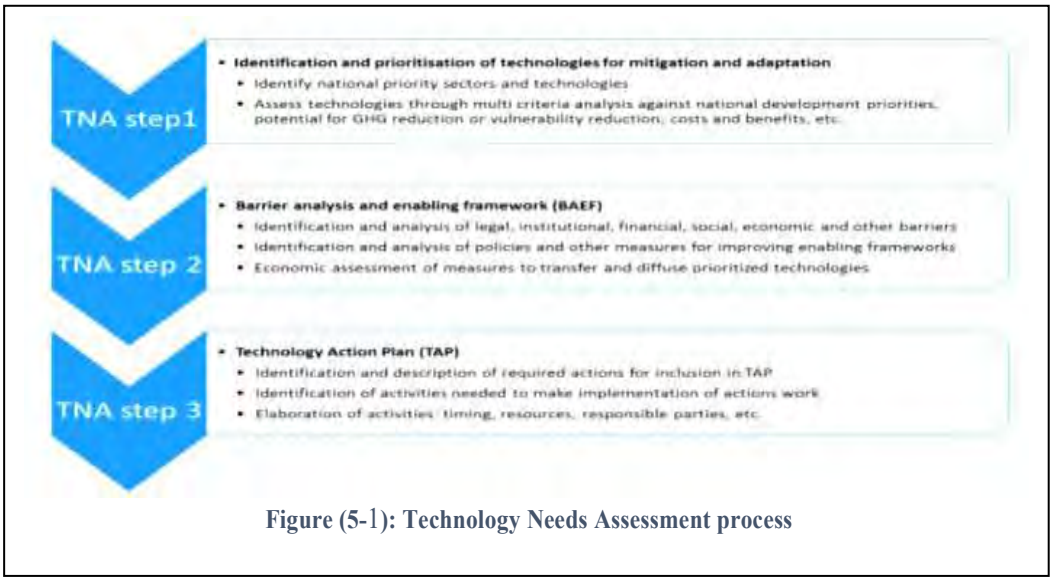

Figure (5-1): Technology Needs Assessment process

Technologies that were identified during initial stakeholder consultations were then assessed in a collaborative fashion among stakeholders relative to a set of four evaluation criteria. Each technology was evaluated qualitatively relative to each criterion and assigned a score of either high, medium, or low. Brief descriptions of the criteria are provided in the bullets below:

- Potential for GHG mitigation or building adaptive capacity:

For mitigation technologies, this involved an assessment of the potential magnitude of the GHG reductions that could be achieved in Kuwait in the near- to mid-term. For adaptation technologies, this involved an assessment of the increased resilience to known adverse climate change impacts.

- Resources available in Kuwait:

This involved an assessment of the ease with which the technology could be implemented in Kuwait. Specifically, the current availability of a critical set of technology-related resources - financial, institutional, and infrastructural - were considered

- Cost-benefit ratio:

This involved an assessment of the performance of the technology in terms of its costs (i.e., capital investment, operation and maintenance costs) relative to the potential benefits (i.e., emission reductions, reduced impacts) achieved

- Contribution to Kuwait development priorities:

This involved an evaluation of the extent to which the technology was consistent with national development objectives and constraints.

5.2. Mitigation technology assessment

Due to the prominence of energy production and consumption in Kuwait's GHG emission profile, the focus of the TNA was exclusively on the energy sector. Specifically, technologies for electricity generation, as well as technologies that can reduce residential building energy consumption were targeted. An overview of the results of the assessment is provided in the subsections below.

Kuwait like all the GCC countries rely heavily on fossil fuel to meet its increasing demand for electricity. One can see that more than 65% of GHG emissions are associated with the power generation, water desalination sector, and manufacturing industries, which exclusively depends on fossil fuel (Figure (5-2). The relative high consumption of electricity and water is the result of:

- Harsh hot environment
- Lack of natural potable water and
- Weak energy efficiency measures.

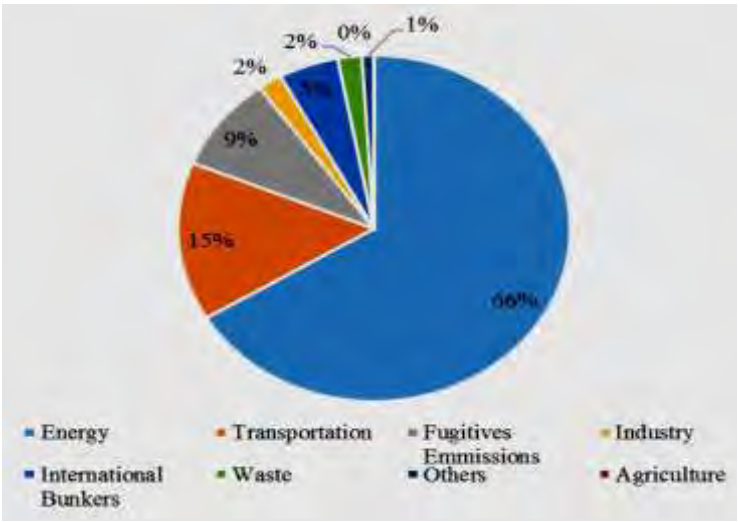

Figure (5-2): Average percentage CO2e emission by sectors from year 1994 to 2016.

The main contributors to the emission are both, the energy with a share of 66%, and transportation sector with a share of 15%. The energy is composed of the following sectors:

- Electricity
- Water and
- Manufacturing that involve fossil fuel combustion activities

Advanced fossil technologies for electricity generation

Achieving a sustainable and more competitive energy system is one of the most critical challenges for Kuwait's future. Advanced fossil technologies for electricity generation refer to options that have either higher operating efficiencies or lead to sharply lower GHG emissions when compared to current technologies in use in Kuwait. Some of these technologies are already in limited use in Kuwait. Examples include high efficiency natural gas combined cycle units and district cooling. Others have yet to be introduced and represent potentially significant contributors for achieving future GHG emission reductions. A brief overview of these priority technologies is provided in the bullets below. Table 5-1 summarizes the results of the evaluation of these technologies.

Technology	Mitigation Potential	Resources Available in Kuwait	Cost Benefit	Contribution to development priorities	Currently Implemented (or in process)
Carbon Capture and Storage	High	High	Low	High	No
Combined Cycle Gas Turbines	Medium	Low	Medium	Medium	Yes
District Cooling	Medium	Low	High	High	Yes
Natural Gas fuel switching	Low	Low	Low	Medium	Yes
Reduced Sulfur Oil Refineries	Low	High	Medium	High	Yes

Table 5-1: Mitigation technology evaluation results for advanced fossil technologies for electricity generation

- ***Carbon capture and storage (CCS):***

This technology prevents up to 90% of CO2emissions associated with power generation from being released into the atmosphere. CCS separates CO2 emissions from the process and transports compressed CO2 to secure geological storage locations, such as Kuwait's abandoned oil fields and deep saline formations. Several methods are becoming commercially available: post-combustion, pre-combustion, and oxy-fuel combustion, each offering different strengths and weaknesses, depending on the nature of the investment.

Carbon capture and storage (CCS) technologies, which could enable the use of fossil fuels while reducing the emissions of CO2 into the atmosphere, have yet to achieve significant cost reductions to be widely deployed.

- ***Natural gas combined cycle (NGCC):***

This technology is able to operate more efficiently by harnessing the large amount of heat emitted by a primary gas turbine for generating steam in a second turbine. Whereas a well-maintained conventional steam plant typically achieves combustion efficiency between 30% and 33%, advanced NGCC units can achieve combustion efficiencies equal to about 45%.

- ***District cooling:***

This is in case of heating; however, district cooling is the centralized production and distribution of cooling units (refrigeration ton).Chilled water is produced by cooling plants (that re in close proximity with building to be cooled) delivered via an underground insulated pipeline to office, industrial and residential buildings. Which would otherwise be wasted, to drive absorption chillers for air conditioning. In Kuwait's urban landscape, district cooling can be developed in new neighborhoods, providing a more efficient central cooling plant, rather than inefficient air conditioning units that contribute to stress on the electricity transmission and distribution infrastructure.

- ***Fuel switching:***

This refers to switching from high-emitting liquid fuels such as residual oil or diesel to natural gas. Fuel switching from oil to gas can reduce CO2 emissions by 10-30% an input basis. This operation strategy is suitable for Kuwait because a large portion of the world's gas reserves is located in nearby countries in the Arabian Gulf region, despite the fact that Kuwait's own natural gas reserves are minimal.

- ***Low-sulfur oil refining:***

This technology refers to the production of low-sulfur fuels at Kuwaiti refineries. Two initiatives for implementing such technology are already underway in Kuwait, the Clean Fuels Project (CFP) and New Refinery Project (NRP). The use of low-sulfur fuels results in lower SO2 emissions, which are an indirect greenhouse gas that is included in the national GHG inventory.

To establish a successful mitigation strategy, Kuwait must promote gas in the energy mix for diversification and decarbonization. The following steps must be considered:

a) Support Kuwait Petroleum Corporation's (KPC's) target to achieve 2.5 Bcf/d of non-associated gas production capacity by 2030
b) Expedite implementation of the Al-Zour LNG import and storage facility
c) Expedite MEW's efforts to maximise gas-fired power generation
d) strategically explore the potential for regional cross-border pipeline gas imports.

Renewable technologies for electricity generation

Exploring the second primary option, Kuwait initiated serious efforts to harness renewable energy much before a worldwide awareness of global warming. Solar power generation and application of solar energy for desalination and air-conditioning were the major areas of research from mid-seventies till mid-eighties. Renewable technologies for electricity generation refer to options that rely on non-emitting energy resources such as solar and wind. Several renewable technologies represent potential opportunities for ready integration in the energy system of Kuwait. A brief overview of these priority technologies is provided the bullets below. Table 5-2 summarizes the results of the evaluation of these technologies.

- *thermal:* This technology encompasses a range of small- and large-scale, A 100 KW solar thermal power station using the parabolic dish collector was commissioned in late 70. Recently, a 50 MW solar concentrating power (CSP) with 10 hours thermal energy storage plant has been online since November 2018. This plant is part of Shegaya Phase 1 renewable energy park.

- *Building-integrated PV systems (BIPV):* This technology involves the small-scale use of photovoltaic panels within parts of a building's envelope such as its roof or facades, solar cooling systems of small and medium cooling capacity using flat plate collectors and vapor absorption chillers were installed in a solar house, kindergarten and the ministry of defense building. Several installations of photovoltaic (PV) solar systems are installed in a school, co-operative societies (supermarkets) and number of public buildings. The total combined installed capacity of these systems is about 2.0MW.

Technology	Mitigation Potential	Resources Available in Kuwait	Cost Benefit	Contribution to development priorities	Currently Implemented (or in process)
Centralized Solar PV	High	High	High	High	Yes
Building-integrated PV	High	High	High	High	Yes
Solar Thermal Energy	Medium	Medium	Medium	High	Yes
Solar Ponds	High	Medium	Medium	High	No
Wind Energy	High	High	Low	High	Yes

Table 5-2: Mitigation technology evaluation results for renewable technologies for electricity generation

- *Centralized solar photovoltaic (PV):* This technology involves the large-scale use of photovoltaic panels that use the sun's rays to induce a difference in charge, or voltage, across two materials and thereby produce an electric current. Mirrors may be used to concentrate sunlight onto a solar cell and tracking —both single and double axis —devices may be installed to maximize a direct line as the sun moves across the horizon. Since Kuwait's daily electricity peaks are coincident with the solar energy profile, centralized solar power is potentially highly viable, therefor, several installations of photovoltaic (PV) solar systems were installed including the one of nearly 40 kW in a school. Other minor size PV units were installed for remote applications.
    - *options that harness solar thermal energy for domestic water heating.*
    - *Solar ponds*: This technology uses temperature gradients within pools of saltwater to collect thermal energy. The salinity gradient causes a density gradient that traps warmer water near the bottom layer. This technology was first considered in Kuwait in the later 1980s.

    - *Wind energy:* This technology harnesses the wind kinetic energy into electrical power. The primary requirement for feasibility of this technology is available wind resources. A site is considered economically feasible with wind velocities of 5.6 m/s at an altitude of 10 meters—also known as class 3 wind speeds. Initial studies show that annual average wind speed in Kuwait is only 5.5 m/s—just below the class 3 wind speed limit for economic feasibility. Shagaya Phase-1 wind farm with capacity of 10 MW is fully operational and currently connected to the national electric grid. Its generation exceeded its guaranteed performance. There is a plan to install more wind turbines in Shagaya Phase-3 of capacity reaching 100 MW.

Shagaya Renewable Energy Power Park

Shagaya project Kuwait's first step toward energy diversification. The renewable energy power plant comes with a national objective, that is to diversify sources of power to supply a considerable part of the local demand. The RE park represents the Kuwaiti Government's long-term ambitions of securing a significant renewable energy capability by the year 2030 in order to contend with rising domestic energy demands and keep additional crude oil resources for export.

This government-funded facility is currently under the supervision of KISR who are dedicated to exhaustively testing solar thermal, photovoltaic and wind energy technologies in order to determine their feasibility for further deployments across Kuwait. Three Phases of the 3.070 GW Shagaya RE Master Plan:

- Phase I: 70 MW of RE capacity (50 MW CSP, 10 MW PV and 10 MW Wind); totally the responsibility of KISR. Figure (6-4)

- Phase II: 1500 MW, extension of the plant to a total of 1,570 MW installed RE capacity; the added 1500 MW plant is going to be totally PV technologies. Phase II will be totally under the supervision of the Kuwait Petroleum Corporation (KPC) and fund will be provided from the Kuwait National Petroleum Company (KNPC).

- Phase III: 1500MW, extension of the plant to a total of 3,070 MW installed RE capacity. The added 1500 MW will be composed of 1200 MW Solar PV, 200 MW Solar thermal and 100 MW wind energy. Phase III will be the responsibility of the Ministry of Electricity and Water (MEW).

Figure (5-3) :Shagaya (phase I) 10 MW wind turbines, total of 5 wind turbines each of 2 MW.

Technologies to reduce electricity consumption in buildings (Residential, public, and commercial buildings)

Technologies to reduce electricity consumption in buildings refer to a range of options that improve building performance from an energy perspective. Building performance is dependent on several factors including envelope design and materials; heating, cooling, ventilation and lighting systems; occupancy density, site topography, and behavior of the building's inhabitants.

Residential sector is the major consumer of electricity accounting for more than half of the total electricity exported by the power plants. Interestingly, nearly 15% of the generated electricity used in the power plants for operation of various motors and for maintaining the indoor environment. In Kuwait, Air-conditioning (A/C) is the single largest consumer of electricity as it accounts for nearly 70% of the annual peak load demand and over 45% of yearly fresh electricity consumption. Lighting, the second most important consumer of electricity accounts for 15% of peak power and 20% of annual energy consumption Both, air-conditioning and lighting are heavily used in all type of buildings, residential, public and commercial, in addition to industrial facilities. Figure (5-4) shows the percentage of electricity consumption for the major consumers of electricity.

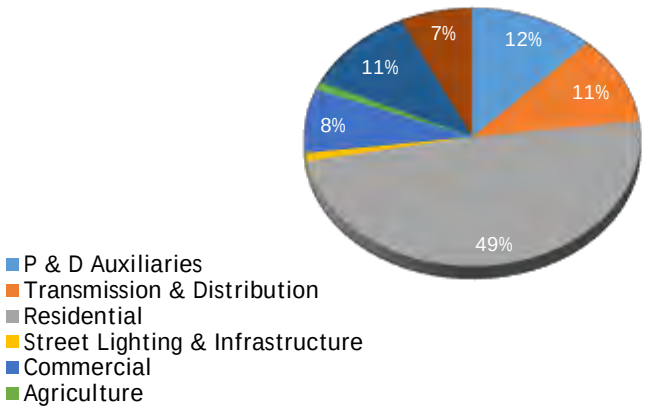

Figure (5-4): Composition of electricity consumption (%)

Reduction in the total primary energy demand, either in its direct consumption as in transport sector or improving conversion efficiency to secondary energy such as in the electricity sector is obviously the primary option to be targeted in the case of Kuwait. Accordingly, due to relevance and benefit to the national economy, energy conservation has been the essential goal, several energy efficiency and conservation measures are already being implemented in Kuwait to minimize electricity consumption from the different sectors. These measures range from regulatory, technology, economic and information measures Other measures represent new and potentially viable opportunities for improving residential, public and commercial sectors performance in Kuwait.

These measures fall under two main categories:

I. Demand side management measures

II. Supply side management measures.

Implementing energy efficiency measures in buildings sector to support a national mitigation policy:

- Update building regulations/codes to reduce AC permissible power, enhance fenestration systems, and install PV building integrated systems
- Retrofit buildings
- Implement district cooling
- Implement standardized labelling program for appliances and equipment
- Promote energy service companies.

Examples for measures from the former category include electrical load management and use of renewable energy sources to produce electricity. Examples for this category include:

- Setting energy efficiency performance standards
- Electricity tariff reforms
- Energy labelling
- Smart metering, and
- Public awareness leading to behavioral change

A brief overview of the priority technologies is provided in the bullets below. Table 6-3 summarizes the results of the evaluation of these technologies.

- Advanced controls: This technology involves the installation of advanced control systems to reduce solar heat gain in buildings. These systems operate by sensing direct sunlight through building windows. When the daylight intensity reaches some pre-set threshold, day lighting controls are triggered that automatically dim lights or close window shades. When combined with occupancy sensors that automatically manage cooling needs, the efficiency and functionality of living spaces can be enhanced, resulting in significant electricity savings. High performance buildings are often characterized by advanced control systems such as these.

Technology	Mitigation Potential	Resources Available in Kuwait	Cost Benefit	Contribution to development priorities	Currently Implemented (or in process)
Advanced Controls	High	Medium	High	High	Yes
Building Rating System	Medium	Medium	High	High	No
Building Codes	High	Medium	Medium	High	Yes
Incentives for Renewable	Medium	High	Medium	Medium	No
Reduced Subsidies	Medium	High	High	High	No

Table 5-3: Mitigation technology evaluation results for residential building performance

- Building rating systems: This technology involves the development of a system that can provide a meaningful metric for measuring the energy performance of residential buildings. Such a system can provide an objective signal to commercial architects, designers, and builders regarding what constitutes a "high performing" building from an energy perspective. Two examples from the Gulf region, the Pearl Rating System in the Abu Dhabi emirate's Estidama (sustainability in Arabic) program and the residential component of Qatar's Sustainability Assessment System (QSAS) may be helpful in informing the development of a rating system for Kuwait.

- Building codes: From a policy perspective, standards and codes are often used as a means of regulating and promoting energy-efficient building design and construction. These codes generally regulate wall and roof insulation, window glazing, ventilation, cooling efficiencies, cooling refrigerants and lighting. In Kuwait, the Energy Conservation Code of Practice (R-6), developed in 1983, sets minimum requirements for efficient energy use in new and retrofitted residential buildings. Efforts are underway since 2009 to update the code to energy conservation codes developed by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE 90.2).

- Incentives for renewable: Incentives may be used to shift behavioral trends among consumers, driven by the prospects of cost savings. Incentives for renewable energy would encourage investment in the use of solar energy for distributed household-scale energy production and domestic hot water heating. Such incentives are currently not in place in Kuwait.

- Reduced subsidies: Tariffs may also be used to affect consumer behavior. For example, retail electricity prices that reflect the total costs of electricity (i.e., production, transmission, distribution, and non-price factors) would encourage more electricity conservation. In Kuwait, residents are charged the lowest electricity rate in the world, at US$ 0.007per kWh, which is only 5% of the actual cost of electivity in Kuwait. Notably, this price has not changed since 1962 (Krane 2012).

5.3 Adaptation technology assessment

Three sectors that are considered highly vulnerable to climate change impacts were the focus of the adaptation technology assessment, coastal zones, water resources, and public health. An overview of the results of the assessment is provided in the subsections below.

Coastal zones

The majority of Kuwait's population resides and works in close proximity to the coastline, rendering the population and infrastructure susceptible to the impacts associated with climate change-induced sea level rise. With the buildup of chalet vacation homes along the coast and other infrastructure investments, the protection of coastal zones is increasing as a national priority.

Technologies for Kuwait's coastal zones refer to a range of options that can to reduce the vulnerability of people and infrastructure from the adverse impacts of rising seas. Some measures are already being implemented in Kuwait to address coastal erosion. Other measures represent new and potentially effective responses to future inundation and erosion threats. below summarize the results of the evaluation of these technologies.

A brief overview of these priority technologies is provided in the bullets below:

- Coastal information systems: This refers to information management regarding key features of the coastal zone, such as high-resolution land elevations and sea levels based on tide gauge data. In Kuwait, a Coastal Information System (CIS) has been developed based on hydrodynamic models to predict wave height and period from wind data for Kuwait's territorial waters. This information translates into water level and current statistics as well. These forecasts are accessible on the internet through a graphical user interface at http://www.hceatkuwait.net/ (Al-Salem 2008).

- Tidal barriers: This technology involves the construction of "hard" coastal protection structures. These include seawalls, levees, floodbanks, stopbanks, and embankments. Each function essentially as a barrier against the sea level at the maximum high tide level.

- Setbacks: This refers to establishing a rigorous definition of what constitutes "buildable land", i.e., land that is located a safe distance inland from coastal inundation zones. Construction within the zones at risk from future sea level rise would not be permitted. These setbacks can be established relative to either elevation or lateral distance from the coast.

- Prediction/prevention Center: This refers to the establishment of a Center in Kuwait to develop the systems, protocols, and models to address the impacts of climate change on coastal zones. The focus of such as Center would be to systematically develop the technical capacity to predict the assorted impacts of sea level rise on the coastal and marine environments, as well as to develop management plans to cope with coastal threats and disasters.

Technology	Adaptation Potential	Resources Available in Kuwait	Cost Benefit	Contribution to development priorities	Currently Implemented (or in process)
Coastal Information System	Medium	Medium	Medium	Medium	Yes
Tidal Barriers	Medium	Medium	Medium	Medium	Yes
Setbacks	High	High	High	Medium	No
Prediction/ Prevention Center	High	Medium	High	Medium	Yes

Table 5-4: Adaptation technology evaluation results for coastal zones

Water resources

The challenge to effectively manage Kuwait's already scarce water resources will likely intensify under climate change. Kuwait's dry, hyper-arid climate places great stress on the scarce freshwater resources available, while desalinated water is both costly and a source of greenhouse gas emissions.

Technology	Adaptation Potential	Resources Available in Kuwait	Cost Benefit	Contribution to development priorities	Currently Implemented (or in process)
Water Resources Program	High	High	Medium	High	Yes
Water Pricing	High	High	High	High	No
Reverse Osmosis Desalination	High	Low	High	Medium	Yes
Multi-Stage Flash Desalination	High	High	Medium	High	Yes
Building Retrofits	Medium	Medium	Medium	High	Yes
Irrigation Water Use Efficiency	High	High	Medium	High	Yes

Table 5-5: Adaptation technology evaluation results for water resources

Technologies to manage Kuwait's water resources refer to a range of options that can either increase water supply or increase the efficiency with which water is consumed. Some measures are already being implemented in Kuwait to address water supply and demand. Other measures represent new and innovative responses to water balance constraints. A brief overview of these priority technologies is provided in the bullets below. Table 6-5 summarizes the results of the evaluation of these technologies.

- Water resources program: This refers to information management regarding key features of the coastal zone, such as high-resolution land elevations and sea levels based on tide gauge data. In Kuwait, a Coastal Information System (CIS) has been developed based on hydrodynamic models to predict wave height and period from wind data for Kuwait's territorial waters. This information translates into water level and current statistics as well.

- Water pricing: This refers to water pricing strategies that can affect consumer behavior. For example, water prices that reflect total costs of extraction/production would encourage more water conservation. In Kuwait, one study predicted a 33% reduction in water from a water pricing strategy that included a free daily allowance of 150 liters per capita, followed by a constant rate of $1 per additional thousand liters of water.

- Reverse osmosis desalination: This technology involves using semi-permeable membranes and pressure to separate water from salt. Compared to other types of desalination technology, reverse osmosis has sharply reduced energy requirements. While the use of solar photovoltaic panels could further reduce fossil fuel needs, some supplementary fuels or thermal storage systems would be necessary to account for the intermittent nature of solar power.

- Multi-stage flash desalination: This technology is the most commonly used in the Arabian Gulf region for desalination. It involves the use of countercurrent heat exchangers to flash evaporate water into steam and collects the resulting condensation.

- Building retrofits: This refers to the installation of water-efficient devices in residential buildings. This is particularly important for Kuwait as the residential sector generates the greatest demand for freshwater. Examples of retrofits include new plumbing fixtures, new or tightened seals, water-efficient appliances such as dishwashers and washing machines, and upgrades to HVAC systems. Devices can be installed to measure water consumption and make the consumer more aware of their consumption.

- Irrigation water use efficiency: This refers to several types of technology to reduce water demand such as bio-diverse plantings, hydrozoning, and smart-irrigation controls. Bio-diverse plantings refer to the selection of particular plants for irrigation that account for Kuwait's harsh climate and biodiversity conditions. Hydrozoning refers to the process of segregating plants based on their water needs to prevent unnecessary or excessive irrigation. Smart irrigation control refers to systems that can sense weather conditions and irrigate plants to maximize efficient water use.

Public health

Climate change is expected to exacerbate public health primarily through the impacts on air quality. Under the increased temperatures associated with climate change, it is possible that dust storm frequency and intensity could increase, as well as concentrations of ozone emissions of volatile organic compounds and nitrogen oxides in the presence of sunlight and increasing temperatures.

Technology	Adaptation Potential	Resources Available in Kuwait	Cost Benefit	Contribution to development priorities	Currently Implemented (or in process)
Air Quality Monitoring	Medium	Medium	Medium	Medium	Yes
Vegetation	High	High	Medium	High	No

Table 5-6: Adaptation technology evaluation results for Public Health

Technologies to build resilience against climate change impacts on public health in Kuwait refer to a range of options that can monitor or reduce environmental loadings that lead to indoor/outdoor air pollution that can contribute to respiratory diseases. Some measures are already being implemented in Kuwait to monitor air pollution. Other measures represent new and innovative responses to public health threats. A brief overview of these priority technologies is provided in the bullets below. Table 4-7 summarizes the results of the evaluation of these technologies.

- *Air quality monitoring:* This technology refers to the development of an enhanced air quality information and monitoring infrastructure to cope with the additional threats to public health from climate change. Currently in Kuwait, the Kuwait Institute for Scientific Research an air monitoring station which can measure NOx, CO, CO2, H2S, SO2, O3, CH4 and non-methane hydrocarbon concentrations at various sites .The government operates and maintains an additional 15 air quality stations to monitor concentrations of SO2, NO2, CO, ground-level ozone (O3), and particulate matter less than 10 microns in diameter (PM10) and one mobile laboratory .

- *Vegetation:* This refers to the role that drought-resistant vegetation can play in controlling and reducing dust fallout from dust storms and land degradation. In Kuwait, one study showed that vegetation decreases dust fallout by at least two-thirds in densely vegetated areas. Terrestrial vegetation options include Nitrariaretusa, a large plant particularly appropriate for areas like Kadhma and Al-Mutla northwest of Kuwait City. Other options include the expansion of conservation land to include major sources of dust, muddy playas, and muddy tidal flats; green belts in the open desert to reduce high wind speeds; and cultivating marshes with salt-tolerant vegetation, like mangroves, to reduce amounts of airborne salt in the winter.

5.4 Barriers to technology transfer

The priority technologies discussed above for mitigation and adaptation face a number of barriers for widespread adoption in Kuwait. Two particular barriers to technology transfer/adoption – existing technology policymaking/regulatory environments and location-specific constraints - have been identified during the TNA process as requiring urgent attention. An overview of these key barriers is provided in the bullets below.

- *Policymaking and regulatory environment:* In Kuwait, policymaking and regulatory practices can often slow down necessary action for GHG mitigation. For example, policymaking related to electricity rate subsidies does not adequately account the extent to which these subsidies can thwart other important national development priorities. High electricity subsidies result in a situation where demand-side energy-efficient technologies, typically among the most cost effective of all GHG mitigation options, are too costly when compared to very low retail electricity prices.

- Location-specific conditions: Kuwait's hyper-arid desert climate presents a major barrier to many hard technologies that could be used for climate change adaptation. Both temperature, which can exceed 50°C in summer, and frequent dust storms, common between March and August, can have serious adverse effects on some of the technologies discussed in previous sections. Effective technology transfer requires maintenance and hygiene requirements that result from dust and sand accumulation. Additionally, the sudden cloudbursts that are common from October to April bring excessive amounts of rain capable of damaging key infrastructure.

5.5 Conclusions and recommendations

The recent oil prices drop (since late 2104), environmental concerns and geopolitical stresses have led to accumulation of negative implications on country's socio-economic sectors. Therefore, the need for an updated sustainable energy strategy that can deal with the domestic and international challenges has become an urgent requirement.

Given the critical challenges faced by Kuwait's energy system, there is a need to draw up a national energy strategy that establishes the main goals to be pursued in the next few years and the fundamental decisions to be taken towards these goals and define the priorities of policy action. A sustainable national energy strategy needs to cover four dimensions:

- Energy security: Recognizing the fact that current energy policies (business-as-usual) are not sustainable in the medium to long term;

- Economic security: Recognizing the impact of rising domestic energy consumption and oil market uncertainty on the Kuwaiti economy;

- Environmental security: Recognizing the environmental benefits relating to air quality improvements and mitigating local pollution impacts, as well as employment and diversification opportunities that a shift to sustainable energy can provide; and,

- Engagement and collaboration with stakeholders (government and private sector): partnerships between them, can be extremely beneficial in promoting and informing policies that can facilitate the transfer of technology for mitigation and adaptation in Kuwait and implementing a successful strategy.

It is of great importance to overcome the barriers identified above in order to develop an enabling framework in Kuwait for technology transfer and local technological innovation. The several key recommendations emerged from the TNA process to promote an enabling environment, as briefly summarized in the bullets below:

- *Implement energy efficiency measures in buildings sector:* (a) update building regulations/codes to reduce AC permissible power, enhance fenestration systems, and install PV building integrated systems; (b) retrofit buildings; (c) implement district cooling; (d) implement standardized labelling program for appliances and equipment; and (e) promote energy service companies.

- *Implement transportation efficiency measures:* (a) expedite the implementation of fuel efficiency standards for passenger vehicles; and (b) expedite the construction of a modern, efficient, mass public transportation system.

- *Implement energy pricing reforms as one of the tools to alter consumer behavior:* (a) gradually replace universal subsidies with targeted compensation schemes to eligible consumers; (b) incorporate measures to protect energy-intensive firms in the economy from the effects of price increases; and (c) launch a sustained long-term public awareness campaign ahead of energy price reforms.

- *Accelerate transmission and distribution initiatives* through tariffs and supply industry restructuring, for instance, by the introduction of smart metering, distribution retrofits for power factor correction, and distributed generation.

- *Involve the private sector in power generation:* (a) develop a clear legislative and contractual framework for the protection of investors' rights; (b) ensure creditworthiness of state institutions contracting with the private sector through government guarantees; (c) empower the designated regulator to enforce decisions under a clear regulatory framework with minimal intervention from higher levels of government; and (d) provide a level playing field for private investors vis-à-vis state companies to support the development of the private sector in energy.

- *Reform and strengthen policies and measures:* Policies and measures must be altered to accelerate the adoption of technology transfer. Furthermore, monitoring, reporting and verification procedures should be set in place in order to properly enforce policies that support GHG mitigation and adaptation to climate change, furthermore, expedite measures to improve the efficiency of electricity and water production.

- *Foster the emergence of technology "champions":* This will involve the establishment of a national research center to support climate change adaptation and mitigation activities. Such investments lead to the emergence of technology champions and key players at all levels. The center would be responsible for identifying processes and measures to be changed, identifying information and training requirements, and building partnerships across stakeholder communities within Kuwait and among potential international partners.

- *Develop market-based technology support systems:* This involves encouraging the development of new markets for technology, and the accompanying financial/technology support services. Priority actions include familiarizing decision-makers of new opportunities, creating new mandates and investment incentives that promote market push-pull dynamics, and raising awareness through information campaigns.

- *Strengthen technical capacity and education:* Skills training and education on all levels are important for the transfer of technologies for adaptation and mitigation. Universities and vocational institutions in Kuwait have already begun educating students about climate change mitigation and adaptation challenges. Successful technology transfer will require the alignment of mitigation/adaptation needs with training for new technologies that can meet future mitigation and adaptation goals.

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6. Constraints, Gaps and Needs related to Climate Change

Inadequate capacity (technical, financial and institutional) remains one of Kuwait's significant challenges as it confronts climate change. Enhancing capacity will depend on overcoming serious institutional, financial and technical constraints and gaps that currently interfere with affective action. With adequate support, Kuwait can build climate change resilience and explore the viability of low-emission development trajectories. The subsections below outline the key constraints, gaps, and needs to facilitate compliance with UNFCCC obligations and aspirational adaptation goals.

6.1 Constraints

Several technical, institutional, legislative, and financial constraints across various levels have been identified hindering implementation of climate change adaptation and mitigation activities in Kuwait. The following bullets are examples of such constraints:

- Lack of accurate data bases, and inadequate information and data collection, analysis and dissemination;
- Weak cooperation arrangements between agencies for providing GHG inventory data, resulting in difficulties in timely data collection; and
- Lack of familiarity with current methods and tools for undertaking a quantification of climate change impacts in vulnerable sectors.

6.2 Gaps

The following outlines the key capacity gaps relative to understanding climate change impacts in Kuwait, as well as policies and measures associated with GHG mitigation:

- Lack of access to long-term climate information and associated uncertainties for use in conducting vulnerability and adaptation assessments;
- Inadequate institutional and technical capacity to plan and implement climate change adaptation measures; and
- Limited funding for climate change related research focused on Kuwait and surrounding region.

6.3 Needs

Several capacity development needs were identified during the process of preparing the SNC. The following are among the key needs:

- Build public, and policy-maker awareness on climate change;
- Strengthen institutional and technical capacities through information and knowledge management;
- Enhance coordination among stakeholders at different levels, especially as it pertains to database development for future GHG inventories;
- Better integrate climate change considerations into national and sectoral development planning and policy dialogues; and
- Promote Involvement of local media in building awareness regarding climate change impacts and risks.

7. Other information

Inadequate capacity (technical, financial and institutional) remains a critical challenge in addressing climate change in Kuwait. Hence, the core objective in the preparation of the SNC was to establish a foundation for carrying out the kinds of assessments that can enhance understanding of the climate change challenge, inform future policy dialogues, and support the process of preparing subsequent national communications and biennial update reports.

The preparation of the SNC was highly participatory in nature. A national team was recruited mostly from relevant ministries and institutions, with senior management at KEPA's Climate Change section responsible for overall coordination and quality control. Carrying out the various assessments and analyses benefitted from inputs from experts from Kuwait University and international organizations. Staff from the West Asia regional office of the United Nations Environment Program (UNEP) provided backstopping guidance and technical support.

Preparing this SNC has been instrumental in establishing a new approach for addressing the challenge of climate change in Kuwait. There is now a network in place facilitating access to data; a system in place to account for and manage emissions data; and a framework in place to improve and upgrade information related to crosscutting components in support of climate policy. Not only have new protocols been established for improved documentation and archiving, but concreate action has begun promoting climate change education, training, public awareness, and capacity building.

7.1 Capacity building recommendations

The survey also provided an opportunity to indicate specific areas where capacity building activities should be targeted. Indeed, strengthening future capacity of stakeholders to promote and support GHG inventory development, climate change vulnerability assessment, identification of adaptation strategies, GHG mitigation analysis, and technology needs assessment is a consensus conclusion from the SNC process.

Key recommendations regarding the development of national GHG inventories are summarized in the bullets below.

- **Survey**

A survey was undertaken near the end of the SNC process to identify key issues and recommendations to inform the design of future capacity strengthening initiatives. Participation was high among all the members of the national team. Of the eight questions in the survey, two in particular were instrumental in understanding key challenges and formed the basis for subsequent recommendations for capacity building. The key questions are shown in the bullets below relative to the preparation of the national circumstances, inventory and vulnerability & adaptation chapters.
Table 7-1 summarizes the responses.

- *Difficulty.* What was the level of technical difficulty/ease experienced in completing each section of the SNC?
- *Constraints/gaps*. What were the key constraints and gaps faced in preparing each section of the SNC?

Table 7–1: Responses to capacity building questionnaire

	National circumstances	GHG inventory/mitigation	Vulnerability & adaptation
Difficulty	• Collecting & analyzing data • Difficulties in providing data • Lack of guidance	•Accuracy& lack of data •Assessment of data quality & analyzing, estimating data •Aon-cooperative authorities •Difference in fiscal & calendar year	• Difficulty in collecting data • Lack of following up • Delays in providing the necessary technology to complete the work
Constraints/ gaps	• Some essential data that was missing • Difficulty convincing some administrations to provide the required data • Gaps in data and years	•Briefing the report •Choosing method that best represents local situation •Missing data from the source due to non-recording for early years •Software requires overly detailed data •Lack of industrial classification according to energy use •Data inconsistency from different sources leading to inappropriate decisions and high uncertainty	• Inaction between members of one team • Climate data (for a long period) for Kuwait and surrounding region • Models and the gaps of the data in the whole region • Data collection of physical and fisheries • Format of the report • Some Experts have no time to meet with other members of the group

- Establish a national system to collect and manage activity and emission data required for updates to the inventory;
- Establish an ongoing GHG inventory committee with high-level representation from key ministries/institutions, having clear oversight and coordination authority; and
- Develop an integrated database of relevant information including annual statistical abstracts and annual reports from specific entities.

Key recommendations regarding the analysis of national GHG mitigation opportunities are summarized in the bullets below:

- Obtain training in methods and tools to analyze in detail the costs, benefits, and co- benefits of GHG mitigation policies and measures, starting with those included in Kuwait's nationally determined contributions;
- Build a cost and performance database regarding energy supply and energy demand management technologies and practices; and
- Develop a centralized database for monitoring and reporting information related to GHG emissions and mitigation projects.

Key recommendations regarding the assessment of vulnerability of key sectors and systems, together with the formulation of adaptation strategies are summarized in the bullets below:

- Obtain training in modeling approaches to assess the impacts of a) rising season coastal zones, b) water efficiency/conservation policies on water demand, c) changing salinity/temperature on commercial fisheries, and d) emissions co-benefits of renewable energy investments on public health;

- Obtain training on how to establish a national framework that links the results of vulnerability assessments to ongoing policy dialogues regarding adaptation options and strategies; and
- Conduct seminars and training workshops to build awareness among managers and decision makers of the consequences of climate change and the need to incorporate adaptation considerations in utility, urban, and resource planning

7.2 Education, Training and Public Awareness

There have been substantial efforts to provide environmental education and targeted educational activities. Several initiatives and projects have been implemented to promote environmental education in schools, universities and as part of continuing professional development to increase awareness of climate change threats. Some of the major institutions and activities are summarized in the bullets below.

- *Kuwait University (KU):* At both undergraduate and graduate level KU offers many courses and degrees through its various faculties. The various undergraduate programs equips students with basic environmental knowledge and advanced applications of environmental technologies in conservation of natural resources along with the use of contemporary information systems in environmental decision-making. The graduate programs offer master's degrees in environmental science and other disciplines.
- *Public Authority for Applied Education and Training (PAAET):* This is the other major academic institution in Kuwait, in terms of number of disciplines and of enrolled students. PAAET offers bachelor's degree in two environment-related field: Industrial Hygiene and Applied Environmental Sciences. In June 2016, PAAET signed a memorandum of understanding with the Environment Public Authority to enhance coordination, unify efforts and support scientific and technical cooperation to preserve the environment and to ensure its sustainability. The MOU will encourage research by faculty members in the environmental fields and assist in educating students about the urgency to preserve the environment.
- *Global Learning and Observations to Benefit the Environment.* On the informal basis, KFAS, in collaboration with Ministry of Education has launched the international Global Learning and Observations to Benefit the Environment (GLOBE) Program. The informal education program provides students and the public worldwide with the opportunity to participate in data collection and the scientific process and contribute meaningfully to an understanding of the Earth system, global environment in general, and climate change in particular. GLOBE provides grade level-appropriate, interdisciplinary activities and investigations about the atmosphere, biosphere, hydrosphere, and soil/pedosphere, which have been developed by the scientific community and validated by teachers. GLOBE connects students, teachers, scientists, and citizens from different parts of the world to conduct real, hands-on science about their local environment and to put this in a global perspective.

- *Kuwait Society for Environmental Protection (KEPS*): This is a well-established civil society organization that has been active in environment safeguards and increasing environmental awareness in Kuwait since 1974. The Society issues a monthly bulletin, which includes studies written by leading scholars who have influenced decisions in environmental planning and management. On 28 March 2017, the Society signed a memorandum of understanding with the Public Authority for the Environment to raise awareness regarding the impacts of climate change on the State of Kuwait in various fields including health, water resources and coasts and ways of adapting them. KEPS has made notable efforts in linking education and awareness of climate change through the inclusion of educational, public schools and university institutions in its programs and activities such as its Green Schools program (see Box 6-1).

- *Marine Environment Campaigns:* National teams and organizations concerned with the marine activities have carried out several campaigns and activities concerning the various aspects of marine environment, either jointly or separately, and more recently they have been focusing on the impacts of climate change on coral bleaching. Such campaigns have been launched by the Environment Public Authority, Senyar diving team at the Volunteer Tasks Center, the Kuwaiti Dive Team of the Scientific Club, the diving team of the Kuwait Oil Company, the Coast Guard, the Marine Surveillance, the Public Authority for Agriculture and Fisheries Resources, the General Directorate of Marine Fire and Rescue, Kuwait Maritime Club, along with research-based institutions like Kuwait Institute for Scientific Research and Kuwait University.

- *Snyar Diving Team:* Snyar is a volunteer diving team working on reconstruction the country's marine environment by monitoring beaches and coasts, preventing damage to the environment, and increasing awareness of marine life. Since its inception, Snyar has accomplished several achievements in the field of environmental protection in general and the marine environment in particular.

- *The Kuwaiti Dive Team:* The Kuwait Dive Team was formed of young volunteer divers in 1991, right after the Iraq war. The main goal was to preserve the marine environment. They started with cleaning up the coastline of military wastes, and gradually assumed the responsibility of lifting objects, rescue and rehabilitation, and restoration of Kuwait's marine environment. With government support and fund from private sector, the team tasks were expanded to include rescuing marine creatures; restoring coral reefs; creating habitats for sea creatures, as well as removing waste and discarded fishing nets. They also provide diverse trainings and environmental awareness campaigns.

7.3 Research initiatives

The Paris Climate Agreement offers new challenges and opportunities for policy-related climate research. This agreement also presents the task of widening the knowledge base on climate change and its consequences. In addition, there is a need for providing data to support evidence-based decisions regarding the implementing of the global sustainable development goals, including those relating to climate change mitigation and adaptation.

Key research areas include atmospheric sciences, soil moisture, hydrologic cycle, the marine environment, ecosystems and biodiversity, and climate impacts. General expenditures on research in Kuwait is typically very low, with only US$ 30 million spent over the 2011-2016 period. Key institutions involved in these research activities are briefly described in the

bullets below:

- *Kuwait Foundation for the Advancement of Sciences (KFAS):* This is a privately funded non- profit organization headed by H.H. the Emir of Kuwait, has a mission to "Stimulate and catalyze the advancement of Science, Technology and Innovation for the benefit of society, research and enterprise in Kuwait". KFAS has been active in supporting scientific research, building capacity, and funding technology application pilots. In 2017, it convened an international conference on climate impacts on coastal zones and the marine environment, oriented around a translation of a book by John Englander on sea level rise (see Box 6-1). KFAS leverages capabilities of national R&D organizations and professionals, focusing on fields of national priorities such as energy and environment sustainability in Kuwait. KFAS also funded the development of the Kuwait Emission Inventory System (KEIS) of criteria air pollutants (CAPs).

- *Kuwait Institute for Scientific Research (KISR):* This institution was established in 1967 by the Arabian Oil Company and became an independent public institution in 1981. Over the decades, KISR has amassed extensive knowledge in environmental research, surveys and management, including coastal management and atmospheric pollution; and urban infrastructure development. KISR also has a reputable capacity building programs aimed at developing skills and expertise of its manpower base (research, support and administrative), as well as providing similar opportunities to wider sectors in other governmental agencies and to the general public.

- *Kuwait Meteorological Department:* Hosted within the Directorate General of Civil Aviation, the Meteorological Department conducts research on atmospheric sciences. This department is the key institution for observing and monitoring atmospheric change. It operates extensive national observation networks, which include conventional meteorological and climatological observation stations and a network of Doppler weather radars.

Box 7–1: Example of KFAS research activities on climate change

In 2017, KFAS organized the Conference: "Our Seas: Theories, Data, and Policies" to present and discuss compelling evidence that the world's oceans – and the Arabian Gulf in particular - are already being affected by climate change. Topics addressed included sea level rise, sea acidification, sea surface temperature rise, and oxygen depletion, and their impacts on the marine and built environment.

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Annex 39

Intended Nationally Determined Contributions

The State of Kuwait - November 2015

Objective:

In accordance with Decision 1/CP.19 and based on the information mentioned in decision 1/CP.20 which invites all parties to submit their Intended Nationally Determined Contributions for the period post-2020. Kuwait prepared and submitted this document to join the world countries the march of limiting climate change based on its sustainable development plans and programs at the national level until 2035.

The State of Kuwait is seeking to adapt with the negative impacts and consequences of climate change. Also it's working towards moving to a low carbon equivalent emissions economy system based on its future business as usual emissions over the period 2020-2030. Through its efforts to achieve developmental, environmental, social and economic priorities under the framework of sustainable development. Therefore, the State of Kuwait attaches a great importance on diversifying the sources of energy production in the country, which contributes in avoiding the increase of greenhouse gases emissions by 2035.

Introduction

The State of Kuwait is considered one of the first countries to sign the United Nations Framework Convention on Climate Change; it joined the Convention on 28 Dec.1994 and entered into force on 28 Mar. 1995, and the state of Kuwait ratified Kyoto Protocol under the United Nations Framework Convention on Climate Change on 11 Mar. 2005, and entered into force on 9 Jun. 2005. The State of Kuwait shares the concerns of the international community in limiting the negative impacts of climate change, it recognizes that the global nature of climate change calls for maximum cooperation and participation in an effective international response in implementing the terms of the United Nations Framework Convention on climate change (UNFCCC) from all countries of the world in accordance with common but differentiated responsibilities as stated in Article 4 paragraph 1 , which says: "All

Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances."

In this context the standards of sustainable development of the State of Kuwait will be taken into consideration, as it is a developing country with a single source of income as the Convention stated in Article 4 .8, which says: " In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures "and paragraph (h), which states that" Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products "

1. The State of Kuwait National circumstances

Kuwait is located in the northeast of the Middle East and North Africa between latitudes 28º 30 " and 30 º5" and longitudes 46 º33 " and 48 º30" in the east. The total area of Kuwait is 17,818 km^2, including the nine unpopulated islands in the Arabian Gulf region. Kuwait's Government is considered constitutional state, where its Constitution has a democratic appeal which is developing rules that controls legislative, executive and judicial authorities.

1.1 Climate Change Impacts on Kuwait

As a results of the geographic location of the State of Kuwait, climatic conditions, geological nature, the characteristics of its soil, the attributes of vegetation cover and the patterns of land use, Kuwait suffers from these numerous environmental challenges including higher temperatures rates, higher airborne dust and sand falling ratio, increased frequency of sandstorms, lack of seasonal rains, limited water resources, increased desertification and decline of vegetation cover.

Note that these environmental challenges have been aggravated dramatically with the beginning of the twentieth century as a result of global climate change. The State of Kuwait is suffering from a rise in average temperatures. It is expected that the annual average temperature increases by 1.6 Cº during the period from 2010 to 2035 to reach its highest average temperature which is 28.7 Cº. In summer months (May to October) the maximum temperature reaches to more than 50 Cº in the shade (Figure 1).

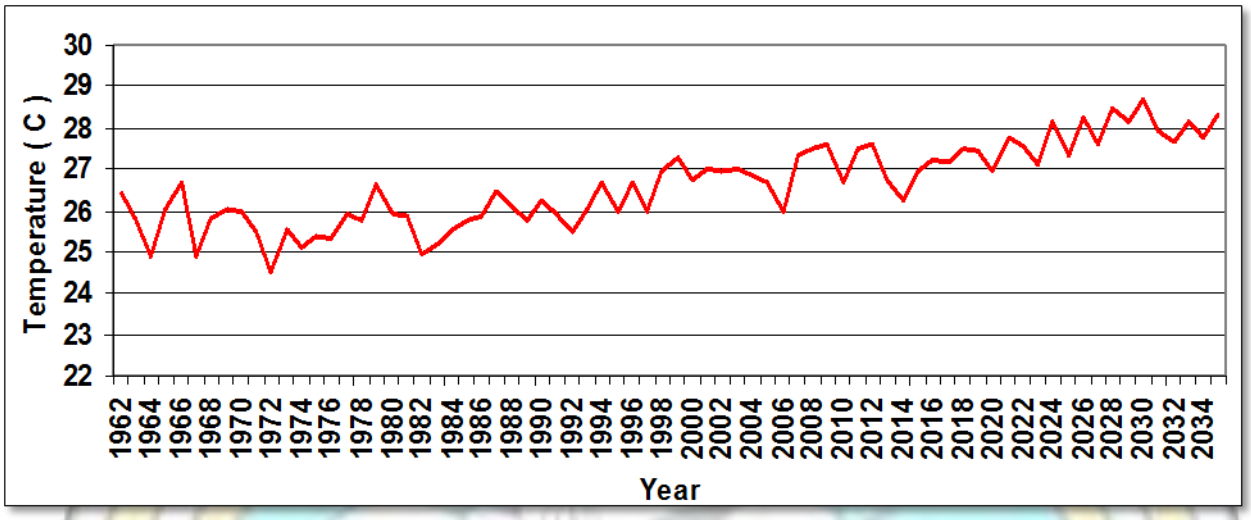

Figure 1: annual Average temperatures expected during the period 1962-2035

The increasing rise in average temperatures is accompanied by scarcity and lack of rainfall. Where the rate of annual rainfall is 116 mm and it is expected to decrease by 2 mm per year in the coming years, which will cause a decline in the groundwater level in the State of Kuwait (Figure - 2).

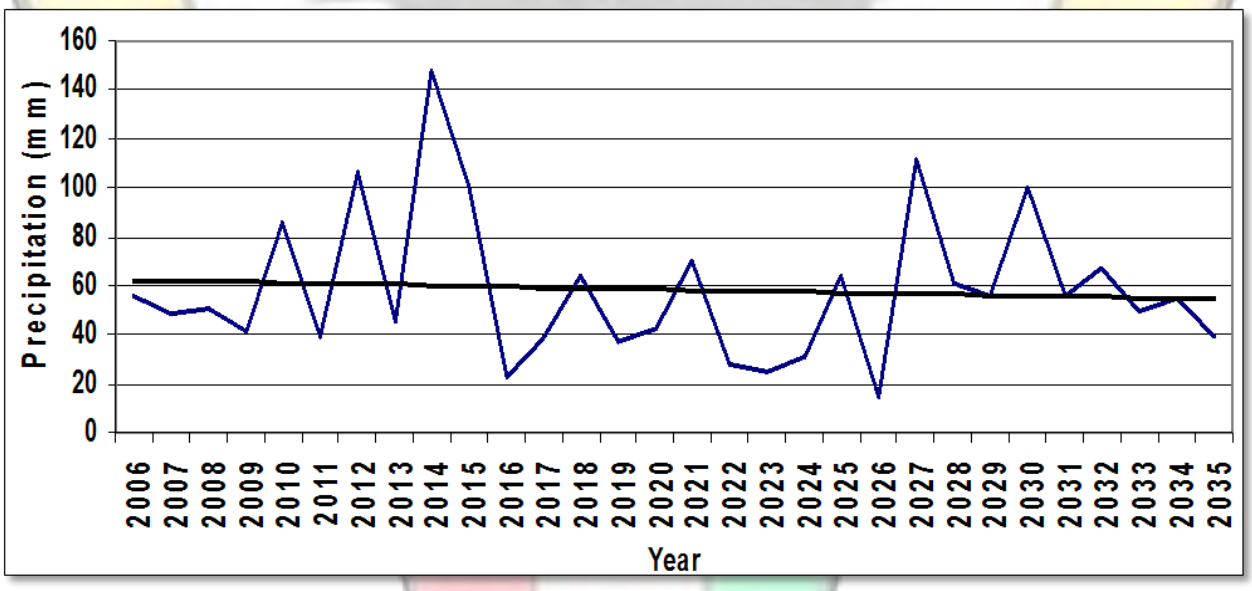

Figure 2: The average amount of annual rainfall expected during the period 2006-2035

All previous factors lead to increase in the percentage of drought and desertification in the State of Kuwait. Which results in the intensity of the frequency of dust storms in the state. Dust fallout rate is equivalent to 55 tons / km^2 per year in total around one million tons of dust falling annually. Moreover, it is expected that the intensity of the frequency of dust storms will increase as a result of the negative impacts of climate change. The impacts of climate change have begun to show in a tangible manner in the form of urban challenges, where the sand storms became more frequent with the rising heat waves and the drop of rainfall rate in winter.

Kuwait relies entirely on sea water desalination process to obtain fresh water where is 93% from the water supply comes from the desalination of sea water, while the remaining percentage comes from non-renewable groundwater due to scarcity of rainfall. However, the seawater desalination process consumes high energy with an adverse impact on marine and coastal ecosystems.

Global sea levels could rise by 1-3 meters during this century according to the Intergovernmental Panel on Climate Change (IPCC). Due to the nature of the low-lying coastal of Kuwait, it is at risk to sea levels rise associated with climate change. With a rise of (0.5 - 2 meters) at sea level. Kuwait could lose 1.4 -3% of its coastal territory, which affects 5% of its GDP.

Kuwait's population reached 3.368572 in 2013 with a steady increase over the past two decades by growth rate around 4.1%. The expected increase in population growth rate is combined with urban development and rapid provision of basic services to the population. In the light of the global decline in oil prices and the high cost of subsidies ratio in energy, water and housing prices, the State of Kuwait is facing many developmental challenges, including diversifying and enhancing work opportunities that provides safe working environments for citizens and residents, urban planning and housing, infrastructure and promoting national capacities to monitor and implement developmental plans.

It is worth mentioning that the state of Kuwait is considered a country with a single source of income, it relies mainly on the extraction and sale of oil in its public budgets. Thus, the state's economy is vulnerable to oil prices fluctuations in supply and demand, and Kuwait's industrial base is based on the extraction, refining and exporting of oil with an export revenue of more than 90% of the country total revenues, the value of the oil contribution to GDP represents 51-55%. Also Kuwait is entirely dependent on fossil fuels for energy production by 83.5% of liquid oil and 16.5% of natural gas.

1.2 GHG Distribution

The contribution of energy sector activities is equivalent to 95% of CO_2-eq emissions from the total national emissions as illustrated in Figure 3. It turns out that the main factor of emissions in the State of Kuwait is the heavy reliance on liquid petroleum fuels in most sectors, Also Current sources for energy production in the country relies on oil by 90% and natural gas 10%, electricity and water production plants Consumes 70% of oil and its derivatives, while the remaining 30% comes from natural gas, in addition to transportation sector which relies 100% on liquid petroleum products.

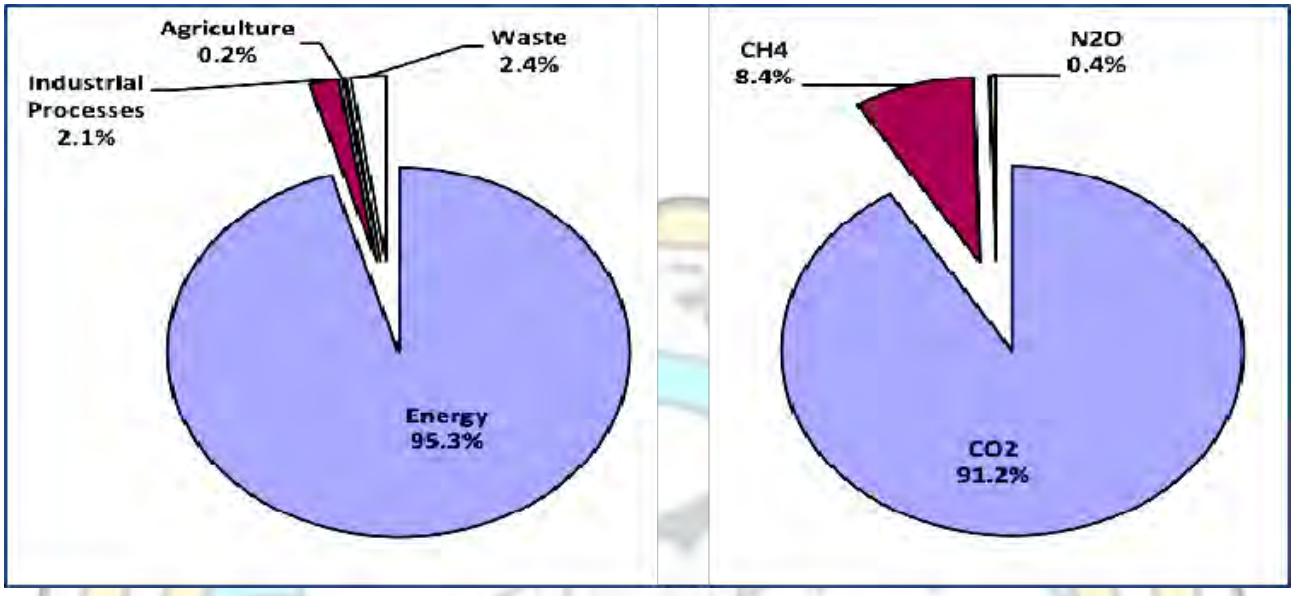

Figure 3: Distribution of greenhouse gas emission rates according to type and sector in 1994

2. Intended Nationally Determined Contributions

2.1 Mitigation

The State of Kuwait is ambitious to move to a low carbon equivalent economy and to avoid the increase in greenhouse gas emissions compared to business as usual patterns, based on plans and development projects in the country, and it is working on achieving this goal on a voluntary basis through the implementation of some projects and enacting laws and regulations, according to its national circumstances, which is Subjected to the availability of financial, technical and technological support through the mechanisms of the Convention. Note that the amount of the reduction resulted from the proposed projects will be estimated later.

2.1.1 Projects

Kuwait seeks to contribute in avoiding increasing emissions through projects and development plans within the most contributing sector to GHG emissions in the country which is the Energy sector and its activities, that represents 95% of the country's total emissions, these projects are:

- Improving petroleum products through producing clean fuel according to environmental specifications to supply power plants with it by 2020, this project will reduce greenhouse gas emissions from power plants and industrial sector in the state significantly.

- Construct a new refinery to replace the state's oldest refinery, which will meet international environmental standards in the way that the refinery will operate, where the amount of emissions will be low and the products of this refinery will be compatible with international specifications and standards.
- Projects related to energy production from municipal solid waste where the first project will start operating by 2020.
- Energy production from renewable sources (photovoltaic energy - solar thermal energy - wind energy), which is expected to reach the maximum production capacity of these projects by 2030.
- Mass transit systems project (metro system).
- Railway project that links ports of the State of Kuwait in order to achieve an integrated and sustainable development for transporting goods and passengers in Kuwait and abroad.

2.1.2 Laws and Regulations

Kuwait began the formal procedures to examine the law of reducing part of government gasoline subsidies starting from the beginning of 2016 and to study the possibility of a gradual reduction of subsidies on electricity and water, which will contribute significantly to rationalize consumption and reducing greenhouse gas emissions.

The Kuwaiti parliament recently adopted the Environment Protection Law No. (42) for the year 2014, amended by Law No. (99) for the year 2015, where the law is aimed to protect the environment and its resources, pollution control, and enhance natural resources, protection of society, human health and living organisms (Environment Protection Law, KEPA 2014), the law consists of 181 article dealing with development and environmental issues, and the protection of land, water and air environment from pollution , biodiversity, environmental management, penalties and civil liability and compensation for environmental damage, and related general provisions.

Some chapters of the Environment Protection Law 42/2014 discuss the energy sector directly and indirectly as listed in article (122) and (123) of Environment Protection Law mentioned the need to use energy-saving systems in the new state facilities. Also the law prevents importing any hardware or equipment that does not match the specifications of energy conservation.

The Environmental Protection Law in Article (111) urged the relevant state authorities to develop environmental strategies, action plans and programs within the scope of their work.

The articles of the law show the interest of the state and its orientation toward reducing greenhouse gas emissions from the energy sector by seeking to improve the management of energy consumption through the establishment of systems and rules for the devices used and the efficiency of energy

consumption in buildings (construction and design materials, air-conditioning systems and lighting ... etc.).

The environmental law paves the way to develop, adopt and implement a national strategy to reduce the state's energy consumption and diversify energy sources, particularly increasing the proportion of clean energies, to achieve His Highness vision the Emir of Kuwait Sheikh / Sabah Al-Ahmad Al-Jaber Al-Sabah may God protect him, where he announced that the state of Kuwait is seeking to fulfill the increasing demand of its energy needs from renewable energy sources by 2030.

2.2 Adaptation

Kuwait seeks to move to low-carbon economic system and adaptable to climate change to enhance and protect its natural resources and achieve sustainable development standards, were it is working hard to adapt with the impacts of climate change from high temperatures, lack of rainfall, sea level rise, lack of water resources and the increasing severity of dust storms.

2.2.1 Projects

- **Strengthen coastal information systems**: the establishment of forecasting and protection centers from water level rise, through data collection and development of information and basic requirements to monitor sea-level rise and to predict it with the purpose of enhancing the ability of strategic planning in adapting with this phenomenon in order to protect the shoreline.
- **Adapting to dust storms**: by Reducing the open desert land ratio from 75% to 51% and increasing the proportion of protected areas from 8% to 18%, and implementing green belts projects in the most vulnerable desert areas.
- **Food Security:** the development plan for developing the agricultural sector and strengthening its role beside increasing growth rates to raise the self-sufficiency ratios.
- **The Use of district cooling system in the new residential cities:** these projects will reduce the electric power consumed in cooling and conditioning houses which will enhances the power supply in the country in a sustainable approach.
- **Adapting to lack of water resources:** through the use of higher efficiency systems such as reverse osmosis system in water production, awareness campaigns for citizens on rationalization of electricity and water consumption and the use of modern techniques to rationalize the human consumption of water and in agriculture and industrial systems.

2.2.2 Laws and Regulations

With the State of Kuwait recent issuance of Environment Protection Law No. 42/2014 out of its believe in the importance of maintaining the ecological balance in the country to create a healthy environment for the citizens and to maintain the sustainability of its natural resources for future generations. The law gave utmost importance in some of its terms to topics related to adapting with

the adverse impacts of climate change phenomenon where it managed the use and consumption of natural resources. In the area of protecting the lands, articles (40) and (41) of the law discussed regulating the camping process and land use in grazing or any other activities that may harm the soil, which contributes in reducing the phenomenon of desertification and soil vulnerability.

In addition, articles (102) and (103) are specified for managing natural reserves in order to maintain biodiversity. Regarding water resources management Articles (88) and (89) have set the foundations to develop a program for water management in the country and the standards and regulations for water conservation in order to adapt to the scarcity of water resources in the country. To adapt to the expected rise in sea level and its impact on the coasts of the country articles (66) and (99) of the Law are dedicated for the marine environment and the need to create a national network for monitoring and regulating the marine environment and conducting studies to monitor sea level rise. Considering that the State of Kuwait suffers from numerous crises and natural disasters such as sand and dust storms and flash floods waves the law established Article (118), which states the needs to prepare emergency plans and crises and natural disasters management plans

Regarding food security, the state has issued laws related to entirely prevent fishing in Kuwait's bay to maintain biodiversity and fish stocks. Furthermore, there are laws specialized in banning fishing of some species of fish and shrimp in the territorial waters and allows it only in specified seasons to prevent the depletion of fish stocks.

The legislator also seeks through the Environment Protection Law No. 42/2014, as amended some of its provisions in Law No. 99/2015 to promote environmental culture in Kuwait society and spread information relating to the environment for public in order to change some the behavioral patterns among the citizens and residents in order to increase public awareness with the concept of natural resources sustainability and the proper usage of it.

3. Planning and Implementation

For the state of Kuwait to be able to implement the procedures of mitigating greenhouse gas emissions and adapting to climate change impacts and achieve sustainable development criteria, Kuwait needs the availability of technological and financial support by the relevant existing institutions under the Framework Convention such as technological mechanisms consisting of the Technology Executive Committee (TEC) and the Climate Technology Centre & Network (CTCN), as well as the Green Climate Fund (GCF).

In accordance with provisions of Article (4.7) of the Framework Convention which states that the extent to which the developing countries, including the State of Kuwait, fulfill its obligations under the Convention will depend on the developed party's providence of support to developing parties in the field of finance, technology transfer, so as to ensure an effective global cooperative action on climate change.

The State of Kuwait will proceed in preparation of low-emission development strategy (LEDs) and an action plan for adaptation. The second national communication project and the development strategy (Kuwait vision in 2035) will provide the general framework for the preparation of these plans.

The Environment Public Authority is currently preparing the regulations and guidelines for the Environmental Protection Law (42) for the year 2014, amended by Law (99) for the year 2015 and these Regulations will include particular topics of climate change such as reporting system of emissions, adaptation and mitigation.

4. Fairness and Ambition

The state of Kuwait assigns great importance to international efforts that deal with global warming, and believe that addressing this phenomenon is a common but differentiated responsibility among the countries of the world. Therefore, the State of Kuwait is keen on increasing its capacity in dealing with issues related to climate change simultaneously with its efforts in adapting with the negative impacts of this phenomenon and its consequences on the social and economic aspects. Also, Kuwaits current total emissions are merely about 0.27% of the total global emissions in 2013. And despite the fact that Kuwait didn't contribute to this phenomenon, Kuwait's geographical location made it vulnerable to the impacts of climate change that began to appear obviously in recent years by a significant rise in temperatures, scarcity of rainfall and increased sand and dust storms that paralyze life in the state and harm public health of the citizens and residents, which leads to increased losses and economic burdens on the state, in addition to the possibility of losing parts of the coastline in the country as a result of rising sea levels, which might endanger about 174 thousand individual !!

The State of Kuwait will suffer from economic and social consequences of negative impacts of response measures, where Kuwait is considered one of the countries that its economy dependent on oil and will be affected negatively from international policies and procedures of the UNFCCC. The Secretariat of OPEC as well as many international consultancy houses have prepared several studies

indicating in its wholeness that as a result of the intensive focus on fossil fuel sectors, particularly oil and oil products, the countries that produce and exporter oil will be affected enormously by the measures which the countries will be pursuing especially the developed ones from policies and procedures to reduce greenhouse gas emissions.

Given the national circumstances of the state of Kuwait, which is currently facing numerous economic, social and environmental challenges. Due to the growing population and the increasing demand of resources, particularly water and energy, which is accompanied with the decline in the national income because of mitigation policies of developed countries. Also taking into consideration the state's responsibility to provide employment opportunities, housing and to maintain the citizen's living standard, the Intended Nationally Determined Contributions of the State of Kuwait is considered very ambitious and fair.

5. General observations and assumptions

The state of Kuwait submitted its INDCs based on the development plans and projects of the state that will be presented later to the Kuwait National Parliament for adoption. These contributions are conditioned in providing financial, technical and technological support from developed countries within the mechanisms of the UNFCCC. The State of Kuwait preserves the right to reconsider these contributions based on future developments in the state's own national circumstances, the state's general policy and in case of any amendment to the Convention or related decisions of the Conference of the parties before it enters into force in a manner that includes rules or provisions that vary with the assumptions under which those contributions are submitted.

Annex 40

Kuwait National Adaptation Plan 2019-2030

Enhanced Climate Resilience to Improve Community Livelihood and Achieve Sustainability

UN environment

NEWKUWAIT

General Secretariat of the Supreme Council for Planning and Development

Environment Public Authority

UNDP Empowered lives. Resilient nations.

Environment Public Authority

Kuwait, 2019

Kuwait National Adaptation Plan 2019-2030

Enhanced Climate Resilience to Improve Community Livelihood and Achieve Sustainability

FOREWORD

Climate change is one of the main obstacles to human development at the present, and the fact that climate change is a global phenomenon, the risk of climate change is not confined to a specific place or who is responsible of emitting greenhouse gases, but beyond it to affect all mankind. where it affects different sectors in different ways and vary from place to another with its severity and the negative Impacts that cause it. The State of Kuwait is not an exception, as it is affected by climate change like other countries of the world, especially in the various vital and environmental sectors such as human health, coastal areas, water resources, marine environments and fisheries.

Climate change in arid areas is accompanied by a range of natural hazards associated with the sequential dynamics between humans, the environment and climate change, which has affected and still affecting the livelihoods of the populations throughout history. However, with the increasing Negative Impacts associated with climate change, it is necessary to increase our capacity to adapt to these changes by increasing resilience and flexibility these global challenges. Adapting to the challenges of climate change is the core of the challenge facing Kuwait and its people / inhabitants.

Kuwait is one of the countries that are most affected by the negative Impacts of climate change, especially those that climate change contributes in causing or increasing them, such as heatwaves, rainstorms and other rapid floods, as well as the increase in the number and intensity of dust storms and the rise of Sea level and the and consequent impacts on infrastructure projects and future long-term investment.

Climate change is the fundamental problem affecting natural resources, especially in arid, semi-arid and dry sub-humid areas. The key factor in the increase climate change negative Impacts is the interaction between natural and man-made factors, which is universally known as global warming. This reaffirms the need for international commitment to combat climate change and build national capacities to adapt to climate change. and concluded that this problem is not restrained to political boundaries but is rather mostly felt by countries that are the most vulnerable and are not equipped to face climate changes, even if they did not cause climate change .Therefore, the United Nations Framework Convention on Climate Change (UNFCCC) was created as a major international effort to halt climate change and increase the resistance to its negative impacts.

As a result of the State of Kuwait's commitment to preserve the local and regional environment, the Environment Public Authority (EPA) has developed The National Adaptation Plan. Which include medium and long-term strategies to increase strength and resilience in the face of climate challenges and to increase national capacity to adapt to climate change. It also includes a description of the environment’s state and the most important sectors affected by climate change and a climate change risk assessment. In addition, an index of the vulnerability of sectors has been developed according to internationally approved scientific methodologies. On this basis, a sequential hierarchy approach was used to determine the socio-economic impacts of climate change risks. And the main material risks of the key sectors were also identified. Accordingly, stakeholders were identified according to each sector and the consequent risks.

The Government of Kuwait, represented by the Environment Public Authority (EPA), has committed itself to ensure the implementation of its National Adaptation Plan (NAP), in partnership with other governmental and non-governmental institutions, furthermore A national coordination mechanism has been identified to implement a range of national initiatives to protect the various vital sectors from the Negative impacts of climate change. Therefore, future programs have been developed to deal with the various risks face the sectors and across time periods.

Despite the difficulty of dealing with the risks of climate change due to its complexity and impacts on more than one sector, A sustainable program have been proposed to increase resilience and build national capacities to address the risks and negative impacts of climate change. The proposed programs are related to the four vital sectors focus on management practices, functional practices, technical practices, land use planning, water management, human health protection and identification of short, medium- and long-term initiatives to adapt to climate change.

One of the expected results is a comprehensive ongoing monitoring program through the necessary environmental data and information to monitor climate change and assess its impact on the State of Kuwait on an ongoing basis, In partnership with all stakeholders such as the academia, private sector and non-governmental actors in the areas of adaptation to climate change.

The implementation of the NAP is not the responsibility of EPA alone. Where Adaptation to climate change requires the work of all stakeholders and integration in the design and implementation of initiatives in several sectors, including water, coastal areas, the marine environment, human health and others. Therefore, EPA will seek technical assistance from international organizations, industrial community and other stakeholders to implement the proposed programs to adapt to climate change and reduce the side effects associated with socio-economic problems. This will be achieved in the manner of implementing the national plan which is based on participation, while maintaining the coordination and oversight role of the EPA in the various activities and initiatives that aim to reach the desired goal to reduce the Negative impacts of climate change and adopt with it.

I would like to take this opportunity to express my sincere gratitude and appreciation to all local and international experts and national institutions who have worked together in a participatory manner to develop an action plan that meets the actual needs of the local environment and the needs of the State of Kuwait. I hope that this plan will be a cornerstone in the policy framework of reducing the risks of climate change and increasing the resilience towards it, continuously, for the benefit of present and future generations.

Sheikh Abdullah Ahmad AlHumoud AlSabah
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ABBREVIATIONS AND ACRONYMS

ASA	**Annual Statistical Abstract**
AQMIS	**Air Quality Management Information System**
BOT	**Build-Operate-Transfer**
BUR	**Biennial Update Report**
CIS	**Coastal Information System**
CMP	**Coastal Management Program**
CVA	**Climate Vulnerability Assessment**
CVI	**Climate Vulnerability Index**
eMISK	**Electronic Environmental Monitoring Information System of Kuwait**
EPA	**Environmental Protection Authority**
EPC	**Environmental Pollution and Climate Program**
FAO	**Food and Agricultural Organization**
GCC	**Gulf Cooperation Council**
GDI	**Gender Development Index**
GEF	**Global Environmental Facility**
GHG	**Greenhouse Gases**
GII	**Gender Inequality Index**
GIS	**Geographical Information System**
GNI	**Gross National Income**
GPD	**Gross Domestic Product**
HDI	**Human Development Index**

HFC	Hydrofluorocarbon
ICZM	Integrated Coastal Zone Management
IPCC	Intergovernmental Panel on Climate Change
IWPP	Independent Water and Power Project
KEPA	Kuwait Environment Public Authority
KEPS	Kuwait Environmental Protection Society
KFAS	Kuwait Foundation for Advancement and Science
KIA	Kuwait International Airport
KIEMS	Kuwait Integrated Environmental Management System
KISR	Kuwait Institution for Scientific Research
KUNA	Kuwait News Agency
KWD	Kuwait Dinar
MCM	Million Cubic Meters
MDGs	Millennial Development Goals
MEED	Middle East Economic Digest
MEW	Ministry of Electricity and Water
MGD	Millions of Gallons per Day
MIT	Massachusetts Institute of Technology
MODIS	Moderate Resolution Imaging Spectroradiometer
MPW	Ministry of Public Works
MSF	Multi-Stage Flash Desalination Unit
MSW	Municipal Solid Waste
NAP	National Adaptation Plan

NBK	National Bank of Kuwait
OPEC	Organization of Petroleum Exporting Countries
PA	Protected Agriculture
PAAFR	Public Authority for Agricultural Affairs and Fish Resources
PACI	Public Authority of Civil Information
PFC	Perfluorocarbon
PIC	Prior Informed Consent
PRB	Population Reference Bureau
RCP	Representative Concentration Pathway
RO	Reverse Osmosis
ROPME	Cooperation on the Protection of the Marine Environment
SDGs	Sustainable Development Goals
SDSS	Spatial Decision Support System
SEA	South East Asia
SLR	Sea Level Rise
SNC	Second National Communication
SST	Sea Surface Temperature
TDS	Total Dissolved Solids
TSE	Treated Sewage Effluent
TSE	Total Sewage Effluent
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme

UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
WEAP	Water Evaluation and Planning
WHO	World Health Organization
WRDM	Water Resources Development and Management Program
WWI	World War I
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY

Background

Climate change has become the most common threat to human development and adapting to climate change is becoming an essential component of any planning processes, at any time and at all levels. The Kuwait Environment Public Authority together with the UN Environment and United Nations Development programme launched a national initiative in 2017 aimed at designing a National Adaptation Plan (NAP) to enhance national adaptive capacity and resilience to reduce vulnerability to the impacts of climate change. In Kuwait, coastal zones and marine life and fisheries are the most sensitive sectors to climate change and its induced disasters.

This report forms part of the country's activities to comply with international environmental agreements. It includes analysis of baseline scenarios and analysis of projected scenarios and their impact on specific sectors in the country. The report represents guidelines of the national actions needed to adapt to climate change in Kuwait. The objectives of establishing the NAP process in Kuwait are to build an adaptive plan with capacity and resilience that can reduce vulnerability to the climate change impacts and facilitate and integrate the adaptation of climate change into policies, programs, and activities, within all national relevant sectors.

Methodology

The methodology included the analysis of existing data, literature review, and GIS modeling to define the impact of climate change on the selected sectors. Following the United Nations Framework Convention on Climate Change (UNFCCC) guidelines, Different decision support tools were proposed to evaluate the future climate change impact on Kuwait. The NAP process comprises four main elements that can be summarized as follows 1. laying the groundwork and identifying gaps; 2. making preparatory elements; 3. implementation strategies and; 4. reporting, monitoring and reviewing. The methodology used in this Action Plan focuses on the real planning activities, which are comprised of elements A and B of the NAP process.

National circumstances

To understand how climate change will affect Kuwait, a holistic view of the state's national circumstances is needed. Kuwait is a dry tropical and sub-tropical desert with a hyperarid climate and summers and winters in Kuwait have significant temperature differences. Due to the arid climate, it is nearly impossible for the soil to form, and strong wind erosion also limits soil formation. Due to its climate, Kuwait suffers from a scarcity of conventional fresh water, groundwater replenishing is even scarcer due to how dry the soil is and the infamous evaporation rate. The Gulf is however rich in vibrantly colonies of coral reefs with fish, sea turtles, sharks, dolphins, and whales swimming in its waters and Kuwait is also the home of many plants and animal species.

Climate hazards and vulnerability analysis

Kuwait NAP was set based on a Climate Vulnerability Assessment (CVA) and a Climate Vulnerability Index (CVI) at strategy level targeting the main four sectors identified in Kuwait Second National Communication Report to the United Nations Framework Convention on Climate Change (SNC). Those sectors are **marine life and fisheries, water resources, coastal zones,** and **human health.** Kuwait CVA's objectives are to identify and understand historical and projected climate risks at the country level, to evaluate sectoral climate risks to inform sector planning, and to identify gaps for conducting climate vulnerability index.

Climate projections such as increased temperatures will put pressure on Kuwait's **water resources** with increased demand for drinking water, which will put more pressure on the groundwater. Extreme weather, such as drought or flood, will affect **human health**, with an increased rate of respiratory diseases and injuries due to weather conditions. **Coastal areas** in Kuwait will face the destruction of infrastructure, due

to risen sea levels, along with corrosion of beaches and negative affected marine resources. Raising temperatures and sea levels will also impact the **marine life and fisheries** through coral bleaching, fish migration and disturbance in microplankton.

Results showed that increased sea-surface temperature risk has the greatest impact on marine life and fisheries sector with 5 points out of 5 in the ranking of climate change risks and vulnerability analysis. This is followed by the increased salinity and inundation of low-lying areas and their impacts on the marine life and fisheries and the coastal zones with 4.35 point each, followed by the risks of increased air temperature and its impact on water resources sector with 4.25 point.

Coordination of Adaptation Actions

As part of the NAP process, a stocktaking of the past and on-going climate change adaptation projects and initiatives that have been implemented in the State of Kuwait was prepared. Kuwait has implemented several projects to adapt to climate change in the water resources sector. The adaptation to climate change in the public health sector is one of the most critical sectors for Kuwait and the nation has undertaken some adaptation projects within this sector. Many projects investing in the agriculture sector are also taking place in Kuwait in addition to introducing new varieties of crops that can adapt to high temperatures and have high resistance to salinity and drought.

Adaptation action plan

Kuwait has implemented key adaptation measures to cope with climate change impacts, however, there are still major gaps and still more to do in all sectors. Within the **fisheries and the marine sector,** there is a lack of integration into adaptation and development plans and projects in Kuwait to help in meeting the local food security requirements as well as the absence of a strategic adaptive framework capable to respond to the emergency situations and hazardous crises. The major gaps in the **water sector** are poor water resources management and the lack of modern technologies, along with absence in information, studies, and knowledge. Within the **coastal zone sector,** the major gaps have been identified as the lack of restrictions, legislation, and policies in addition to inadequate communication. Finally, the major gaps within the **health sector** are insufficient climatic information which results in lack of awareness along with a lack of financial and physical capacities in Kuwait.

A set of adaptation measures are proposed in the NAP. These were divided into three categories; short-term initiatives to be implemented in less than a year; medium term-initiatives to be implemented in three years, and long-term initiatives those need three to five years to be accomplished. In total, 56 initiatives were proposed as follows; 21 short-term initiatives, 18 medium-term initiatives, and 17 long-term initiatives. The marine life and fishers' sector required the highest number of initiatives; 16, followed by the water resources sector with 15 initiatives, then the coastal areas sector with 13 initiatives and finally the human health sector needed 12 initiatives.

The important conclusions that can be drawn from the analysis are the high level of interest at the national level to enhance national and sectoral capacities to adapt to climate change and its induced disasters. The climate change and the variations among years, the high vulnerability of four main sectors and the adverse impacts of the different climate change scenario are of high concerns to decision-makers in the country. Therefore, the report had included many recommendations for adaptation at sectoral and national levels. In summary, the Action Plan recommends the preparation of sectoral action plan for adaptation with emphasis on the four main sectors. Mobilization of financial resources, therefore, is urgently needed for technology transfer and for implementing the proposed adaptation measures.

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CHAPTER 1: INTRODUCTION

1.1. Background

Climate change has become the most common threat to human development. Global climate change-induced disasters, such as increases in global temperatures, drought, flash floods, and sea levels rise, became sensible threats to human settlements and natural environments in recent decades. The Fifth Assessment Report of Inter-governmental Panel on Climate Change (IPCC) revealed that these global climate change aspects would have multi-directional impacts on anthropogenic and natural features at global, regional and local scales (IPCC, 2014). These impacts are expected to be severe in developing countries, especially those that extend in arid and semi-arid environments where the ecosystems are highly vulnerable (Lioubimtseva & Henebry, 2009).

Climate change has occupied a front seat and a major challenge to our planet. This necessitated adaptation plans for climate change to become a top of the list essential component of planning at all levels. The Kuwait Environment Public Authority together with UN Environment and UNDP aim at designing a National Adaptation Plan (NAP) with adaptive capacity and resilience to reduce vulnerability to the impacts of climate change. Also, this NAP will strengthen the national capacity of the country to assess climate change policy options and development planning strategies across different sectors and economic activities.

Adaptation can be classified as preventive and reactive adaptation, autonomous and planned adaptation, and private and public adaptation (IPCC, 2007a). The establishment of NAP requires adequate information on risks and vulnerabilities to identify the needs and appropriate adaptation options that can reduce risks and build resilient capacity. It is important to engage stakeholders with different knowledge, experience, and backgrounds

in order to reach a shared approach to addressing the challenges and needs (Preston and Smith, 2009; Tompkins et al., 2010; Fünfgeld and McEnvoy, 2011).

1.2. Purpose and objectives of the UNFCCC

Adaptation is defined as a human-driven change in social, ecological or economic systems or policy processes, in response to a climate stimulus and their potential impacts (IPCC, 2007a). The Intergovernmental Panel on Climate Change (IPCC) has defined adaptation with regards to the ecosystems, human societies and the possible exploitation of the climate change benefits: "Adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007b).

The main objective of the UNFCCC is to "*stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*."[1] through genuine and collaborative action at all levels, supported by international cooperation and partnership arrangements, in the framework of an integrated approach consistent with Sustainable Development Goals (SDGs), with a view to contributing to the achievement of sustainable development in affected areas.

1.3. The need for National Adaptation Plan (NAP)

Adapting to climate change is becoming an essential component of any planning processes, at any time and at all levels. At the 17th Conference of Parties (COP), of the United Nations Framework Convention on Climate Change, the Convention acknowledged that national adaptation planning enables affected countries, mainly developing and least developed countries, to assess their vulnerabilities, to mainstream climate change risks, and to address adaptation. It also acknowledged the need to address adaptation planning in the broader context of sustainable development planning to enable countries to achieve their millennium development goals (MDGs) and more recently the sustainable development goals (SDGs). Hence, the COP established the national adaption plan (NAP) process to facilitate effective adaptation planning. Accordingly, the planning for adaptation at the national level should be a continuous,

[1] UNFCCC. Article Number 2. Retrieved 5 January 2019.

progressive and iterative process. It should be based on national priorities with a focus on vulnerable communities and sectors and should be mainstreamed in national strategies, action plans and policies to ensure effective implementation. According to the UNFCCC, COP 17th, the main objectives of these action plan are[2]:

a) *To reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience;*
b) *To facilitate the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular, development planning processes and strategies, within all relevant sectors and at different levels, as appropriate.*

Accordingly, the NAP shall incorporate long-term strategies, within the national policies for sustainable development, to adapt to climate change. It is also expected that NAP should enhance national climatological, meteorological and hydrological capabilities and the means to contribute to climate change-induced disasters early warning. It should promote policies and strengthen institutional frameworks which develop cooperation and coordination, in a spirit of partnership between the government, local populations, and community groups and facilitate access by local populations to appropriate information and technology. As a participatory approach, NAP is expected to provide effective participation at the local, national and regional levels of non-governmental organizations and local populations, both women and men, particularly resource users in policy planning, decision-making, and implementation and review of the NAP; and require regular review of, and progress of implementation.

1.4. Climate Change

Despite the different debates in definition and causes of climate change, the term "*Climate Change*" was used to indicate any change in the climate over time, whether due to natural variability or as a result of human activities. The most widely accepted definition of climate change, climate variability, adaptation, resilience, and vulnerability come from the IPCC Fourth Assessment Report (2007) as:

[2] Decision 5/CP.17, paragraph 1.

Climate change Refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC AR4, 2007).

Climate variability Variations in the climate (as measured by comparison with the mean state and other statistics such as standard deviations and statistics of extremes) at all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability) or to variations in natural or anthropogenic external forcing (external variability) (IPCC AR4, 2007).

Adaptation human-driven adjustments in ecological, social or economic systems or policy processes, in response to actual or expected climate stimuli and their effects or impacts (LEG, 2011). Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC Fourth Assessment Report (AR4), 2007).

Resilience The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization and the capacity to adapt to stress and change (IPCC AR4, 2007).

Vulnerability The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity. Therefore, adaptation would also include any efforts to address these components (IPCC AR4, 2007).

These definitions are widely used in all development, humanitarian and research work related to climate change adaptation and mitigation. As included in the UNFCCC work and IPCC reports, the problems of climate change are mainly affecting developing and least developed countries.

1.5. National Adaptation Plan in Kuwait

This document represents guidelines of the national actions needed to adapt to climate change in Kuwait. The overall objective of the National Adaptation Plan (NAP) is to *provide an integrated development plan and subsequent programmes targeting local communities and environmental components in areas under the threat of climate change*. The NAP is prepared in accordance with the UNFCCC directives and articles and includes a detailed survey of the environment and the most affected areas and sectors in climate change, detailed analysis pertaining to climate change vulnerability, and gaps in each sector to adapt to climate change. Subsequently, programmes and projects are to be initiated in the short term and in the long term to adapt to climate change in the country. The programmes form integrated strategies and plans for sustainable development under the threat of climate change.

1.6. Process and methodology of establishing the NAP

The key frameworks for implementing adaptation actions are Action Programmes. The convention calls upon affected countries to develop National Adaptation Action Plan (NAP) with the full participation in the process of all parties with a stake in the issue of climate change. The proposed projects and programmes need to reflect the factors that contribute to climate change as well as generate practical solutions to adapt to its consequences. The convention also calls for the building of partnership at national, regional and global levels as well as for the development of innovative resource mobilization strategies and well-structured effective implementation plans.

The United Nations Framework Convention on Climate Change (UNFCCC) has produced technical guidelines to support the NAP process in the Least Developed Countries. The process aims to assist in reducing the vulnerability to the impacts of climate change and to address adaptation options (UNFCCC, 2012).

The UNFCCC technical guidelines for the national adaptation plan process is proposed to be followed in the preparation of the NAP process framework and roadmap. The main objectives of establishing the NAP process in Kuwait are to:

a) build an adaptive plan with capacity and resilience that can reduce vulnerability to the climate change impacts; and

b) facilitate and integrate the adaptation of climate change into policies, programs, and activities, in specific development planning strategies and processes, within all national relevant sector.

The process of NAP preparation in Kuwait was based on the following principles:

- The NAP preparation was based on the "Second National Communication Report to the UNFCCC", in which the country's vision is clearly reflected and the main sectors affected by climate change are identified,
- The NAP was processed in a well-designed time frame following the UNFCCC NAP preparation guidelines which were also tailored whenever and wherever needed. Moreover, the innovative projects have been formulated based on priorities determined throughout the SNC process in order to maintain credibility with affected sectors,
- The international knowledge and know-how in climate change adaptation were utilized by involving key international experts in NAP development and finalization. National experience in climate change adaptation was also integrated by involving a few national experts in the NAP development,
- National consultations at different levels were undertaken to identify main stakeholders, build long-term commitment, mobilize support and to create a consensus for action.
- Several national consultation meetings and workshops were held as part of the consultative mechanism to enable various interest groups to reach consensus on how to proceed with the NAP, which priorities to address, and in what order. The stakeholders' involvement workshops included extensive consultation with all key stakeholders

at all levels and from different sectors to ensure the involvement of all sectors' representatives.

The NAP process defined by the UNFCCC comprises four main elements that can be summarized as follows:

(A) laying the groundwork and identifying gaps;
(B) making preparatory elements;
(C) implementation strategies and;
(D) reporting, monitoring and reviewing.

Elements A and B are the main skeletons of the NAP, while elements C and D are implementation post plan stages (UNFCCC, 2012). This UNFCCC framework can be customized according to the specific situation and requirements of the State of Kuwait as shown in Figure 1 highlights the detailed steps of each element.

FIGURE 1: PROPOSED NAP PROCESS ACCORDING TO UNFCCC

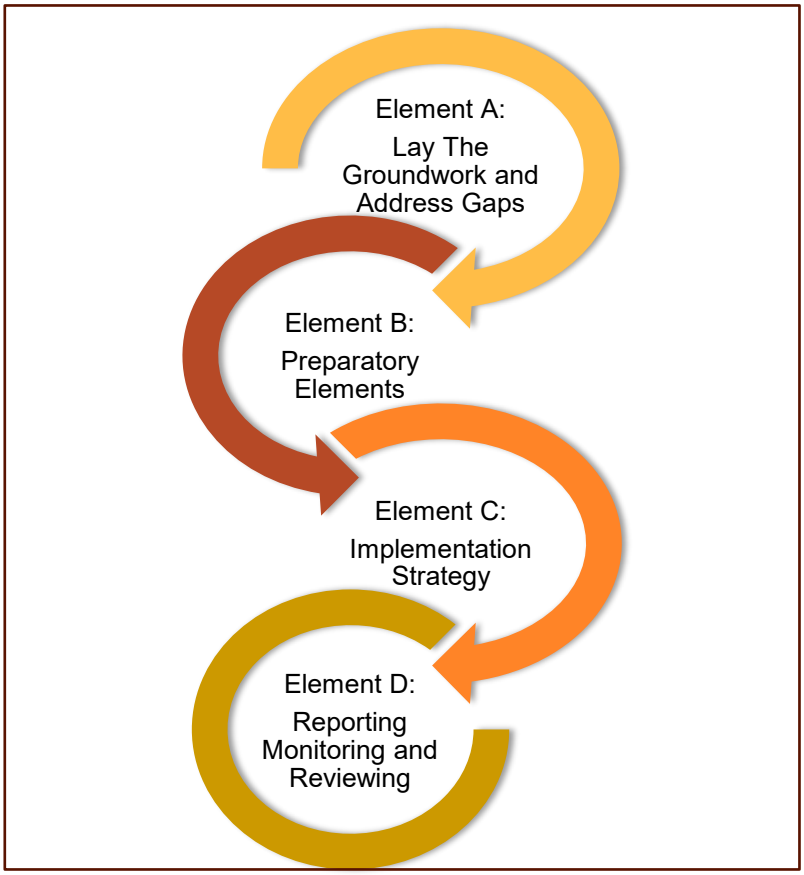


TABLE 1: NAP PROCESS ACCORDING TO UNFCCC[3]

Item	Description
Element A: Lay the groundwork and address gaps	
A.1	Initiating and launching the NAP process
A.2	Stocktaking: identifying available information on climate change impacts, vulnerability and adaptation and assessing gaps and needs of the enabling environment
A.3	Addressing capacity gaps and weaknesses in undertaking the NAP process
A.4	Comprehensively and iteratively assessing development needs and climate vulnerabilities
Element B: Preparatory elements	
B.1	Analyzing current climate and future climate change scenarios
B.2	Assessing climate vulnerabilities and identifying adaptation options at sector, subnational, national and other appropriate levels
B.3	Reviewing and appraising adaptation options
B.4	Compiling and communicating national adaptation plans
B.5	Integrating climate change adaptation into national and subnational development and sectoral planning
Element C: Implementation strategy	
C.1	Prioritizing climate change adaptation in national planning
C.2	Developing a (long-term) national adaptation implementation strategy
C.3	Enhancing capacity for planning and implementing adaptation
C.4	Promoting coordination and synergy at the regional level and with other multilateral environmental agreements

[3] Source: UNFCCC, 2012

Element D: Reporting, monitoring and reviewing	
D.1	Monitoring the NAP process
D.2	Reviewing the NAP process to assess progress, effectiveness, and gaps
D.3	Iteratively updating the national adaptation plans
D.4	Outreach on the NAP process and reporting on progress and effectiveness

These four elements can be summarized as follows:

- **Laying the groundwork and identifying gaps:** A pre-planning stage of NAP process. It covers three major areas: (1) initiating and launching NAP process; (2) stocktaking and synthesizing the available information and data on climate change impacts, vulnerability, adaptation in addition to assessing gaps and needs of the enabling environment (3) addressing capacity gaps and weaknesses in undertaking the NAP process.
- **Making preparatory elements:** This is the planning stage of the NAP process. Planners must identify the suitable methodological framework for respective countries considering the ground realities in respective countries. However, UNFCCC emphasizes the necessity of extensive consultation of relevant stakeholders in the planning stage.
- **Implementation strategies:** This is a post-planning stage that deals with implementing the selected interventions of the action plan. However, essential aspects of implementation strategy should be laid down in the plan itself with necessary flexibility for adjusting unforeseen changes that may come up in the future.
- **Reporting, monitoring and reviewing:** The final post-planning stage of NAP process deals with the monitoring of the implemented activities of the plan. However, mechanisms for reporting, monitoring and reviewing the progress of the plan shall be set. These mechanisms aim at reviewing the progress and iteratively updating the plan according to the unforeseen changes.

1.7. Kuwait Methodology

The methodology used in this report focuses on the real planning activities, which are comprised of Elements A and B of the NAP process, they include (a) initiating and launching NAP process; (b) stocktaking and synthesizing the available information and data on climate change impacts, vulnerability, adaptation in addition to assessing gaps and needs of the enabling environment, (c) addressing capacity gaps and weaknesses in undertaking the NAP process, (d) analyzing current climate and future climate scenarios; (e) assessing vulnerabilities; (f) identifying, reviewing and appraising adaptation options and (g) compiling and communicating national adaptation plan.

This methodology aims at covering the main elements of the NAP as summarized in Table 2.

TABLE 2: METHODOLOGY FOR THE NAP PROCESS IN KUWAIT.

Steps	Description
1.	Analyze the major climatic changes in the atmospheric and coastal systems for the State of Kuwait.
2.	Determine the physical impacts and dimensions of these changes accompanied by the major projections.
3.	Assess the main vulnerabilities and risks caused by the determined physical impacts of the projected changes on major sectors of the country.
4.	Estimate the socio-economic outcomes of the changes in the concerned stakeholders and sectors.
5.	Recognize the concerned stakeholder and relevant sectors adaptation needs such as: - Social Needs - Biophysical and Environmental Needs - Institutional Needs - Need for Engagement of the Private Sector - Information, Capacity, and Resource Needs
6.	Promote appropriate adaptation options to fulfill the needs and select the most suitable alternative.

7.	Prioritize the actions required for the implementation of the selected options for fulfilling the national adaptation needs.
8.	Producing a draft of NAP and have the NAP process endorsed by KEPA, then communicate it with the relevant stakeholders at the national level.
9.	Identifying the opportunities and constraints for integrating climate change into the planning process.

Consultations' outputs:

- An agreed upon and clearly-outlined mechanism for coordination among the existing concerned institutions, i.e. all relevant activities and consultations have been overseen by the Government lead agency responsible for climate change,
- Participation of all concerned stakeholders ensured,
- Agreed on and identification of priority areas in which projects are to be formulated and implemented.

Sectors identified in the SNC:

- Water Resources;
- Human Health;
- Coastal Areas; and
- Fisheries and Marine life.

1.8. Road Map Checklist for NAP Process

A proposed checklist for the road map of the NAP Process is prepared to highlight the detailed activities and the expected outputs for each of the four elements of the NAP process. Figure 2 includes the proposed framework for the road map of the NAP Process.

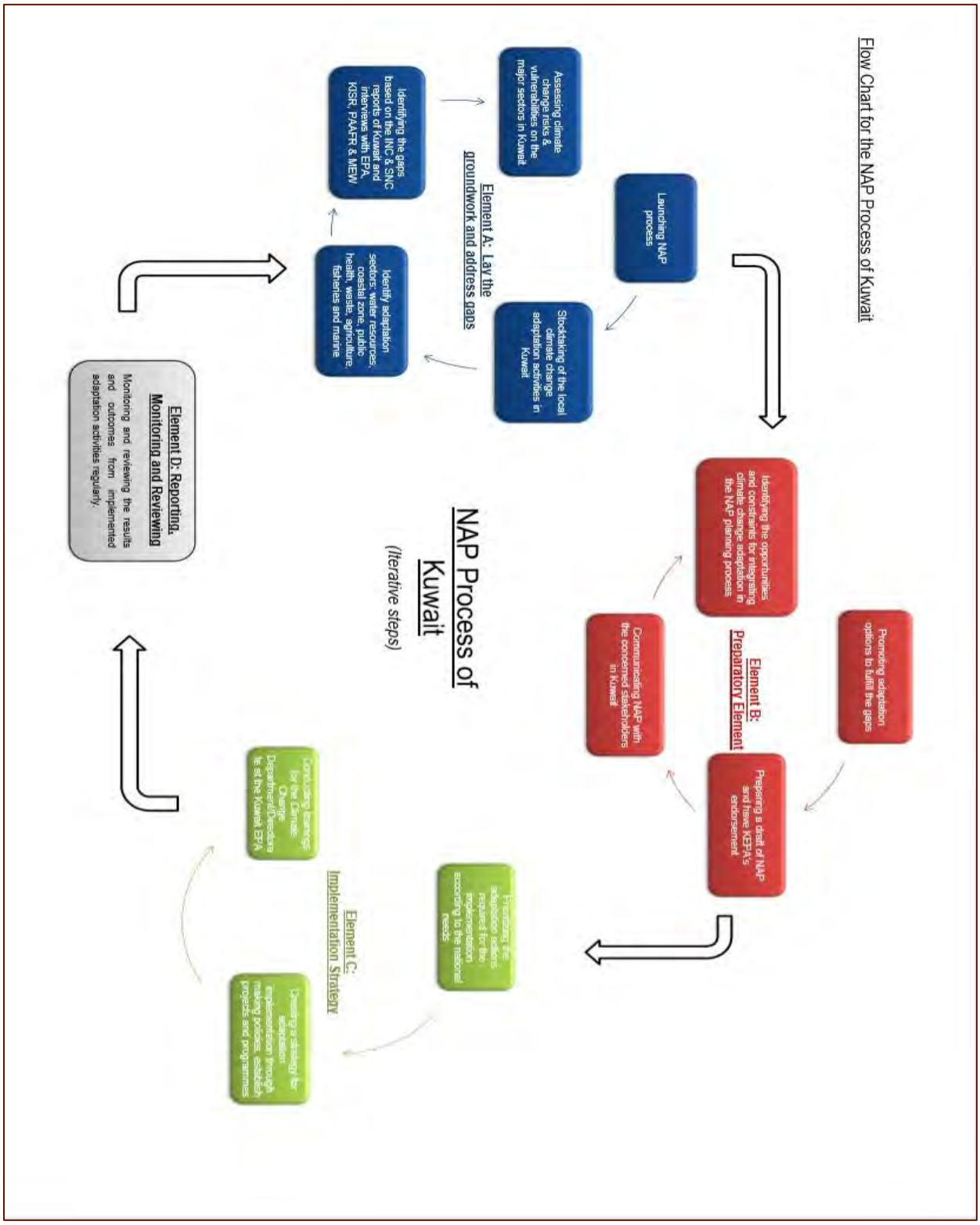


FIGURE 2: THE PROPOSED ROAD MAP OF THE NAP PROCESS IN KUWAIT, MODIFIED AFTER THE PROPOSED UNFCCC METHODOLOGY.

1.9. Structure of the NAP document

The document of the NAP is divided into the following parts:

1. ***Introduction***: The introductory part includes a definition of Climate Change and the need for NAP within the context of the UNFCCC,
2. ***National Circumstances***: This includes a description and brief analysis of the country's climate and natural resources, socio-economic characterization of the country including the demography, economy as well as sectors analysis,
3. ***Climate Hazard and Vulnerability Analysis:*** The main sectors affected by climate change, causes, indicators, and aspects of climate change in the main affected areas have discussed this part of the document,
4. ***Coordination of Adaptation Action:*** This part of NAP summarizes the main environmental laws and by-laws related to climate change. It includes a comprehensive review of all ongoing initiatives in relation to climate change adaptation. Deficiencies and gaps in current legislation are also briefed in this part. A proposed coordination mechanism for the implementation of the NAP is presented based on the comprehensive review and listing of concerned stakeholders, and
5. ***Adaptation Action Plan:*** This part utilizes the previous information in the synthesis of action plan divided into programmes. Listing and justification of programmes and projects are also included in this part.

1.10. Outlook and future objectives

The NAP has benefited and made use of the results and recommendations of previously conducted research and studies related to climate change, mainly the second national communication to the UNFCCC. Monitoring and evaluation of the plan and subsequent impacts of interventions from the different programmes are future objectives and tasks of

the Kuwait Environment Public Authority. This is a very important task as it provides a feedback mechanism for modification of programmes, setting priorities and implementation of activities based on the needs and requirements of local communities in most affected areas.

CHAPTER 2: NATIONAL CIRCUMSTANCES

2.1 Introduction

The abundant marine life has always been prosperous in the shorelines of the Kuwait bay due to the rich silt content in the river systems of southern Iraq, and so humans chose Ras Subiyah; the northern shores of Kuwait Bay, as a place to settle back from the Ubaid period in 6500 BC. It provided a place of interaction between the people of Mesopotamia and Neolithic. Ras Subiyah proved to have the earliest evidence of urbanization in the Arabian Gulf area. Debris of stone walls, tools and the remains of boats link the Ubaids with the Mesopotamians. Early evidence of a large town built and lived in on the Failaka Island by the Dilmun people was also found, and what said to be one of best structures in the Bronze Age, which resembled buildings typical to those found in Iraq at the time.

The discovery of oil in 1937 in Kuwait proved the beginning of another era of prosperity for Kuwait. The large oil reserve was uncovered by the US-British Kuwait Oil Company; however, further investigation was not until after World War II in 1951. Only a year after, Kuwait became the largest oil exporter in the region. Foreign workers started coming into the country for a better standard of living from Palestine, India, and Egypt. Upon its newly acquired independence in mid-1961, Kuwait constructed a new Constitution and became the first state in the Gulf to initiate parliament and constitution.

The state of Kuwait extends in a semi-arid region in the northeastern part of Arabian Peninsula facing the Arabian Gulf with a 495 km border with Saudi Arabia (KEPA, SNC, 2019) (Figure 3) The coastal zone of Kuwait is enriched with biodiversity. For instance, Subkhas[4] extending along the northern coast of Kuwait and considered an ecotone between the terrestrial and marine environments are productive ecosystems that support a number of plant species and other organisms (El-Sheikh, El-Ghareeb, & Testi, 2006). Coral reefs in the southern offshore islands of Kuwait are unique environments that

[4] Subkha is an Arabic word widely used in the scientific documents written in English to refer to coastal salt marshes of inland salt flat. The subakha is one of distinct coastal features in Arabic lands

support various trophic levels. Kuwait islands are indeed fabulous environments where marine and terrestrial organisms interact. The coastal region of Kuwait can be divided based on urbanization into two regions. The northern coastal area that extends from the Kuwait-Iraq border in the north to the northern coast of Kuwait Bay is non-urbanized, but some mega developing projects on this area have already started, such as Mubarak Al-Kabeer Port on Boubyan Island (Al-Gabandi, 2011; Baby, 2014). The middle and southern coastal area of Kuwait that extends from the western and southern coast of Kuwait Bay to the Kuwait-Saudi border in the south is extensively urbanized.

FIGURE 3: THE GEOGRAPHIC LOCATION AND INTERNATIONAL BORDERS OF THE STATE OF KUWAIT

The middle and southern coastal is a very vital area in Kuwait where most of urban, commercial, industrial, and recreational activities are concentrated. The coastal area of Kuwait Bay hosts Kuwait City, the capital, and the main commercial port in Kuwait,

Shuwaikh Port. The southern coast includes residential, commercial and recreational areas, power plants, and desalination stations (Bakri & Kittaneh, 1998).

This urbanized area that lies within only 20 km of coast is settled by most of Kuwait population that reached 3.5 million in 2011 (Annual Statistical Abstract (ASA), 2011). The urban districts of Kuwait have been divided administratively into six governorates (i.e., the capital, Al-Jahara, Hawalli, Al-Farwaniyah, Mubarak Al-Kabeer, and Al-Ahmadi). Most urban districts extend along the coastal zone, from western and southern Kuwait Bay to the southern area of Kuwait, and are home to most of the Kuwaiti population, which in 2011 reached three million people, about two-thirds of them non-citizens (FIGURE 4).

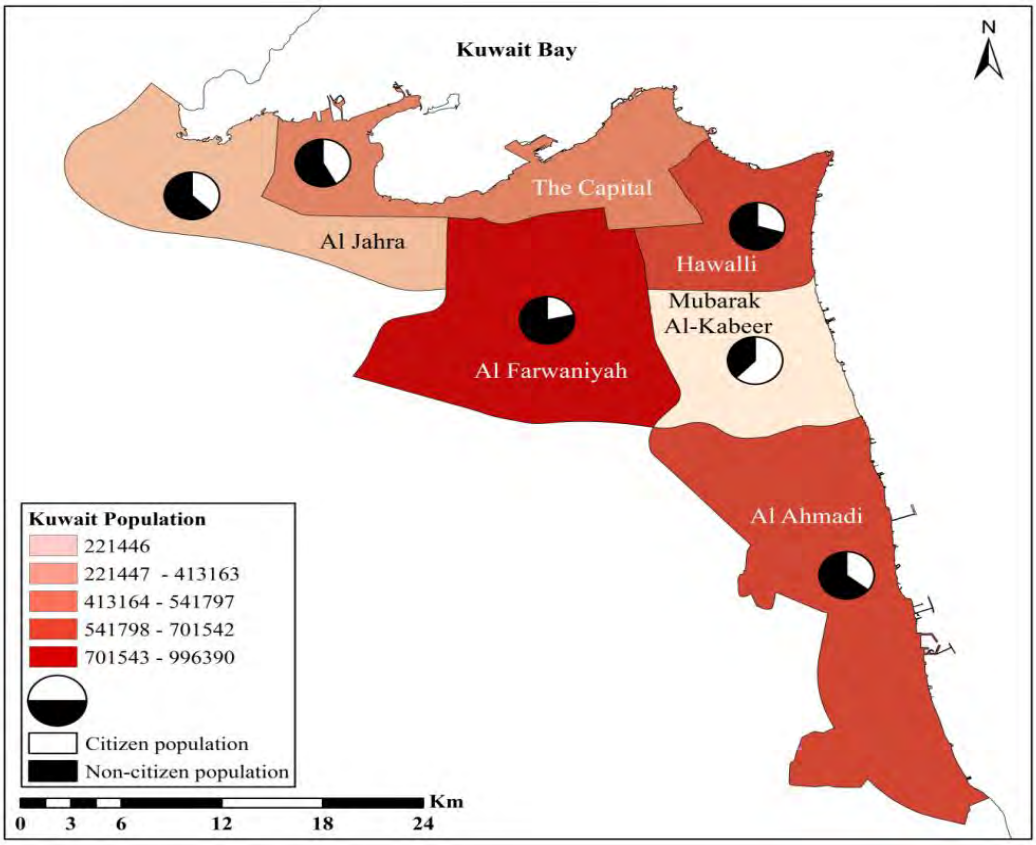


FIGURE 4: THE POPULATION DISTRIBUTION IN KUWAIT'S GOVERNORATES. THE PIE SYMBOLS ILLUSTRATE THE POPULATION PROPORTION OF CITIZENS AND NON-CITIZENS IN EACH GOVERNORATE[5]

[5] Source: KEPA, INC, 2012

2.2 Geography

Kuwait, officially known as The State of Kuwait is a country in West Asia, located in the Arabian Peninsula in the northeastern head of the Arabian Gulf. It lies between latitudes 28° 30° N and 30º 50º, and longitudes 46° 30º and 48° 30º E (e-Misk, KEPA). At 17,818 km^2 (6,880 sq mi), zero of which is water, Kuwait is one of the smallest countries in the world, ranking 158 in the world. Kuwait is 170 km in length from West to East and 200 km from North to the South (**FIGURE 5**). Kuwait's land boundaries are shared with both Iraq taking up to 195 km from the north-west and Saudi Arabia, 495 km, from the south. (KEPA, SNC, 2019).

FIGURE 5: SATELLITE IMAGE OF KUWAIT

Accounting for a significant length of Kuwait's shore is Kuwait Bay, which provides natural protection for the port. And within the coastline lies nine islands, some of which are Bubiyan, Warbah, Failaka, and Kubbar.

The territorial sea of the State of Kuwait extends seawards for twelve nautical miles from the baselines of the mainland and of Kuwaiti islands as mentioned in Article 1 of the Decree regarding the Delimitation of the Breadth of the Territorial Sea of the State of Kuwait of 17 December 1967 (National Legislation, 1969). Kuwait shares maritime boundaries, Territorial sea, with Iraq, Saudi Arabia, and Iran.

The Arabian Gulf has the lowest elevation in Kuwait coming at 0 m, and the highest point is at 306 m above sea level by the Al-Salmi Border in the west. The elevation gradually rises from the coast (east) to the west (FIGURE 6). The landscape provides elevations and depressions throughout. Most depressions found in Kuwait are in the north (e-MISK, KEPA).

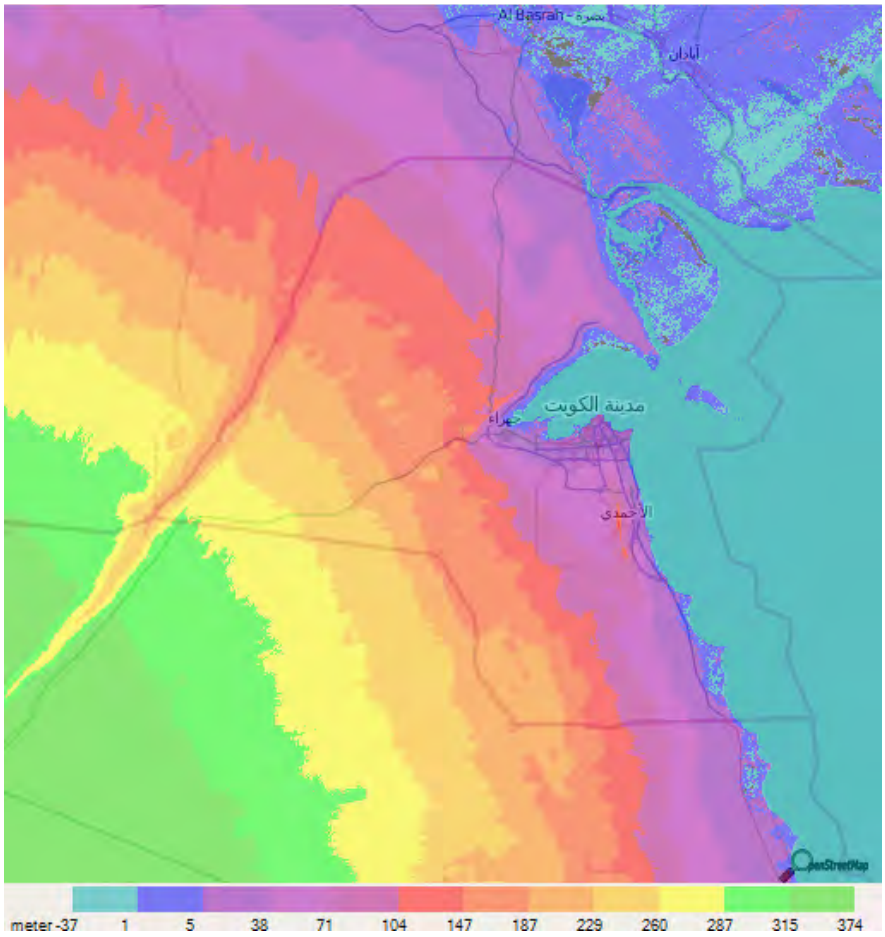


FIGURE 6: KUWAIT ELEVATION MAP[6]

[6] Source: OpenStreetMap Contributors, www.FloodMap.net

Kuwait's northern landscape is mostly a gravely plain with pebbles. Along the west, courser gravel lines up the plain along Wadi Al Batin, continuing to the southern borders between Wadi Al Batin and Minagish[3]. Kuwait Bay has a decreasing topography from the south to the west. To the south and west of the AL Ahmadi, there is the Burgan fields, north of the Burgan lies the Wara hills, where the topography rises. Looking south of the Burgan, the elevation drops back.

2.3 Climate

Kuwait is a dry tropical and sub-tropical desert with a hyperarid climate. Annual rainfall has a range of 75 – 150 mm, but actual rainfall has reached as high as 600 mm one year. Summers and winters in Kuwait have significant temperature differences. In summer, the temperature can reach up to 48 ºC and an average of 44 ºC. On 21 July 2016, the temperature has reached its all-time high in all of Asia at 54 ºC.

Due to its location at relatively the furthest north in the Gulf region, the winters in Kuwait are colder than in Qatar, Bahrain or the United Arab Emirates. Northern winds blowing from Iran and Iraq ensure that Kuwait experiences lower temperature than other Arabian Gulf countries. Rainfall mostly happens from October till April.

During the summers, which are significantly longer than the winters, aggressive north-western dust storms dominate most of the weather happenings during the months March through April. In later months of the hot summer, between May and September, humidity is more likely. The south-eastern wind blows July through October from the Arabian Gulf, hence the humidity during these months (SNC, 2019). By the end of October, the winter-summer cycle starts again, with the temperature dropping as low as -6 ºC during the night. Daytime has a higher range of temperatures at 10 – 17 ºC. Thunderstorms usually occur during this time, with frost happening if temperatures drop below 5 ºC.

2.4 Natural Resources

2.4.1 Soil

Due to the arid climate of Kuwait, it is nearly impossible for the soil to form, as the evaporation rainfall ratio is very low, most parent material is formed from marine origin

sedimentary rocks. The soil is coarse and has high salinity content. Vegetation in these soils is not very effective on soil due to the ineffectiveness of biological weathering to provide organic matter. Strong wind erosion, which displaces the topsoil layer, also limits soil formation. Very small percentages of the land are being used for agriculture, about 5.7 km^2, and are in Jahra, Sulibiya, and Mangaf. The water used for the plants is saline water from the wells. This, along with other factors like wind erosion, low rain, high evaporation, temperature and the hardness of the soil, all limit the productivity of the soil (SNC, 2019).

The Soil in Kuwait falls under several classifications. The great soil group, which is a group of soils that have similar internal characteristics, and there are four kinds of great soils found in Kuwait; Desert, Desert-Regosol Intergrade, Lithosol, and Alluvial.

Desert Soils are generally pale brown with a sandy texture with cemented subsoil, which is very pale brown, consisting of lime pan, silica pan and/or lime-silica pan. Desert Soils extend largely on the Kuwait horizon. Highly drained desert soils could be found as well as imperfectly drained. This type of soil is very poorly developed in Kuwait; AC horizons could be found; however, B horizon is weakly developed if found at all. The soils in Kuwait deserts have not been well developed, in the west the soil is covered with a gravelly layer with different sizes and colors, with a more calcareous material than the layer below.

The Desert-Regosol Integrates Soils have similar conditions in which they were developed to those of the desert soils, they differ slightly in color, being lighter, less developed than the latter, have better drainage and are younger. Where desert soils could be found in the west, these soils are indigenous to mostly the south to the southeast, they stretch over undulating relief and have good vegetation cover. Two categories of Desert-Regosol integrated soils were found in Kuwait; Sandy Desert Soils and Desert Dune Soils.

Another type of soil found in Kuwait was the Lithosole and mostly found on Az Zor escarpment, east of Kuwait Bay. This type of soil is usually found on rock fragments from consolidated rocks on sloping land. They are either A or C Horizons and while the A horizon is weakly developed it has considerable thickness due to the $CaCO_3$ and gypsum layers. Only one kind of soil form this category was found on Kuwaiti soil which is the Escarpment.

The Alluvial Soils are the fourth type of soils found in Kuwait. Unlike the previous soils, this type is formed by material carried by running water. They originate from the Kuwaiti marine, and so are mostly found by the shoreline on the level and concave relief. Due to their proximity to the water and thus the high-water table, they are almost always wet. They also have low water drainage. Two kinds of Alluvial soils were found; the Hydromorphic Saline Alluvial Soils and the Recent Alluvium Soils. The Kuwait group identifies recent and less recent sediments of multiple types including but not limited to gravel, clay, silts, and limestones covering all of Kuwait like the Dammam limestone formation.

The Kuwait group aquifer was divided in the north into three formations depending on the evaporate deposits, as follows; the Dibdibba Formation, Sand and Gravel; the Fars Formation, Evaporite Sequence; and the Ghar Formation, Sand and Gravel. The following table shows the aquitards and the aquifer sequence within the Kuwait Group, from top to bottom (Y. Villacampa, 2008).

Due to the environmental conditions, soil capacity, and weather conditions agriculture is very limited in Kuwait. Vegetation types cover Kuwait are presented in FIGURE 7.

TABLE 3: AQUITARD AND AQUIFER SEQUENCE WITH KUWAIT GROUP[7]

Dibdibba Aquifer (gravel sand).
Aquitard (silty sand).
Upper Kuwait Group Aquifer (sand and gravel).
Aquitard (clay and clay sand).
Lower Kuwait Group Aquifer (sand).
Aquitard (basal clay and cherty limestone at the top of Dammam formation)

[7] Source: Mukhopadhyay & A. Akber, 2018

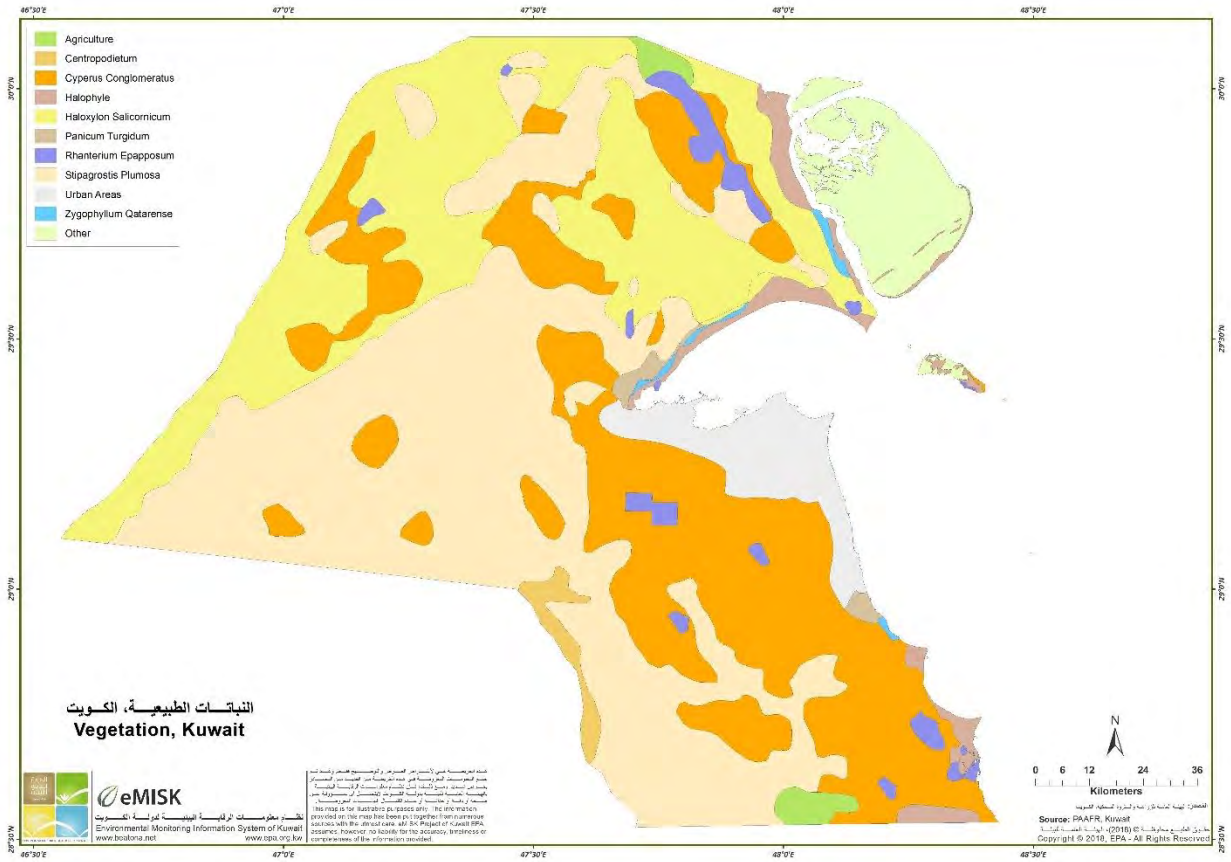


FIGURE 7: MAP OF KUWAIT DENOTING VEGETATION IN KUWAIT.

2.4.2 Water resources

As per its climate, Kuwait suffers from a scarcity of conventional fresh water. Endogenous precipitation is 121 mm/year (long-term average), which amounts to 2.156k 10^9 m^3/year in 2014, which is respectively low. It increases to 39.18 mm in December 2017 from 13.26 mm in November of 2015 as shown in **FIGURE 8** (Y. Villacampa, 2008).

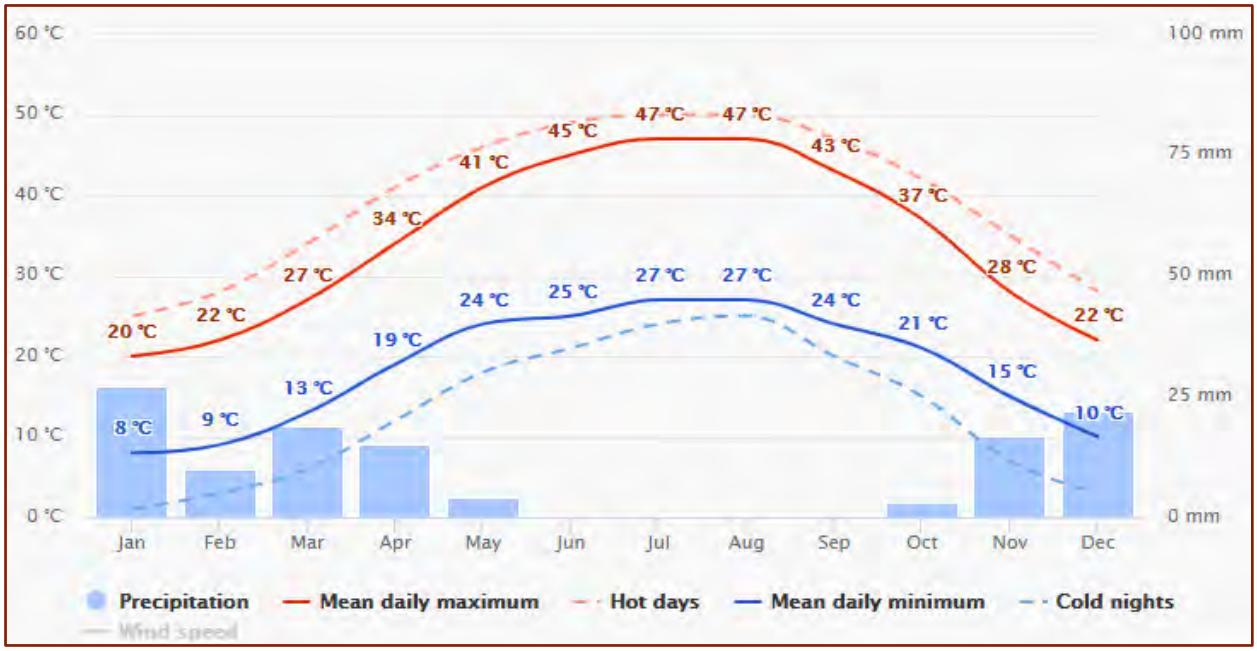


FIGURE 8: AVERAGE ANNUAL TEMPERATURES AND PRECIPITATION[8]

With the increasing growth of population, water from wells is no longer enough, and so the government built a desalination plant in Kuwait in 1953, followed by others, two in Doha with capacity reaching 138 M gallons per day. A third plant was built for desalination by reverse osmosis nearby. There are three main water sources for urban and agricultural uses in Kuwait, desalinated water groundwater and treated wastewater (Y. Villacampa, 2008).

There are no permanent rivers in the country and with how high the level of evaporation is streams and runoff water only last a few hours after rain. Groundwater replenishing is even scarcer due to how dry the soil is and the infamous evaporation rate. The groundwater produced internally amounts to nothing, as is the surface water, meaning that there is no overlap between the ground and surface water. The accounted groundwater inflow from Saudi Arabia through lateral underflow is estimated to be 20 MCM/year (Aquastat, 2016), and groundwater in Kuwait does not flow into neighboring countries groundwater basins. The total renewable water resources per capita are 5.139k m^3/year in 2014 (Aquastat, 2016).

[8] Source: meteoblue: https://www.meteoblue.com/en/weather/forecast/week/kuwait-city_kuwait_285787

Groundwater in Kuwait can be categorized into three classifications; the distinction is made according to the salinity level in the water. Fresh groundwater has less than 1 g/L of a soluble salt, and it is mainly considered a freshwater reservoir from drinking water rather than used for irrigation. Due to the precipitation patterns, which include intense rainfall in a short period of time, and the soil types that allow filtration, fresh groundwater can be found in the fields of Raudhatain and Umm Al Eish. Water extraction at these aquifers is 5,500 and 3,500 m^3/day respectively (Kwarteng et al, 2000).

Another type of groundwater is the Saline groundwater. The content of soluble salts in this type of groundwater is between 7 g/L to 20 g/L. It cannot be used for either agriculture or domestic use. The brackish groundwater is another type of groundwater present in Kuwait. It contains higher amounts of soluble salts than the fresh groundwater coming at an amount of 1 to 7 g/L. This type of water is used domestically, for agriculture and drinking water for animals, namely cattle. The source of this water is the Al Shaya, Al Qadeer, Al Solaybeia, Al Wafra, and the Al Abdali fields. The distribution of groundwater fields in Kuwait is shown in **FIGURE 9**. The outtake from these fields is estimably 545,000 m^3/day (Y. Villacampa, 2008), which is significantly higher than the fresh groundwater outtake.

In 1993 the water withdrawal was calculated to be 538 MCM; however, in 2002 it has increased to 913 MCM and that is due to the increasing water consumption by the Kuwaiti individual (**FIGURE 10**) and (**FIGURE 11**). 44% of the water withdrawn is being used for domestic uses, 2% for industrial purposes and the rest is for irrigation, which amounts to 492 MCM; 80% of it is for productive agriculture, 300 MCM is brackish water from the Al Abdali and Al Wafra private wells, 66 MCM is treated wastewater.

The quality of the groundwater is deteriorating due to the excessive withdrawal which reached its peak in 2006; 164.7 MCM. At which point the Ministry of Electricity and Water (MEW) realized that water preservation was necessary for future prosperity. Thus, the fresh and brackish water consumption started gradually decreasing as of 2007-2008 (Figure 11). The current groundwater withdrawal rate from each the Wafra and the Adbali wells is estimated to be 300,000 - 400,000 m^3/d.

FIGURE 9: KUWAIT'S GROUNDWATER RESOURCES

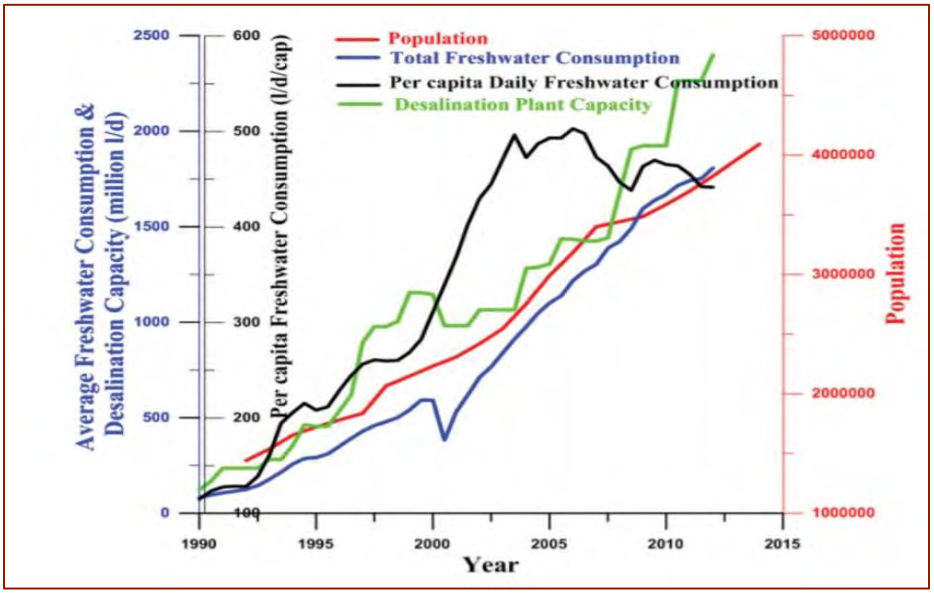


FIGURE 10: VARIATION OF FRESHWATER WATER CONSUMPTION, POPULATION GROWTH, AND DESALINATION PLANT CAPACITY IN KUWAIT 1990 -2015[9]

[9] Mukhopadhyay & A. Akber, 2018

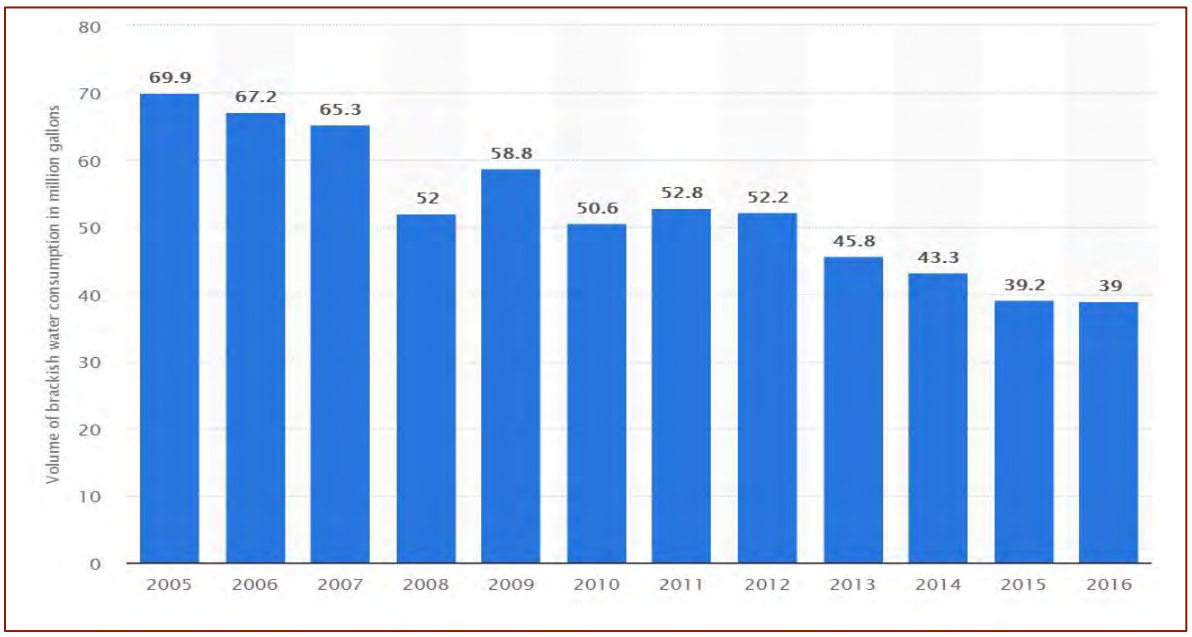


FIGURE 11: BRACKISH WATER CONSUMPTION IN KUWAIT[10]

Raudhatain, which is a freshwater field in the north, started with a production rate of above 9090 m^3/d in the years 1963-1967, now pumping about only 4545 m^3/d. The decrease of outtake is due to the increasing relativity of the total dissolved solids in the water acquired. By the year 1989, the water produced from the two water wells decreased to about 300 m^3/d (Mukhopadhyay & A. Akber, 2018).

Producing groundwater, be it fresh, brackish or saline water has the accompanying costs of pumping and desalination treatment, which includes the multi-stage flash evaporation process, Figure 13. The cost of the thermal process is largely dependent on the consumption of energy during the operation accounting to about 50% of the water unit cost. In 2014, desalination capacity was recorded to have reached 2.4 M m^3/d. Wastewater treatment has similar cost priorities; over 90% of the population of Kuwait has access to a central sewage system collecting both domestic and industrial wastewater. The total length of pipelines stretches over 650 km.

[10] @Statista 2019 https://www.statista.com/statistics/648858/kuwait-average-daily-consumption-of-brackish-water/

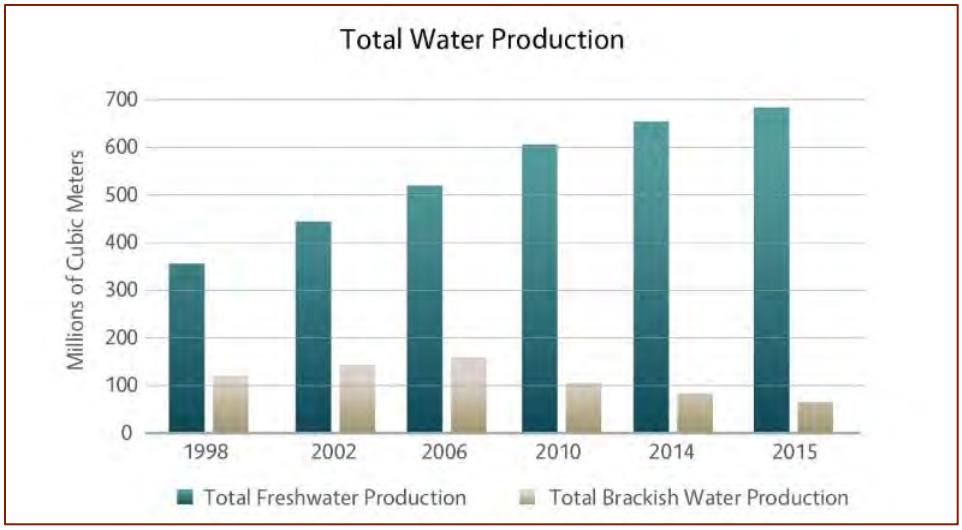


FIGURE 12: TOTAL FRESHWATER AND BRACKISH WATER PRODUCTION[11]

FIGURE 13: WASTEWATER TREATMENT PLANTS

[11] Source: KEPA, GIS portal, eMISK.

In 2004 a municipal wastewater treatment plant was constructed by a private consortium on Build – Operate – Transfer (BOT) formula in Sulaibiya, the plant uses Reverse Osmosis Process (RO) and has the capacity of 375,000 m^3/d. In 2006 the efficiency of the plant was at 94.7%, producing 355,102 m^3/d of treated wastewater from a 375,000 m^3/d influent (Abdel-Jawad et al.).

Future demand for water is increasing and does not show any signs of stabilizing. The availability of desalinization capacity will depend on the economic growth in the country. Burney et al. carried out a study projecting the water demand in Kuwait by 2025, and results show that it will rise to 2 M m^3/d to 8.3 M m^3/d. There seem to be several available options for rationalizing water demand, one of many is to reduce the gap between the increase of income and the government-fixed price of water, another is the used of reclaimed municipal wastewater. In 2007, 76% of the treated wastewater was used for landscaping and agriculture (Mukhopadhyay & A. Akber, 2018).

2.4.3 Ecosystems and biodiversity

While oil and gas are two of the major natural resources in Kuwait, history and culture have been tied to water for far longer than oil has been a dominant resource. Shipping pearls, diving, and fishing have provided a livelihood in the region for centuries. Underwater ecosystems contain around 600 kinds of coral in the world, 35 of them grow in Kuwait's waters. The Gulf is home to vibrantly colored colonies of coral reefs with fish, sea turtles, sharks, dolphins, and even whales swimming in its waters. Kuwait has three major coral islands; Umm Al Maradem Island, Garo Island and Kimber Island. Tragically, many of the reefs were severely damaged during the years 1990-1991; the Gulf War and continue to be harmed by pollution.

There are 15 marine protected areas and 15 terrestrial protected areas in Kuwait and their percentage out of the total surface area accounted in Kuwait is 1.48%. The terrestrial and the marine protected areas out of the total territorial area amounts to about 11% (Trading Economics, 2018). Figure 14 presents total fisheries production in Kuwait over the last 10 years in Marine Cages.

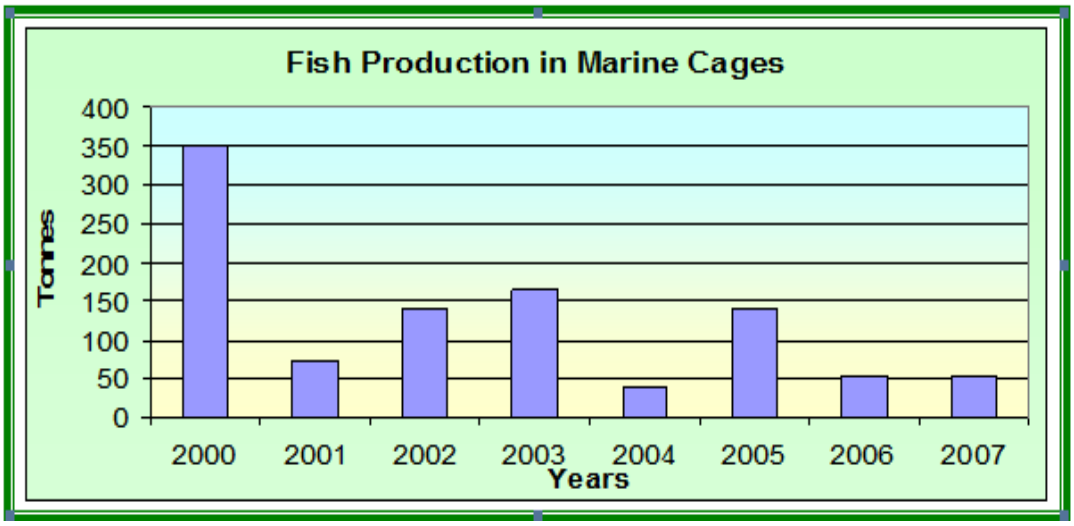


FIGURE 14: FISH PRODUCTION IN MARINE CAGES[12]

Land ecosystems are also significantly important as Kuwait's coastlines are home to threatened Mangrove trees. The groves provide homes for a variety of Fauna and Flora, including big flocks of flamingos. Regular beach cleanups helped to ensure these animals and plants can live in a suitable environment clear of waste and hazardous materials. Kuwait is at a crossroad of three continents, where migrating birds flying through the skies of Kuwait every year to reach their destinations. There are two major routes for migration passing through the skies of Kuwait, one is from north-eastern Europe to the southern half of Africa and the other is from western Europe to southern Asia. Bird lakes and sanctuaries are being created for these animals by teams working to protect marine and other habitats in the Gulf.

There are many plants and animals species in Kuwait, about 354 species of birds, 11 of which are being threatened, 32 species of mammals, 7 threatened (Trading Economic, 2018), 42 species of amphibians and reptiles and 806 species of arthropods (Al-Oula Shamal Azzour, 2017), including but not limited to, Barrel Catus, Armadillo Lizard, Bobcat, Cactus Wren, Jumping Cholla, Ocotillo, Thorny Devil, Mound Cactus, Desert Locust, two types of scorpion; the Yellow Scorpion and the black scorpion[9]. There are also 26 subspecies if grasshoppers in Kuwait, numerous species of beetles, wasps, bees,

[12] Source: Hyder A. Murad, Deputy Director General, Public Authority for Agriculture Affairs and Fish Resources, State of Kuwait: National review on marine cage aquaculture

butterflies, ants, and ladybirds. Birds, namely Eagles, fall under two categories in Kuwait, the residential birds and the migratory one. Twice a year, once during the winter and the other during the spring, birds of all species travel through the Kuwaiti skies in the routes mentioned earlier (Al-Oula Shamal Azzour, 2017).

As mentioned earlier, Kuwait hosts routes of migration for birds from all over the world. There are two routes passing through Kuwait's skies. Some of the many species of birds that fly through Kuwait's skies, whether as migrating or indigenous, are Spotter Eagle, Steppe Eagle, Imperial Eagle, Golden eagle, Booted Eagle, Common Kingfisher, Mallard, Night Heron, Squacco Heron, Indian Pond Heron, Cattle Erget, Reef Heron, Purple Heron, Crab Plover, Collard Dove Saker Falcon, Yellow-Throated Sparrow, Chaffinch, Hoopoe, European Roller, Bee-Eater (Al-Oula Shamal Azzour, 2017).

Unfortunately, Kuwait has lived through the extinction of many species due to extensive and unregulated hunting, habitat loss and fragmentation, genetic pooling, species isolation and loss of proper habitat for their specific species. All these reasons lead to the endangerment and extinction of animals like the Arabian wolf, Arabian Oryx, striped hyena, jackal, honey badger, Gazelle subgutturosa and G Gazelle, sand cat, Ruppell's fox, and Cape hare, and unless immediate and drastic changes and actions are being taken in order to protect and preserve these species, Kuwait will continue to suffer a drop in its biodiversity.

The number of mammals in Kuwait is no less intensive, and just as is the case with birds, mammals have suffered a plummet in their numbers and species over the centuries. The selected species of mammals in Kuwait include the Red Fox, Wanger's Gerbil, Cheesman's Gerbil, Libyan Jird, Sundevall's Jird, Lesser Jerboa, Naked-Bellied Tomb Bat, Long-Eared Hedgehog, Wild Cat, House or Black Cat, Kuhl's Pipistrelle Bat. The Reptiles and amphibians are restricted to remote areas in the deserts with limited human interaction, these species include; the Spiney-Tailed Lizard, Jayakar's Sand Boa, Green Toad, Loggerhead Turtle, Green Turtle, Arabian Rear-Fanged Snake, Hissing Sand Snake, Rat Snake, Leaf-Nosed Snake, Black Desert Corbra, Arabian Cobra, Pallied Agama, Blue-Throated Agama, Sand Gecko, Stone Gecko, Rock Gecko, Fringe-Toed Sand Lizard, Lacertid Lizard, and many other.

At 863 km^2, Bubiyan Island is the largest island in Kuwait; it is near the border with Iraq, third Island to the north. Now the island is a nature reserve with very limit access to the marshland and creeks manly due to military reasons (Al-Oula Shamal Azzour, 2017). Figure 15 illustrates the distribution of protected areas in Kuwait.

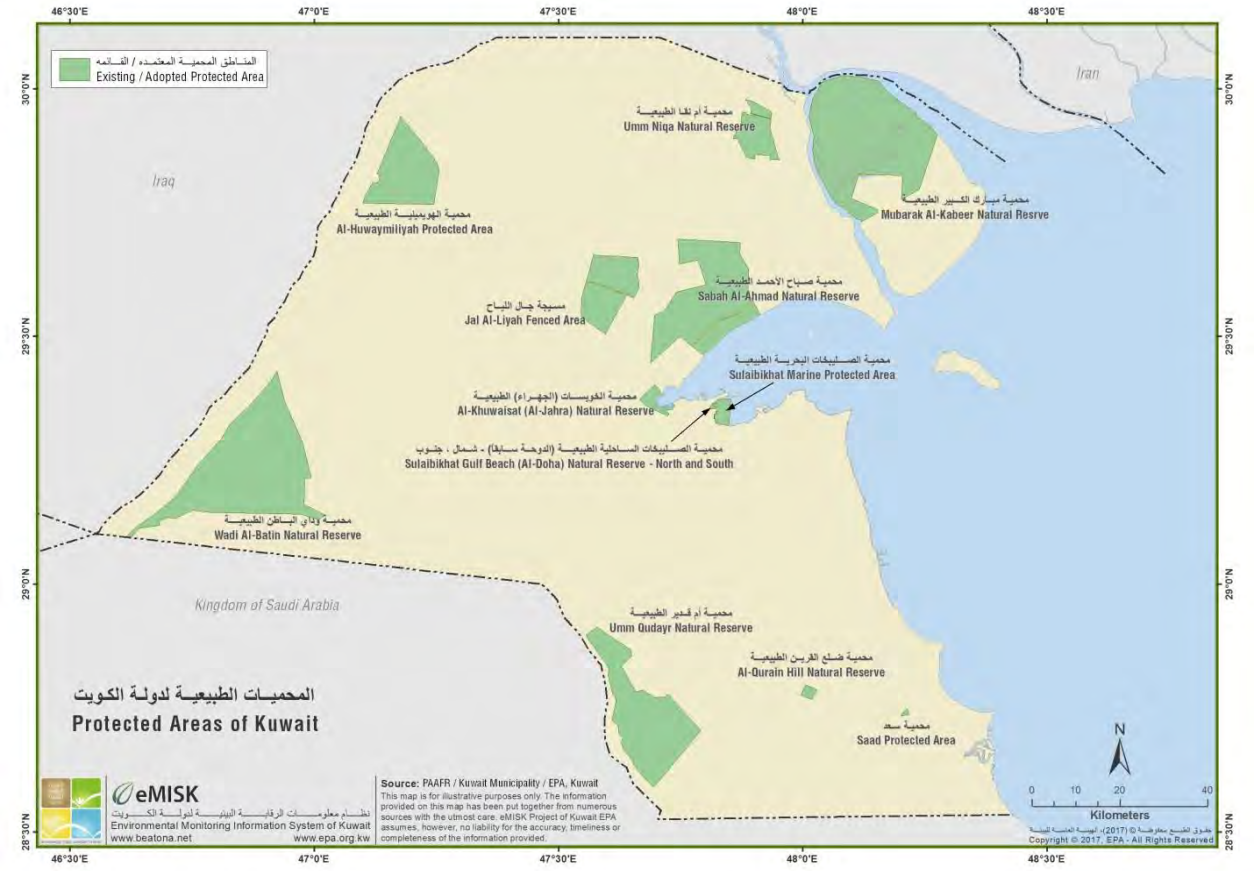


FIGURE 15: PROTECTED AREAS OF KUWAIT

2.4.4 Environment

As the contributor to over 90% of the oil consumption in Kuwait, vehicle causing pollution is strictly regulated by the authorities responsible. The Kuwait Institute for Scientific Research (KISR) has conducted a study on vehicle exhaust. The results of the study showed that the rate of HC, CO and NOx emissions in Kuwait is higher than the emission in the US. Owing to this study and others following, legislative and regulation on the limit of exhaust a car can emit were put in place, and thus vehicles were adjusted during maintenance (E. Al Bassam and A. Khan, 2004).

Since signing into the United Nations Framework Convention on Climate Change, Kuwait has introduced new policies and rules concerning the emission of gases into the atmosphere. Kuwait also encouraged the consumption of unleaded fuel by decreasing its price compared to the leaded fuel; also, the number of gas stations offering the leaded option is very few.

Greenhouse gas emission is a serious pollution issue that all countries around the world suffer from, in varying degrees, and Kuwait is no different. **Table 4** provides an overview of some of the emissions taking place in Kuwait.

To define the air quality and illustrate changes in four specific parameters of air quality during the period of 2010-2015, KEPA has aggregated the daily observations from different air quality monitoring stations as presented in **Table 4**.

Solid waste has increased substantially in the last decade in Kuwait due to several reasons like the industrial growth, population increase, and slow development of solid waste management in the country. Solid waste management includes the collection, sorting, processing, and disposal of MSW (municipal solid waste). As of 2011, there were 15 sites of solid waste management under the authority of the Municipality, only 5 of which are operational. Kuwait has one of the highest waste generations in the world, coming at 2 million tons per annum, largely owed to a high standard of living and lack of awareness about sustainable solid waste management (Salman Zafar, 2018).

Table 4: Data on Gases Emission in Kuwait[13]

Indicator		Value (Gg)
Total GHG emissions of CO_2 equivalent		**86336.469**
Emissions by Gas	**CO_2 emission**	**83910.932**
	CH_4 emission	**2002.077**
	N_2O emission (Gg)	**423.46**
Emissions by Sector	**GHG emissions from electricity and water**	**47665**
	GHG emissions from oil and gas	**16464.208**
	GHG emissions from Transportation	**15000.175**
	GHG emissions from industry (Energy + Process)	**4788.445**
	GHG emissions from Agriculture	**141.181**
	GHG emissions from Waste sector	**1706.539**

Figure 17 shows some of the pollution sources in Kuwait. Naturally, there are other factors, these are the major causes.

[13] Source: KEPA, 2019.

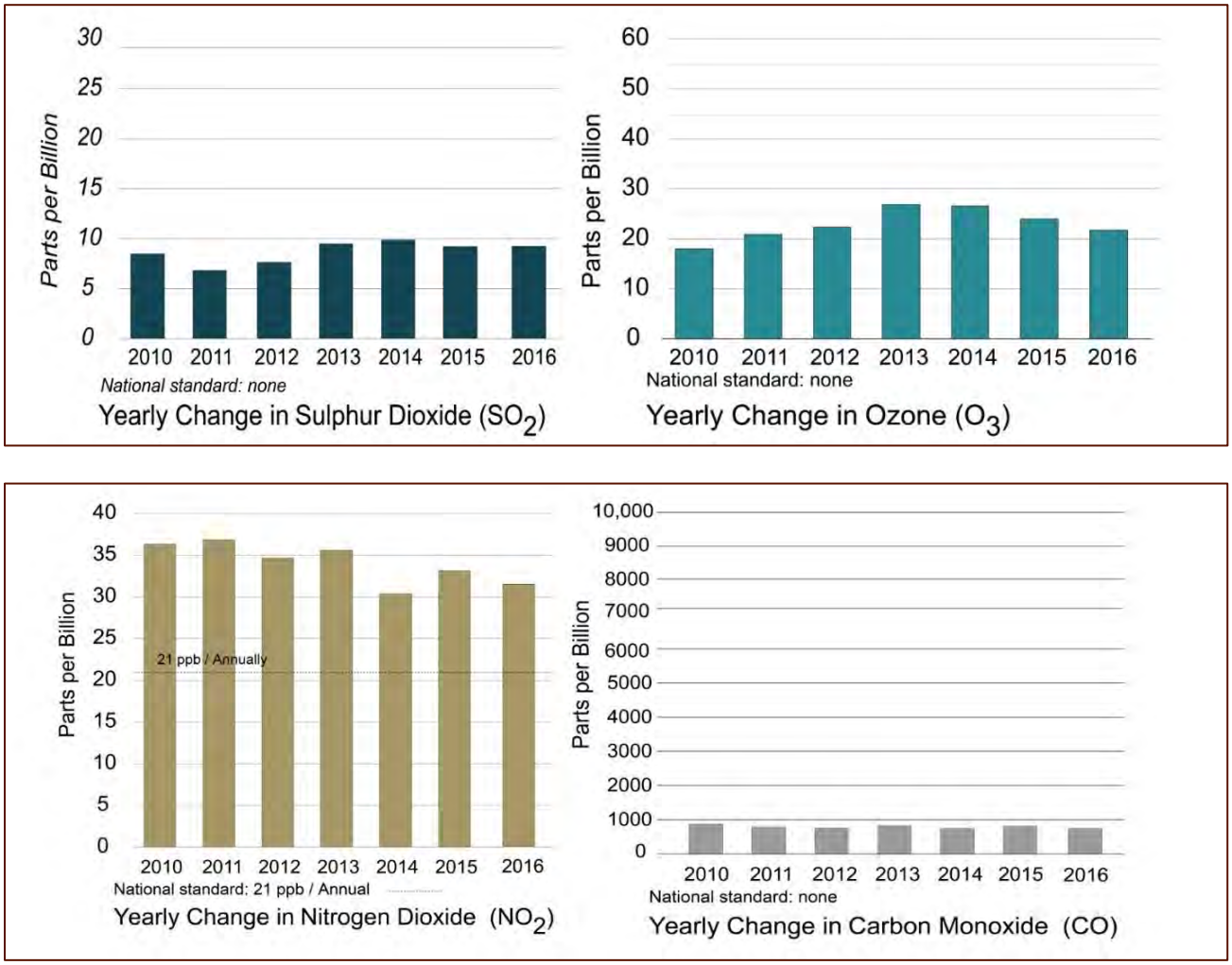


FIGURE 16: YEARLY CHANGES IN AIR QUALITY (2010-2015)[14]

Table 5 shows the readings of air pollution in Kuwait collected in the span of a year. The investigation showed that Kuwait has a low level of air pollution; below the required standards by EPA. Traffic vehicles are the main contributors to Benzene and other gases. The wind direction and speed, on the other hand, have great effects on SO_2 concentrations. Temperature affects the relationship between gases and the accumulation of gases in the air (Jasem Al-Awadhi, 2014). The $PM_{2.5}$ concentration over time is presented in **FIGURE 17**.

[14] Source: KEPA, Emisk, 2019.

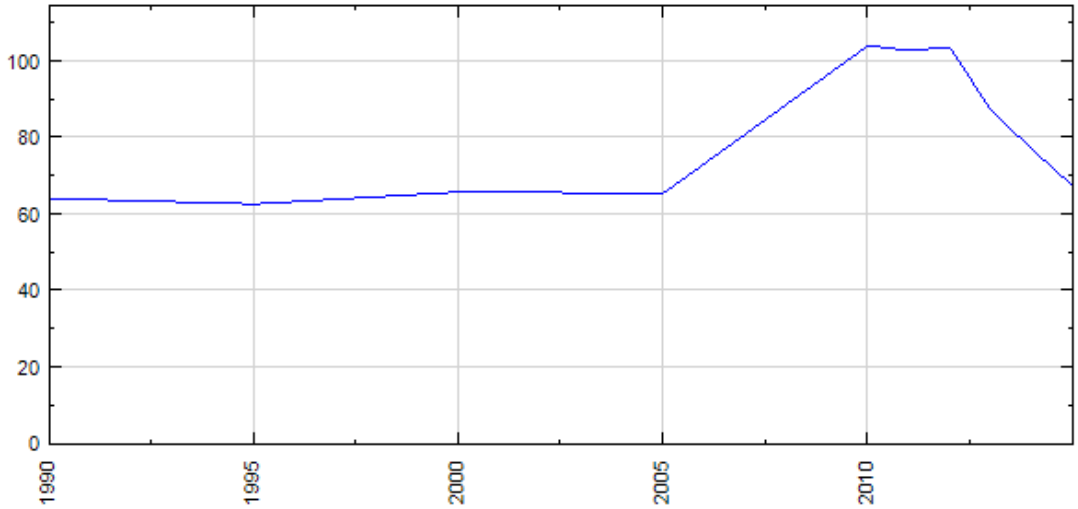


FIGURE 17: PM2.5 AIR POLLUTION, MEAN ANNUAL EXPOSURE (µ/M^3)[15]

	Mean	95% Confidence Interval for Mean		5% Trimmed Mean	Median	Variance	Std. Deviation	Minimum	Maximum	Max/Min	Range	Interquartile Range	Skewness	Kurtosis	25th percentile	75th percentile
		Lower Bound	Upper Bound													
H_2S	5.5	2.2	5.6	3.8	3.8	8.0	2.4	3.9	7.5	2.0	6.3	4.0	0.3	−0.6	4.6	6.3
SO_2	13.4	6.5	15.4	10.8	11.4	62.5	6.3	8.8	20.2	14.4	16.0	9.4	0.3	0.1	10.7	15.4
O_3	42.8	21.7	46.8	34.2	36.0	339.9	16.3	27.1	65.0	8.7	41.2	28.2	0.1	−0.3	32.4	51.0
NH_3	4.8	2.1	5.0	3.5	3.7	4.3	1.9	3.0	8.0	3.8	4.9	3.2	0.0	−0.6	3.7	5.8
NO_2	28.9	12.8	29.0	20.8	20.6	163.7	11.4	21.1	35.6	2.3	28.3	20.0	0.1	−0.7	24.3	33.5
NO	42.4	16.0	42.6	28.5	24.3	409.1	18.6	25.7	62.8	4.3	52.9	29.3	0.8	0.7	32.1	53.0
Benzene	2.5	1.4	2.8	2.0	1.9	1.2	1.0	1.8	3.7	2.2	2.7	1.6	0.4	−0.6	2.0	3.1
Toluene	15.7	7.5	18.3	12.6	11.8	64.1	7.5	9.1	26.9	3.2	22.2	11.4	0.6	0.1	10.7	20.4
N-Octane	1.3	0.7	1.4	1.0	1.0	0.3	0.5	0.8	1.8	3.6	1.3	0.8	0.2	−0.8	1.0	1.5
Ethyle-Benzene	4.6	2.2	5.2	3.7	3.5	5.4	2.1	2.4	7.4	10.9	6.0	3.5	0.4	−0.6	3.2	6.0
m&p Xylene	18.1	9.0	20.7	14.6	13.8	79.7	8.2	10.5	29.1	2.9	23.6	12.8	0.4	−0.4	12.4	23.6
O-Xylene	7.3	3.7	8.2	5.9	5.6	12.1	3.2	4.3	11.4	2.8	9.2	5.1	0.3	−0.5	5.1	9.4
Nonane	1.1	0.3	1.3	0.8	0.7	0.6	0.7	0.6	2.6	4.3	2.3	0.6	2.0	4.7	0.7	1.2

TABLE 5: DESCRIPTIVE STATISTICS OF AVERAGE MEASURED POLLUTANT CONCENTRATION (µg/m^3) AT 10 SITES FROM MARCH 2011 TO FEBRUARY 2012[16]

[15] Source: indexMundi, 2015
[16] Source: Jasem Al-Awadhi, 2014.

The two percentile points define the upper and lower tails of data. The range indicates the difference between the maximum and minimum measured values. Interquartile represents the difference between the 75th and 25th percentile. Skewness number measures to what extent the distribution of values deviates from symmetry around the mean. Kurtosis number measures the “peakedness” or the “flatness” of a distribution. Positive kurtosis indicates a shape flatter than normal.

2.5 Agriculture

The total area that could be potentially used for agriculture is marginal, less than 1% of the total land and the area that is used for cultivation is less so. There are several areas in Kuwait equipped for agriculture; the Ahmadi occupies about 3,935.3 ha, the Jhara district is 6,206.9 ha. The water used for irrigation is either groundwater or from non-conventional sources, amounting to 7,742.1 ha and 2,400.1 ha, respectively (FAO, 2013).

Due to the country’s harsh climate and the huge negative impact the Gulf war had on the land and agriculture, farmers had to replay on Protected Agriculture (PA). Protected Agriculture ranges from “simple uncooled and unheated plastic tunnels to very sophisticated computer-controlled, cooled and heated, metal-frame glasshouses. Approximately 85% of the PA is carried out in uncooled (57%) and cooled (28%) plastic tunnels, with the remaining 15% in cooled greenhouses covered with fiberglass, glass or acrylic material. Cucumber and tomato are the two main crops grown in PA, accounting for approximately 90% of the total area” (Afaf Y. Al-Nassar and N.R. Bhat, 1998). However, Kuwait has yet to develop a proper monitoring system to keep track of the changes in the environment. The number of greenhouses with cooling systems is also not as high as it should be. Figure 18 illustrates agricultural and animal farming in Kuwait.

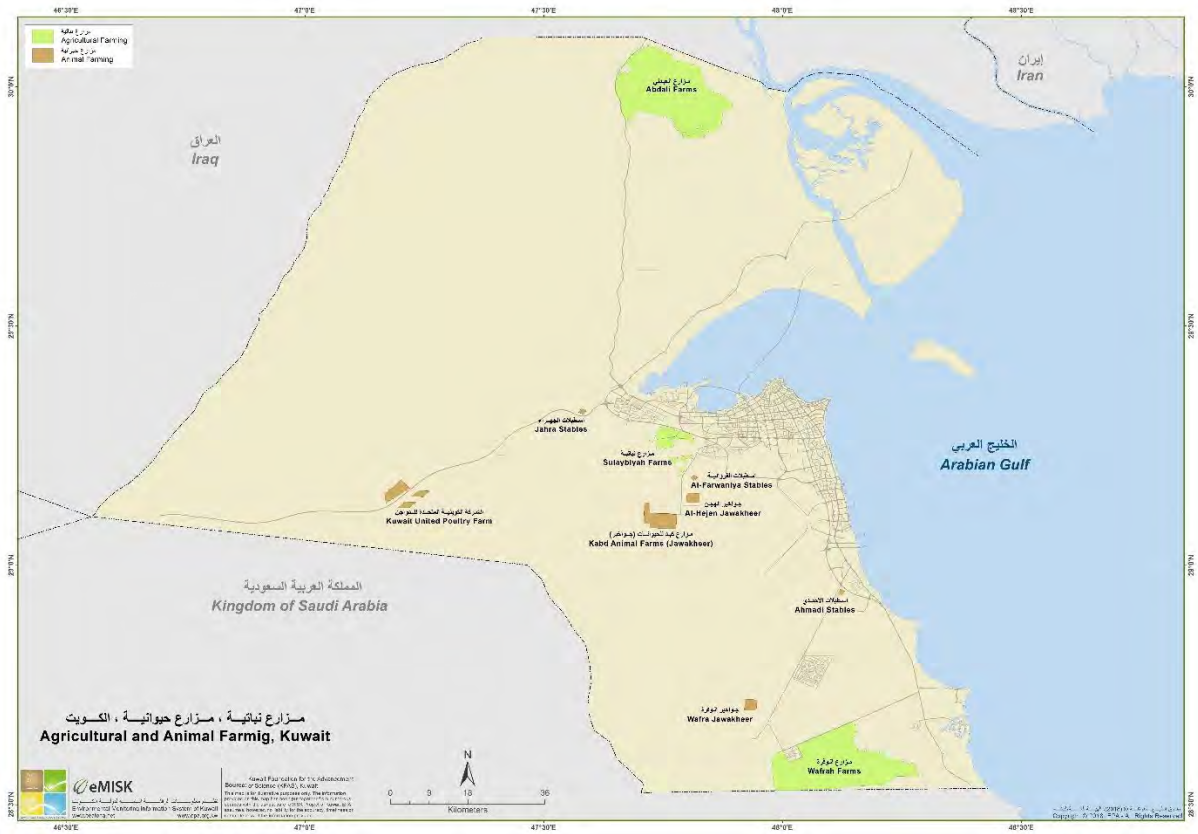


FIGURE 18: AGRICULTURE AND ANIMAL FARMING, KUWAIT

2.6 Economy

Kuwait's economy is highly dependent on oil exports and thus vulnerable to drops and changes in the global oil market prices. The GPD in 2018 was estimated to be at $303 billion and the GDP per capita at $69,669. Since 2014, Kuwait's GPD has decreased substantially going from 174.16 and 162.63 billion US dollars in 2013 and 2014 respectively to a sudden drop to $114.57 billion dollars in 2015 (Trading Economics, 2018). Although the GPD has increased marginally in 2017 to $120.13 billion dollars, it has a long way of reaching its previous values. The currency is Kuwaiti Dinar (KWD). And the highest valued currency in the world. Kuwait offers help to other developing countries through the Kuwait Fund for Arab Economic Development. Although the oil and petroleum shares contributed to over 50% of Kuwait's economy in the previous decade, in 2018 Kuwait's economic dependency on oil has decreased to 46.5% (Niall McCarthy, 2016).

There are other activities that contribute to the non-oil GPD fraction, such as the social and financial services, transport and manufacturing.

Due to higher OPEC quotas set in June 2018, the economy is expected to increase by 3.5% in 2019, according to the private bank NBK. The output would be increasing by 1m barrels per day (bpd), which translates to an increase in production from 80,000 bpd to 2.8 bpd. Figure 19 presents the oil and gas production as a percent of real GDP growth.

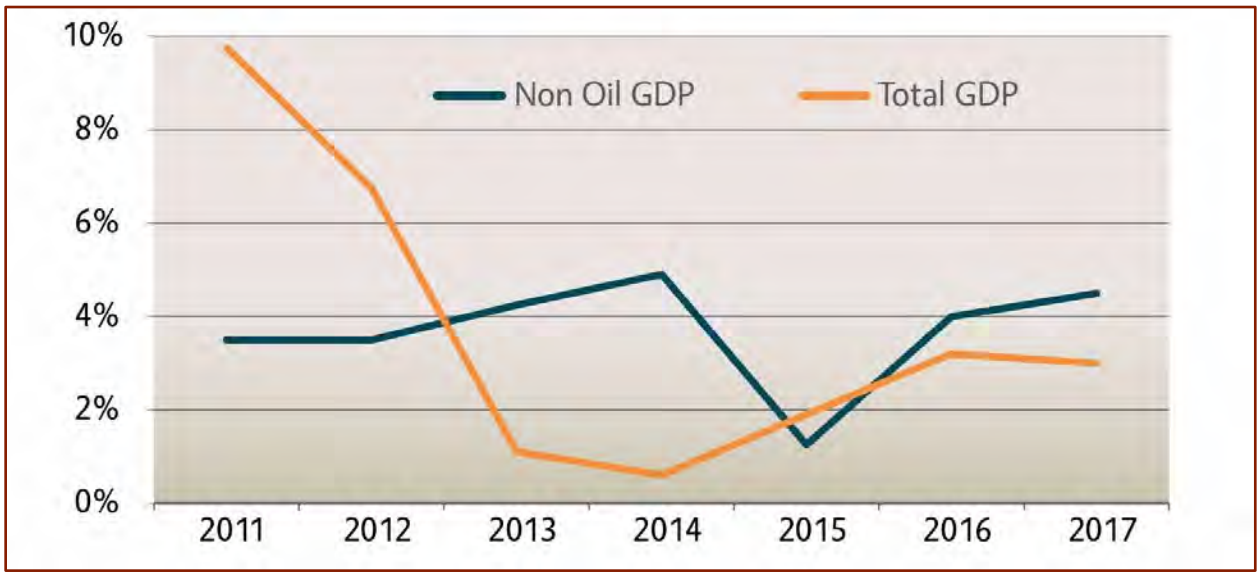


FIGURE 19: OIL AND GAS PRODUCTION AS A PERCENT OF REAL GDP GROWTH[17]

2.7 Socio-Economy

2.7.1 Development Indicators

The Human development indicators (HDI) assess the progress a country is making in the long run in areas where the life of an individual is making by measuring the standard of living, how healthy their life is and their accessibility to knowledge. The assessment of knowledge is done by accounting the number of years an adult receives of education in a lifetime.

[17] Source: Central Statistical Bureau, NBK, 2016.

In 2017, the HDI in Kuwait was 0.803, which is relatively high at a rank of 56 out of 159 countries worldwide. The increase from the year 1990 until the latest date comes at 12.6%. Life expectancy at birth increased from 72.1% in 1990 to 74.8% in 2017, and the expected years of schooling increased by 3 years, whereas the average schooling years increased from 5.5 years to 7.3 years. The GNI, gross national income increased by 32% in that time period. FIGURE 20 shows the trend of increase in the HDI. However, compared to the average HDI of other Gulf countries, Kuwait's falls behind. Qatar's values are the highest in the region (UNDP, 2018).

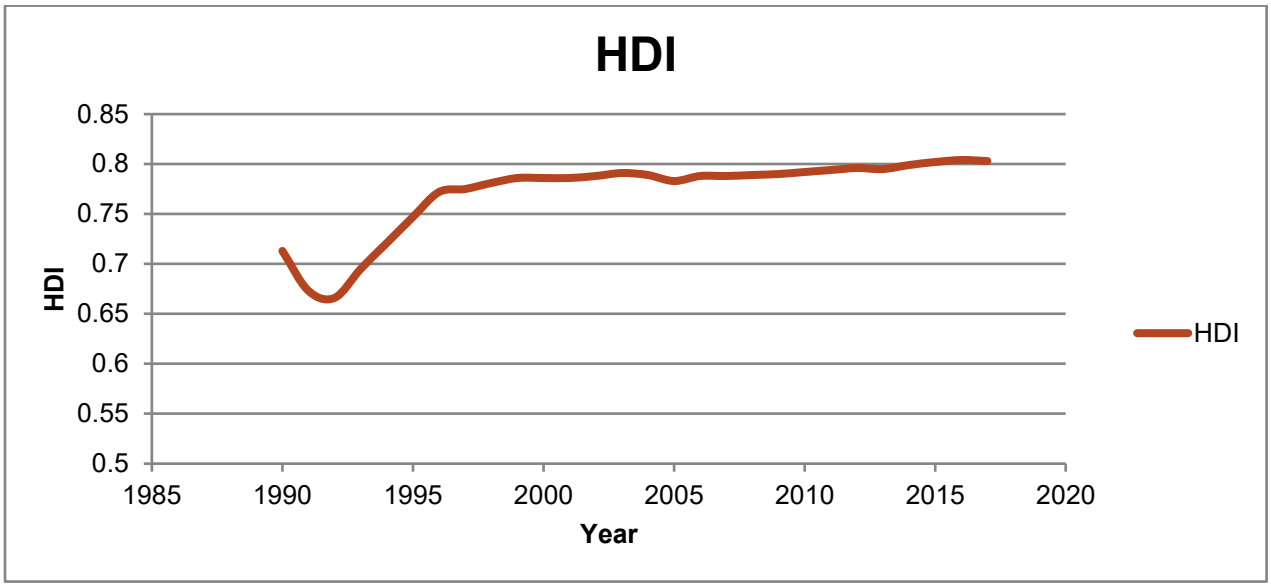


FIGURE 20: TRENDS IN KUWAIT'S HDI [18]

2.7.2 Health

After the ministries of education and interior, the Ministry of Health is the largest in the country. Assisting the Minister of health are the Undersecretary and twelve secretary undersecretaries, the latter is responsible for "public health affairs, dental health, health services, blood transfusion and laboratories, nutrition and drug control, drugs and medical supplies, financial affairs, administrative affairs, legal affairs, quality control affairs, and

[18] Source: countryeconomy.com - https://countryeconomy.com/hdi/kuwait

newly established health regions and private health services & licensing department" (WHO, 2006).

Kuwait was split up in 6 different health regions; in the Capital, Ahmadi, Jahra, Farwania, Hawali and Al Suabah. Each health region has different and assigned responsibilities as a separate unit, in charge of its area. The prime tasks of the area include:

1. Carrying out the ministry's plans in order to confirm and protect health services for the people of the area;
2. Providing training of all kinds for the body of professionals employed;
3. Offering every health care possible;
4. Introducing and perfecting a digital and computerized system of health data for residents in the area.

There are different kinds of care in the health system in Kuwait, the primary, secondary, tertiary and specialized health cares, each with their separate centers. The primary health care includes the general clinics, maternal and child clinics, dental and diabetes. It also includes the school health centers, police and paramedics are also in this sector of health care, all provided in 72 centers in the country. The secondary and tertiary health care is provided at six hospitals, and these include general hospitals and health centers. The specialized health care centers- according to the World Health Organization- are the following: Obstetrics (delivery) hospital: for maternity, Chest hospital: for pulmonary ailments, Psychiatric hospital: for mental disorders, Ibn Sina hospital: for neurosurgery, Razi hospital: for burns, Kuwait Center for Allergies: for allergies, Kuwait Cancer Control Center: for cancer diagnosis and treatment, Hearing Impairments Center: for disorders connected with hearing, Hamed Al-Essa Transplant Center: for organ transplants, and Sulaibikhat hospital: for physiotherapy and rehabilitation.[19]

While the public health sector is heavily involved in preventing disease, like vaccinations and such, the private sectors offer little services in that regard. The number of staff and patients in the private sector compared to the public sector is not negligible; 798,985 to 1.75 million patients, respectively. Some of these Hospitals are Ahmadi Hospital, Texaco Hospital, and Kuwait National Petroleum Company Hospital. In 2014, the health

[19] Source: The World Health Organization, Health System Profile – Kuwait, 2006.

workforce was counted to be 25 doctors and 59 nurses and midwives per 10,000 people (WHO, 2006).

2.7.3 Demography

The population of Kuwait has increased sharply since the 1960s owing to the income from oil: from about 0.5 million in 1965 to about 1.5 million in 1995, mostly attributed to migration (Kuwait Central Statistical Bureau, 2013). This population growth has been accompanied by rapid urban extension: Many public hospitals, health centers, and clinics were established during this time to fulfill the increasing demand for public health services. The population also increased greatly during the last two decades. During this period, however, urban development was relatively slow, and thus the country's infrastructure faced increasing pressure, including public health services.

As of July 2017, Kuwait's population was at 2,875,422. However, with immigration amounting to more than 69.5%, the population, it has increased to 4,437,590 according to Kuwait's Public Authority for Civil Information. The growth rate at which the population is increasing is 1.46%. Immigration to Kuwait has been taking a slow descent at a rate of -0.24%. In 2018, almost 100% of Kuwait's population lives in its Capital city; Kuwait and on Failaka Island, as opposed to just the year before that where 96.4% of the population lived in Kuwait.

TABLE 6: POPULATION DATA[20]

Indicators	Value
Population (million) mid-2018	4.2
Births per 1,000 People	14
Deaths per 1,000 People	2
The Rate of Natural Increase (%)	1.3
Population (million) mid-2030	4.9
Population (million) mid-2050	5.6
Infant Fertility Rate	8
Pop. per km^2 of Arable Land	54,508

[20] Source: 2018 Population Reference Bureau

The total dependent ratio, meaning those who are unable to depend on themselves to earn their living and be a part of the labor force, is 29.8, the youth dependency ratio is 27.1 and the elderly is 2.7, as of 2015. Kuwait has a densely urban population and is gradually increasing. In 2017, the urban population was consistent with 98.4% of the total population of Kuwait (PUBLIC Authority of Civil Information, 2018). However, in 2018, that percentage has increased to nearly 100%. Studies in 2017 show a rate of urbanization at 2.29% annual rate of change (2015-20) est, while the ratio of population as a whole has increased from 62.8% to 69.6% over the past three decades. (PACI, 2018).

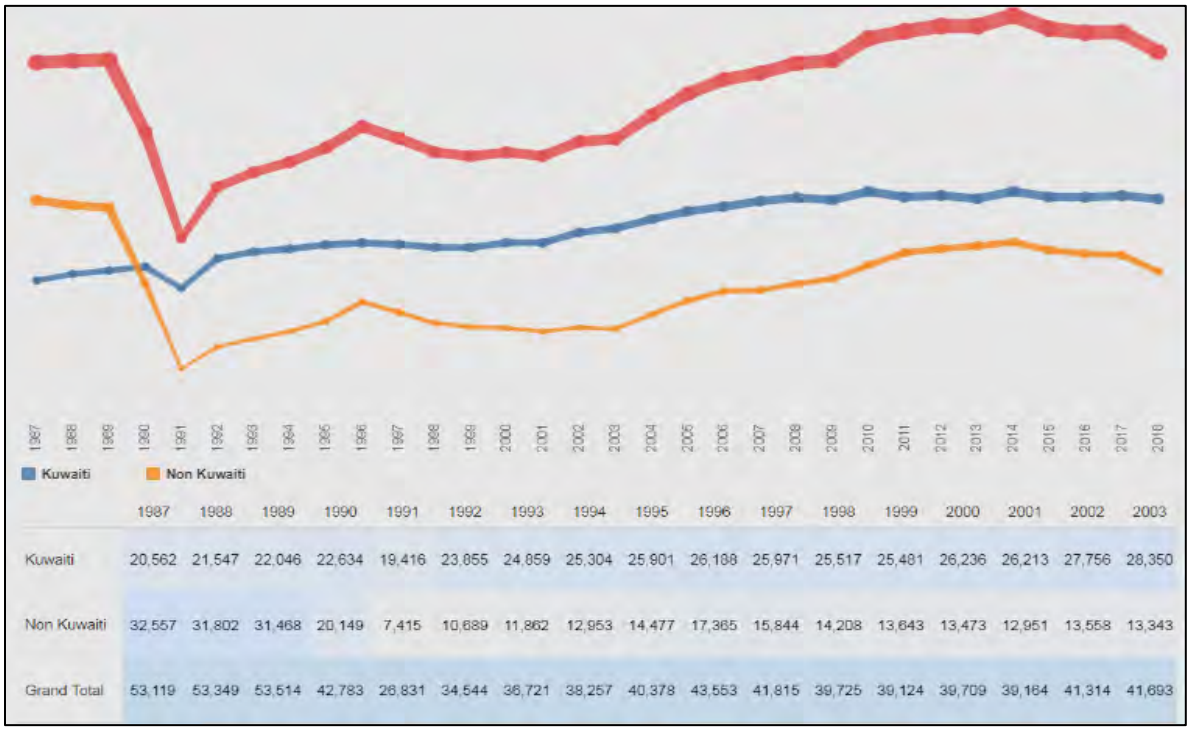
> The urban expansion along the coast and the rapid population growth due to the uncontrolled migration rate are significant non-climate stressors that are expected to play a great role in increase the country's susceptibility to climate change.

Islam is the official religion in Kuwait with most of the Kuwaiti population being Muslims. In 2015, Christianity made up 26.4% of the population of non-citizen, and 0.02% of a citizen in Kuwait. The percentage of non-citizens that are Muslim is 64.1%, 26.4% Christian and the rest of other religion; Hindu, Buddhist, mostly due to the large Indian population in Kuwait. 65% of Kuwaiti citizens are Sunni while the rest are Shi'as. Official Arabic or otherwise known as Modern Standard Arabic is the official language in Kuwait, however people speak the Kuwaiti dialect, standard Arabic is used in school books, newspapers. Most private schools and Universities teach in English rather than Arabic. French is taught as a third language.

As the case is in all the countries in the world, not only natives reside in it, however, the ratios may vary. For example, America has the biggest ethnicity diversity in the world. Kuwait, on the other hand, due to its small size and another factor like the weather and its geographical location, has lower ethnicity percentages than most. The Kuwaiti citizens make 30.36% of the population, other Arab 27.29%, Asian 40.42%, African 1.02%, other 0.9% (includes European, North American, South American, and Australian) (2018 est.). (PACI, 2018).

2.7.4 Gender and Age Structure

Depending on the culture, eating habits, jobs and other variables, a society's mortality vary in gender and age simultaneously, making for varying sex ratios for different ages in the communities. In Kuwait, at birth, the sex ratio is 1.05 males to females, 1.08 from ages 0-14, 1.22 from ages 15-24, 1.72 from ages 25-54, 1.31 from ages 55-64, 0.89 from ages 65 and over. The total population seems to settle at a ratio of 1.41 male/female. **FIGURE 21** illustrates the birth rate in Kuwait for the last 30 years.



	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Kuwaiti	20,562	21,547	22,046	22,634	19,416	23,655	24,859	25,304	25,901	26,188	25,971	25,517	25,481	26,236	26,213	27,756	28,350
Non Kuwaiti	32,557	31,802	31,468	20,149	7,415	10,689	11,862	12,953	14,477	17,365	15,844	14,208	13,643	13,473	12,951	13,558	13,343
Grand Total	53,119	53,349	53,514	42,783	26,831	34,544	36,721	38,257	40,378	43,553	41,815	39,725	39,124	39,709	39,164	41,314	41,693

FIGURE 21: BIRTH RATE, CRUDE[21]

The median age lies at 29 years, 30.4 for males and 27.4 for females. Age group ratios male to female from 0-14 years make 51.11% to 48.89%, 15-29 years make 61.51% to 38.49%, 30-44 years are at 68.66% to 31.34%, 45-59 years: 67.47% to 32.53% and 60-74 years 57.2% to 42.79% on average in 2018. (PACI, 2018).

The Gender Development Index is a relatively new indicator, introduced in 2014 in the Human Development Report. The GDI is a ratio of comparison of the female to the male

[21] Source: PACI, 2018.

population. In 2017, the GDI was 0.990 because the HDI value for females in Kuwait was 0.791 as opposed to 0.799 for males. The life expectancy at birth for females sits at 76.1, 73.9 for males, the expected years of education is 14.3 and 12.9, the GNI per capita is 39,570 and 93,476, respectively. The Gender Inequality Index (GII), which studies the gender-based inequalities in society by measuring the "reproductive, empowering and economic activity". Maternal mortality and birth rates are indicators of Reproductive Health; empowerment is measured by the amount of higher education a woman gets and the number of seats in the parliament dedicated for females, and lastly, the economic activity is measured by the amount of female involvement in the workforces. The higher the GII, the lower the country's HDI is. The percentage of women in the Kuwaiti parliament is 3.1%; the number of women that have reached at least secondary education comes up to 54.8%, as opposed to men where the percentage is 49.3%. The GII index in Kuwait is 0.270 (UNDP, 2018).

TABLE 7: KUWAIT'S GII FOR 2017[22]

	GII value	GII Rank	Maternal mortality ratio	Adolescent birth rate	Female seats in parliament (%)	Population with at least some secondary education (%)		Labour force participation rate (%)	
						Female	Male	Female	Male
Kuwait	0.270	57	4	9.0	3.1	54.8	49.3	47.4	84.1

2.7.5 Education

Kuwait offers education to all its citizens with the goal of improving lives and the community. Although receiving an education is seen as a right for all in Kuwait, it is not free, especially higher education. The municipality of education has long-term goals concerning the educational and schooling systems. A successful educational system offers a balance between keeping the county's identity while preparing the student for all kinds of changes the country might undergo. Education also prepares for any technological, industrial or mechanical advancements. The 2005-2025 Education Strategy includes;

[22] Source: UNDP, 2018

1. Contributing to the achievement of interaction with the current age requirement of freedom of thought and response to the dynamics of change without conflict with the cultural identity of the society;
2. Contributing to enhancing the values of faith in the importance of dialogue and respect for human rights among the educated and providing the basis for a sound democratic life;
3. Enhancing the concept of wealth production, the preservation of the environment and the resources of the country;
4. Enhancing the basic requirements for school curricula in the general education system to ensure the achievement of the objectives and principles of the state[23].

There are numerous laws, regulations, and legislation concerning education in the Constitution of Kuwait;

- **Article 13;** "Education is a fundamental requisite for the progress of society, assured and promoted by the State".
- **Article 14;** "The State shall promote science, letters, and the arts and encourage scientific research therein".
- **Article 40;**
    1) "Education is a right for Kuwaitis, guaranteed by the State in accordance with law and within the limits of public policy and morals. Education in its preliminary stages is compulsory and free in accordance with the law.
    2) The law lays down the necessary plan to eliminate illiteracy.
    3) The State devotes particular care to the physical, moral, and mental development of the youth" (Kuwait Constitution, 1962).
- **Article 1 of the Compulsory Education Law:** "Education shall be compulsory and free for all male and female Kuwaiti children from the beginning of the primary stage until the end of the intermediate stage. The State undertakes to provide school premises, books, teachers and any other human or material resources, which guarantee the success of education". However, this law only applies to Kuwaiti citizens, rather than all the children living in Kuwait, which would mean that

[23] Points directly quoted from "World Data on Education VII Ed. 2010/11" by UNESCA-IBE.

not all children receive the same opportunities or level of education. Non-citizens could enroll in private schools (Kuwait National Assembly, 2017).

- **Legislative Decree of 1979 regarding the Ministry of Education;** defines the Ministry's role "as the development of Kuwaiti society and the upbringing of its young within an integrated scientific, spiritual, moral, intellectual, social and physical framework. They were tasked with meeting this objective in light of the principles of Islam, Arab heritage, defines the Ministry's role as the development of Kuwaiti society" (Kuwait National Assembly, 2017).
- **Legislative Decree No. 4, 1981 concerning the Eradication of Illiteracy;** it states that all males between the ages of 14-40 and females 14-35 to enroll in literacy programmes (United Nations Economic and Social Sector, 2015).
- **Legislative Decree No. 4 of 1987 concerning Public Education;** the first legislative giving legal framework for public education. This legislation focused on the constitutional laws in the State of Kuwait Kuwait National Assembly, 2017).

Despite the dedication and the amount of money spent on the educational sector (FIGURE 22), Kuwait is said to deliver a relatively poor level of education. According to the Global Competitiveness Report 2015-2016, Kuwait is ranking 66th of 140 countries and that the level of education has receded in 14 categories in the past decades, and places 47th out of 53 countries in the Gulf Cooperation Council assessment.

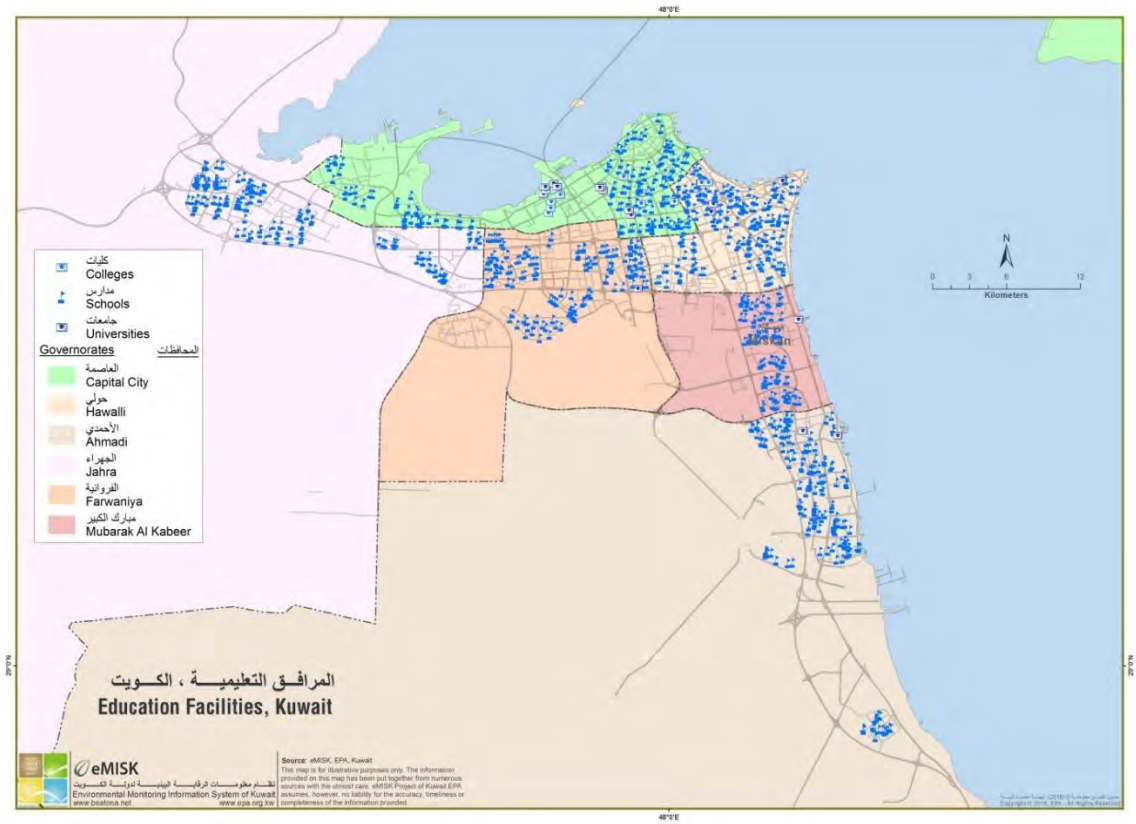


FIGURE 22: EDUCATION FACILITIES, KUWAIT

2.7.6 Unemployment

According to the 2015 United Nations Economic and Social Council the second developmental plan of (2015/2016-2019/2020) included many policies to achieve the increasing productivity and cooperation between international labor standards, environmental safeguards, productivity, competitiveness, and economic growth as follows:

7 “Expat workers in Kuwait enjoy health, education and social services for them and their dependents, according to laws and regulations, which assures Kuwait respect to international labor standards.

8 Improving the business environment, facilitating the procedures, and providing major investment opportunities are the most important aims of the second development plan. Establishment of joint-stock companies, engagement in partnership projects with the

private sector, improving public projects management, review and amend legislation, support the establishment of small businesses, and improve investment rates; are the most important policies to create opportunities at the private sector and to improve the economy in general.

9 The second development plan aims at increasing the productivity and efficiency of the economy by reducing the role of the public sector, increasing competition in the private sector, fighting monopolies, and rationalizing subsidies".

Kuwait has attempted to tackle the issue of graduates and job mismatch by undertaking several steps; analyze and investigate the marketplace and the needs and shortages in it, which indicates the shortages of specialized graduates, and then directing the higher education towards those need and demands. In the second development plan, the importance of integrating the product of the education to the labor market was put in highlight. The second development plan also included a few policies concerning training; one being the need for formulating and implementing a clear training methodology in Kuwait, also adopting strategies and standards from the National Institutes of Training to elevate the level of training programs (UN Economic and Social Council, 2015). The Kuwait unemployment rates over the last decade are presented in **FIGURE 23**.

FIGURE 23: KUWAIT UNEMPLOYMENT RATE[24]

[24] www.tradingeconomics.com, SESRIC

2.8 Industry

The Construction Industry, one of the industry sectors in Kuwait is massive with about $12.6 billion of infrastructure investment. With oil generation and a somewhat steady economy, Kuwait is more than capable of funding large projects. Coupled with the infrastructure and construction expertise, and the leading development in this field between the Gulf States in the GCC, opportunities will be readily available for Kuwaiti firms. The opportunity to expand the energy infrastructure and construction projects come with the success of the Al Zour projects. According to the Building and Construction Sector in Kuwait; "Kuwait's construction industry value is forecast at approximately USD 3.2bn in FY13, representing a real value annual growth of 3.6%. MEED estimates the total value of projects planned or underway in Kuwait at USD 188bn". The distribution of industrial areas is presented in Figure 24.

Transport Construction takes up to 76% of the budget of the total construction in Kuwait:

- "Kuwait City's USD 7bn metro project has been subject to delays, although there are signs of progress. The project is expected to be completed by 2020. However, according to Khaled Mahdi, the secretary general of the supreme council for planning and development, the AL Zour oil refinery project is to be completed in December of 2019.
- USD 3.3bn Kuwait International Airport (KIA) terminal will open in September 2016".

The Energy and Resources construction sector in Kuwait accounts for 20% of the total:

- "Kuwait National Petroleum Company is set to construct the largest oil refinery in the Middle East.
- The USD 14.5bn facility will have a daily processing capacity of 615,000 barrels from 2018.
- USD 1.8bn water and power project is being developed at Al Zour North".

Social Construction accounts for 4%:

- "Kuwait has at least USD 5bn of university building projects either in the planning stage or under construction" (Mounif Kilwani, 2014).

The first phase of the project is said to take a 1.7 M bpd in 2025 and 2 M bpd by 2035 in the second phase. And that includes building a new refinery, amongst other things. (Ian Simm, Newsbase Ltd. 2019).

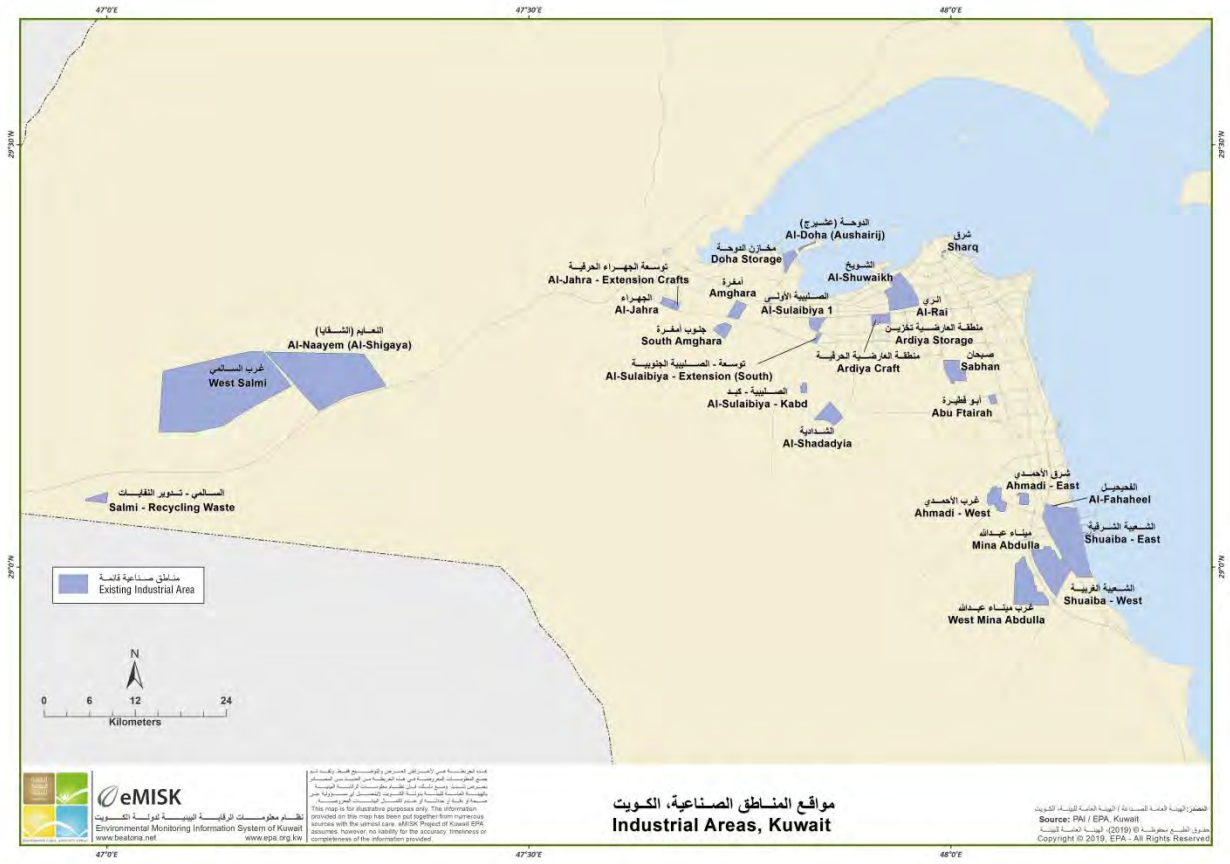
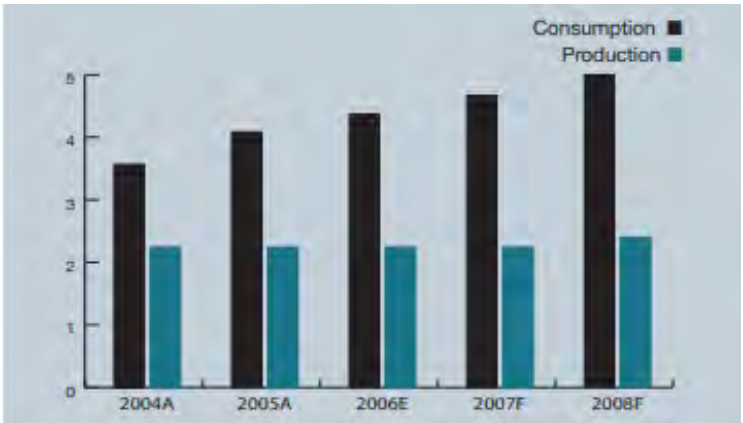


FIGURE 24: INDUSTRIAL AREAS, KUWAIT

There is only one cement company in Kuwait as of 2018, with the capacity of 2.24Mta. There is no indigenous raw material in Kuwait, rather all imported from UAE and Iran. In 2005, the Kuwaiti government gave license to a one-time export of 20,000t of cement to Iran. In 2006, The Kuwait-Jordan Holding Company launched that another cement factory ($230 M, 1.8Mta) was to be built in Kuwait. The cement prices are government controlled and sold in bulk coming at US$55/t export works, locally US$65/t. In practice, the government sells to Kuwaiti nationals at US$50/t by covering the cost between this price and the local free market price of more near to US$75/t (The Global Cement Report, 2018). Figure 25 illustrates cement industry growth in Kuwait, as an example.



m tonnes	2004	2005	2006E	2007F	2008F
Consumption	3.57	4.08	4.37	4.67	5.00
Change (%)	0	+14.5	+7.0	+7.0	+7.0
Production	2.24	2.24	2.24	2.24	2.24
Exports*	0	0.02	0	0	0
Imports*	1.40	1.84	2.13	2.43	2.80

* cement only

FIGURE 25: CEMENT GROWTH IN KUWAIT[25]

2.9 Current climate trends

2.9.1 Temperature

Kuwait extends in a desert region characterizing with very high air temperatures during summer seasons that ranged from 43.0 to 48.6 ºC, and relatively low air temperatures in winter seasons ranging from 6.4 to 10.6 ºC: These ranges were absorbed based on the climatic data recorded at Kuwait international airport station during the last decade (2007 – 2016). Temperatures occasionally exceed this range. For instance, the highest maximum temperature ever recorded (51.7 ºC) was observed in Kuwait international airport station in July 2017, while an air temperature of 54 ºC was recorded in Mitibah station during July 2016. Also, lower temperatures below the range during winter seasons were occurred in 47 days from 1962 to 2017. This wide yearly range of temperatures is one of the significant harsh environmental conditions that Kuwait experiences. The overall temperature trend during the study period exhibited an observable rise in the temperature estimated to be 1.6 ˚C.

[25] Source: ICR Research

2.9.2 Rainfall

The average annual precipitation over Kuwait for the period of 1962-2017 was 112 mm: Most of the precipitation occurred during winter and spring seasons. Some years clearly deviated from this annual average: For instance, the annual precipitation of 1979 was 244.8 mm, while it was only 32.2 mm in 1964. The precipitation trend, however, was not clearly stated in the second national communication report. The statement that can be concluded from these precipitation values is that the lower and fluctuating precipitation values are expected to be one of the significant factors disturbing Kuwait ecosystems.

A study, by Jaber Almedeij in 2012 was conducted using a model to form and understand the precipitation (mainly rainfall) patterns in the urban areas in Kuwait. Rainfall data, whether spatial or temporal, are collected from different stations in Kuwait and Kuwait International Airport, respectively and then analyzed accordingly. One of the objectives of this study is to connect the rainfall intensity and frequency in Kuwait and how that correlates to the amount of water that goes to agriculture and helps with the supply of water that is dedicated to Agriculture in Kuwait. The mentioned weather stations in Kuwait for the Spatial Rainfall data collections in the urban areas in Kuwait are Jahra, Shwaikh, Ahmadi, Salmiyeh and a few more. The data was collected from the mid of 1990 decade till 2005. The average annual total rainfall data for 20 years is presented in Figure 26.

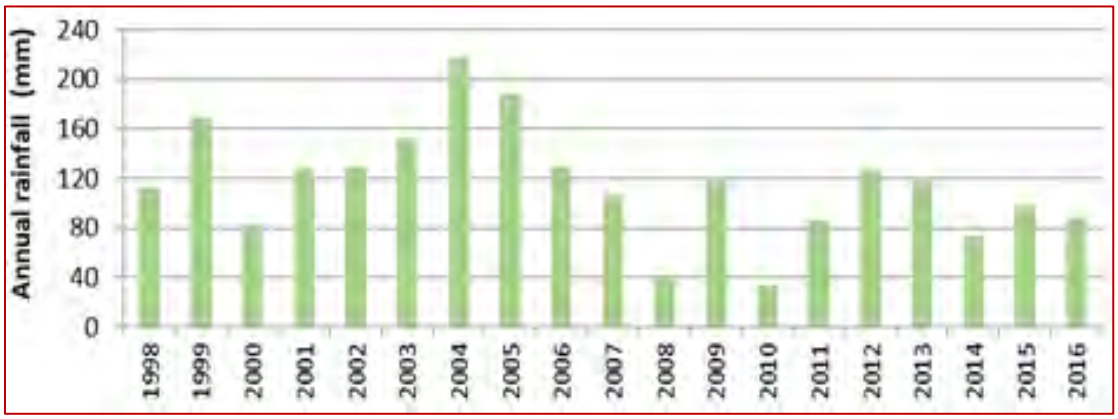


FIGURE 26: AVERAGE ANNUAL TOTAL RAINFALL DATA 1998-2016[26]

[26] Source: Kuwait Civil Aviation – Metrology Department

The precipitation diagram for Kuwait City shows on how many days per month, certain precipitation amounts are reached. In tropical and monsoon climates, the amounts may be underestimated (Figure 27).

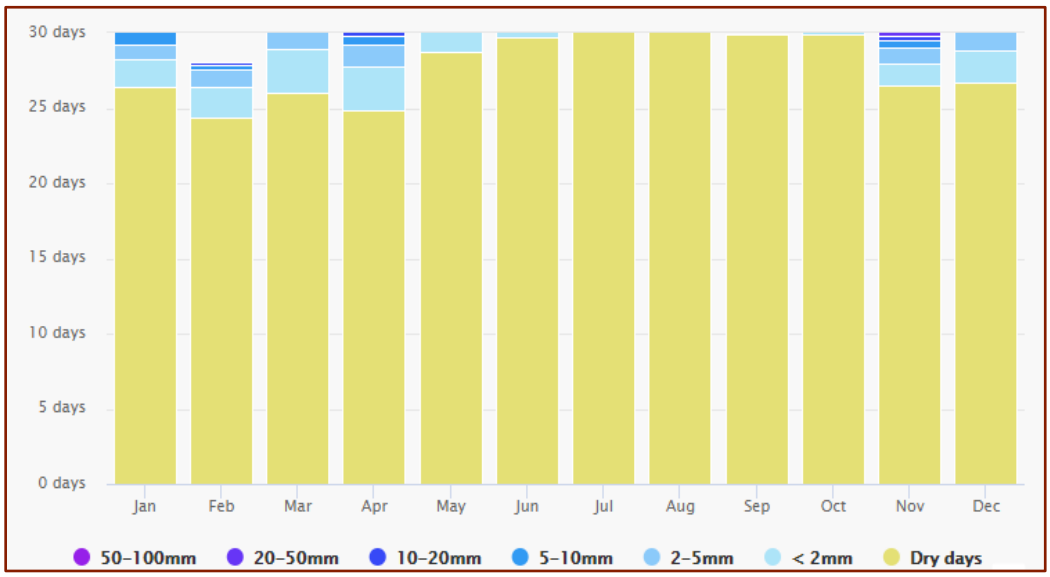


FIGURE 27: PRECIPITATION AMOUNTS[27]

2.9.3 Relative Humidity

Other climatic aspects that are disturbing Kuwait urban ecosystems are dust storms and rising dust that occur frequently in Kuwait during the last three decades. For instance, the yearly average durst storm events and rising durst events from 1987 to 2016 were 8.3 and 97.4 days, respectively. These frequent dust events were highly associated with air quality degradation by increasing the concentration of particulate matter ($PM_{2.5}$ and PM_{10}) in the atmosphere leading to serious health-related issues. The annual median of $PM_{2.5}$ levels was 75 of $\mu g/m^3$ (about seven times higher than the safe limit recommended by the World Health Organization, 10 $\mu g/m^3$) (KEPA, SNC, 2019). These high levels of $PM_{2.5}$ would increase the vulnerability of Kuwait urban areas to climate change.

[27] The precipitation diagram for Kuwait City shows on how many days per month, certain precipitation amounts are reached. In tropical and monsoon climates, the amounts may be underestimated. Source: meteoblue- Kuwait.

Samples were taken in ten locations over the period of a year. The data collected were the humidity concentration, Temperatures, wind information, and air pressures, as shown in the following table;

TABLE 8: DESCRIPTION OF THE SAMPLING PROTOCOL[28]

Month	Sampling duration		Temp °C	Humidity %	WD °N	WS m/s	Pressure m Bars
	Start	End					
March	03/03/2011	26/3/2011	19.75	46.17	213.14	3.81	1013.60
April	04/08/2011	23/4/2011	25.49	43.19	155.69	3.77	1007.25
May	05/07/2011	22/5/2012	32.31	37.58	134.14	3.47	996.13
June	06/11/2011	30/6/2011	36.81	30.80	234.38	3.82	994.43
July	16/7/2011	31/7/2011	38.04	32.68	204.67	3.38	994.89
August	08/01/2011	16/8/2011	38.08	33.61	195.70	3.34	1000.00
September	09/05/2011	20/9/2011	35.06	38.10	130.77	3.42	1008.62
October	14/10/2011	31/10/2011	28.55	43.37	171.01	3.51	1014.27
November	16/11/2011	30/11/2011	20.35	51.12	211.51	4.26	1019.65
December	12/02/2011	21/12/2011	15.07	55.16	253.84	3.96	1019.65
January	01/01/2012	28/1/2012	15.83	51.12	187.43	4.07	1016.74
February	02/10/2012	03/02/2012	15.76	55.96	195.84	3.66	1012.89

2.10 Future climate trends

2.10.1 Temperature and Rainfall Projections

Two scenarios of temperature rise drawn in the second national communication of Kuwait were considered: The first scenario, called RCP 4.5, was estimated considering low to medium emission increases; the other called RCP 8.5 was estimated considering intensive uses of fossil fuel in this century. The table below illustrates the expected temperatures based on the two scenarios. These temperatures were divided based on time intervals to draw detailed information of the future temperature trend for the next decades. Such detailed information would be a valuable mean in setting an adaption plan that imitates climate changes during each time interval. Overall, temperatures are expected to increase from 2.4 to 4.8 ^{o}C at the end of this century.

[28] Source: Jasem Al-Awadhi, 2014

THE SAME SCENARIOS WERE USED TO PREDICT PRECIPITATION CHANGES OVER KUWAIT. BOTH SCENARIOS SHOWED THAT PRECIPITATION VALUES ARE EXPECTED TO DECREASE DUE TO CLIMATE CHANGE IN THIS CENTURY.

Table 10 illustrates the expected decreases in precipitation based on the two scenarios. The precipitation values are expected to fall from 25% to 30% comparing to the baseline data recorded from 1986 to 2005. The expected temperature and precipitation values for the surrounding regions were also provided in the report. In conclusion, severe temperature increases and decreases in precipitation values would fundamentally change the02 ecosystem functions and socioeconomic aspects. Some recommended efforts to minimize the effect of these changes are tree plantings to decrease the albedo, educating citizens and raising public awareness about climate changes consequences.

TABLE 9: AN ILLUSTRATION OF TEMPERATURE CHANGES DIFFERENT TIME INTERVALS[29]

Scenario	Increase in Temperature (ºC)	Projected period
RCP 4.5	0.6-1.2	2031-2050
	1.2-1.8	2051-2070
	1.8-2.4	2071-2100
RCP 8.5	0.2-1.4	2031-2050
	2.4-3.0	2051-2070
	3.0-4.8	2071-2100

TABLE 10: ILLUSTRATES PRECIPITATION CHANGES IN DIFFERENT TIME INTERVALS[30]

Scenario	The decrease in annual mean precipitation (%)	Projected period
RCP 4.5	5 - 15 to 20 - 25	2031-2050
	5 - 20 to 5 - 25	2051-2070

[29] Source: KEPA, SNC, 2019.
[30] Source: KEPA, SNC, 2019.

	5 - 25 to 5 - 15	2071-2100
RCP 8.5	0 - 5 to 5 – 15	2031-2050
	5 - 25 to 5 - 15	2051-2070
	5 - 15 to 25 - 30	2071-2100

CHAPTER 3: CLIMATE HAZARD AND VULNERABILITY ANALYSIS

3.1 Introduction

Climate change is expected to have a profound effect on developing countries in different important sectors including water resources, food security, human health, terrestrial ecosystems, and coastal zones. For instance, variations in the temporal and spatial distributions of precipitation due to climate change would add a significant pressure on developing countries, especially those extending in arid and semi-arid environments, such as the State of Kuwait, where freshwater resources are scarce and desalinated water is the main source of freshwater (AL-Yamani, Bishop, Ramadhan, AL-Husaini, & Al-Ghadban, 2004). In Kuwait, the agriculture is highly vulnerable sector relying on domestic water supply from desalination: Groundwater is a minor source for the agriculture in the country (Al-Rashed, Al-Senafy, Viswanathan, & Al-Sumait, 1998). Thus, experiencing frequent drought events would increase the water demand for irrigations and other domestic needs (Pereira, Oweis, Zairi, & Santos, 2002). This demand requires more energy consumption to fulfill: According to the statistical year-book of 2017 published by the ministry of electricity and water, Kuwait consumed more than 710,000 BTUs of energy to fulfill it demands of electricity and desalinated water costing the country more than 1 billion KD (Ministry Of Electricity & Water, 2017). Such disturbance would also have other consequences, including increases in dust storm events that degrade the urban air quality and consequently put people with chronic epidemiological disease in danger (e.g., Barnett, Fraser, & Munck, 2012; Geravandi et al., 2017; Yang, Tsai, Chang, & Ho, 2005).

Drought events, dust storms, and heat waves play a significant role in degrading Kuwait terrestrial ecosystems. These harsh environmental conditions increase the susceptibility

of biodiversity reduction and threaten Kuwait food security. For instance, Asem and Roy (2010) stated that some indigenous plants and animals are less tolerance to drought conditions and are expected to be significantly disturbed due to climate change. Also, increasing temperatures would have multiple impacts not only on Kuwait terrestrial ecosystems but also on its coastal and marine ecosystems. Al-Husaini et al., (2015), for instance, discussed that the observed decline in shrimp production from 1985 to 2013 might be linked to increased coastal water temperatures due to climate change.

The coastal zone of Kuwait is also expected to be affected by sea level rise (SLR), one of the major consequences of global climate change. (KEPA, INC, 2012) revealed that about 65 thousand people would be exposed to SLR risk and more than 240 km^2 of land (1.35% of Kuwait's land) would be inundated when sea level increases only 0.5 m: These lands include vital services and infrastructures, such as hospitals, educational institutions, and major ports. Thus, designing an adaptation plan to face climate change, which has already observed, is a mandatory task to ensure the sustainability of human settlements and natural environments of Kuwait.

3.2 Designing Climate Vulnerability Assessment (CVA) for Kuwait

3.2.1 Climate Vulnerability Assessment

Climate Vulnerability Assessments (CVAs) are derived mostly from qualitative analyses to identify the susceptibility of people as individuals, their societies and ecological systems to climate change. CVAs are also set to draw strategies of facing climate change impacts so that stakeholders can use those strategies as a tool to mitigate climate change and maintain human settlements and natural resources. Successful assessments would help individuals, communities and societies to understand which sectors and natural resources more vulnerable and which activities should be taken to reduce their vulnerability. CVAs also illustrate links between climate change factors (e.g., elevated temperature and sea level rise) and non-climate factors (e.g., population growth and corruption): Understanding these links would assist societies to improve their capacity building for climate change (Kim, Calzada, Scott, & Zermoglio, 2018). Such efficient CVAs require systematic methods to be delivered.

Methods used to conduct CVAs depends on several factors including the complexity of CVA framework, spatial and temporal extents, objectives, and level of expertise required for conducting the assessment (Kim et al., 2018). The amount of detail and depth of analysis presented in the CVA depend on its scope: An overall CVA covering the most important sectors might involve gathering and synthesizing results of previous studies, whereas targeting a specific sector might require data collection and extensive analyses including modeling exercises. Also, CVA spatial and temporal extents might vary from a local to global scale and from short-term to long-term periods including projection exercises (Hansen, Hoffman, Drews, & Mielbrecht, 2010; Warren et al., 2018): The spatial and temporal extents would determine which method is most appropriate for conducting the CVA. The objectives are also an important factor in determining the adequate CVA method. CVAs involving identification of climate change impacts require methods differ from those aimed to monitor the progress of climate change impacts. Finally, the level of expertise that requires establishing a CVA is very important in determining the CVA method. Some assessments require, for instance, the Geographic Information System (GIS) skills to analyze geospatial data and illustrate informative maps of Climate Vulnerability Index (CVI, (Kim et al., 2018)).

CVAs can be classified into three levels in terms of the scope and depth of analysis: These levels are strategy, project, and activity. The objectives of CVAs at strategy level are addressed at the country level and set to understand and identify climate risks, allocate climate risk hotspot and evaluate climate risks on the most vulnerable sectors. Achieving these objectives would assess in prioritizing the most vulnerable regions and sectors to climate change. The output of CVAs at strategy level might include identifying adaptation measures and highlighting areas for further analysis. CAVs at project and activity levels are conducted to answer more specific and detailed questions focusing on the smaller spatial extent and specific groups: CVAs at activity level address the most specific questions comparing to the other two levels (Kim et al., 2018). CAVs at project and activity levels are beyond the scope of Kuwait NAP.

3.2.2 Kuwait CVA Objectives[31]

Kuwait CVA's objectives are:

1. Identify and understand historical and projected climate risks at the country level,
2. Evaluating sectoral climate risks to inform sector planning, and
3. Identifying gaps for conducting climate vulnerability index.

Questions raised from these objectives were:

1. What are the historical trends of climate change?
2. What are the projected changes in climate to 2010?
3. What are the potential impacts on coastal zones?
4. How is climate change expected to affect fisheries and other marine resources?
5. How is climate change expected to affect human populations?
6. What are the gaps for conducting CVI?

3.2.3 Methodology to develop a CVA

Kuwait NAP was set based on a CVA at strategy level targeting four sectors (i.e., marine and fisheries, water resources, coastal zones, and health) identified by the stakeholders and the SNC. Data and information used to conduct the CVA were derived the SNC, national reports, peer-reviewed studies, and technical reports published by local and international agencies. The overview of methods, data, and information used to conduct the CVA of Kuwait are illustrated in the following table:

TABLE 11: OVERALL METHODOLOGY

Objectives	Methods	Sources	Output
Identify and understand historical and	A desktop review of	• Kuwait SNC	• Description of Kuwait's general climate.

[31] Kuwait CVA objectives were set following the suggestion of Kim et al., (2018).

projected climate risks at the country level	secondary sources		• Climate trends and modeled climate change: - Temperature projections. - Precipitation projections. - Sea level projections.
Evaluating sectoral climate risks to inform sector planning	A desktop review of secondary sources and basic GIS analysis	• Kuwait SNC • Peer-reviewed studies and technical report on relevant sectors, non-climate stressors, and climate impacts on Kuwait. • Geospatial data produced for Kuwait SNC.	• Description of: - Kuwait's marine and fisheries, water resources, coastal zones, and health sectors, - Climate impacts, and - Non-climate stressors (population growth, negative anthropogenic activities and SST). • Maps of climate risk hotspot (SLR). • A table describing SLR scenarios on Kuwait. • Distribution maps of total population, population density, and asthma patients. • Profile summarizing climate risks, vulnerability, and impacts on marine and fisheries, water resources, coastal zones, and health sectors. • Adaptation options

3.3 Assessing and Ranking climate change vulnerability

Assessing the climate change vulnerability of sectors is usually carried out by conducting CVI in which climate change vulnerabilities are spatially analyzed and indexed using geographic information system (GIS): This requires each sector to be spatially ranked

based on its vulnerabilities to climate change. In the SNC, the only sector that its vulnerability to climate change was spatially ranked was the coastal zone. The other sectors were analyzed using non-spatial approaches. Thus, this section presents the methodology and data required for conducting the CVI of Kuwait as a guideline for Kuwait national communication teams.

3.3.1 An Overview of the CVI method

CVI is calculated using spatial analysis tools available in GIS (mainly raster recalculation, reclassification, and GIS overlay function) through five main steps:

i) Selection of evaluation criteria,
ii) Determine and prepare the input layer (convert input data into spatial layers),
iii) Define criteria weight,
iv) Assessing the weights (constructing hierarchy, standardization of criteria, and assigning weights) and produce maps, and
v) Evaluate and assess output (matrix consistency check).

Determining criteria of climate change vulnerabilities is based on the previous studies that investigated climate change impacts and consequences on each sector such as those used to assess the vulnerability of the coastal zone. The required input GIS layers for the climate change vulnerability analysis are specified based on the selected criteria. These layers must share the same spatial extent, or at least they have a spatial overlap.

The CVI map is carried out using a raster-based GIS analysis. Thus, any input vector layer must be converted to raster as an initial step in the spatial computation. The processed raster layers are ranked and then weighted based on their priorities (Aldababseh, et al., 2018). Although the priority of layers is subjective, the decision can be made based on the monetary values or exposure to climate change risks.

The ranked weighted layers are then spatially overlaid to compute the sum of weighted scores. This process produced a CVI layer for each sector. These layers are weighted with the same manner to calculate the overall CVI map illustrating the vulnerable places to climate change: The highest pixel values in the CVI map revealed the most vulnerable

places to climate change. Figure 28 provides an overview of the processes involved in hypothetical vulnerability analysis.

3.3.2 Identifying and analyzing data

Proposed Kuwait NAP covers four sectors: Marine and fisheries, water resources, coastal zone, and health. These sectors must be spatially analyzed as an initial step to calculate CVI for Kuwait. In the SNC, the marine and fisheries sector focused on the impact of three water quality variables (i.e., SST, pH, and salinity) on coral reefs and other marine communities. The spatial distribution of SST and salinity can be significantly mapped by integrating into situ measurements with remotely sensed data, whereas understanding the spatial and temporal distribution of pH requires monthly well spatially distributed in situ measurements ($n \geq 30$). Another variable that can be mapped by integrating into situ measurements with remotely sensed data is water transparency measured using Secchi disk depth (SDD). Water transparency is one of the most important water quality variables that indicates light availability in aquatic ecosystems. It influences by various important factors, such as colored dissolved organic matter (CDOM), chlorophyll concentrations and suspended sediments (Attivissimo, Carducci, Lanzolla, Massaro, & Vadrucci, 2015; Cui, Zhang, Ma, & Li, 2007). SST, pH, salinity, and SDD layers can be used to allocate the vulnerable places within Kuwait coastal and marine environments. The susceptible areas, such as coral reefs, should gain more weight when calculating CVI for the marine and fisheries sector.

The CVI map of marine and fisheries must be analyzed impudently: It cannot be incorporated with CVI layers for the other sectors since the spatial overlap between them does not exist (INC, 2012; SNC, 2019). The water resource and health sectors share the same spatial extent, whereas the coastal zone sector spatially overlaps with them. These sectors can be analyzed together to calculate the overall terrestrial CVI for Kuwait.

Kuwait relies on three water resources: desalinated water, brackish groundwater and treated wastewater to fulfill its water demand in domestic, agriculture, and industrial sectors: The water desalination source is the main source of water in Kuwait. In the SNC, future water demands were analyzed using different scenarios based on three main inputs: water supply, water demand, and water transmission. The scenarios were drawn

considering a normal population growth (3.2%). These scenarios can be spatially analyzed to index the vulnerability of Kuwait to climate change in the water resource sector by considering the spatial distributions of water supply, water demand, water transmission, and population within Kuwait districts. Also, the cost of water supply for each district can be considered since this factor is expected to be varied from district to district.

The health sector in the SNC described the effects of harsh environmental conditions in degrading the quality of human environments and consequently exposing people lives to danger. The susceptibility of asthma patients to dust events and effects of heat waves discussed in the SNC can be investigated from a spatial perspective. The association of asthma patients with suspended dust and other air quality variables (e.g., ozone, sulfur dioxide, and nitrogen dioxide) can be spatially detected by observing them in each district. The in-suite measurements can then be spatially interpolated and represented as GIS layers, whereas asthma patients can be spatially mapped by the number of patients' visits to emergency departments from each census block (Gorai et al., 2014). The spatial association between the asthma layer and air quality layers can be evaluated using spatial relationship tools available in GIS (Gorai et al., 2014; T.J., P., J.M., S., & S., 2017). Understanding the role of climate stressors and non-climate stressors will assess in predicting the unhealthiest places for asthma patients (i.e., the most vulnerable places).

Events of heat waves, on the other hand, can be incorporated in this analysis if they exhibited spatial variability within the study area.

The coastal zone resource was spatially analyzed in the SNC: The CVI map of this sector was produced based on four physical parameters (i.e., elevation, coastal slope, geomorphology, and distance to 20 m isobath) and four socioeconomic parameters (i.e., population, land-use, cultural heritage, and transportation) (KEPA, SNC, 2019). The CVI map of this sector can be used as an input layer to calculate the terrestrial CVI of Kuwait.

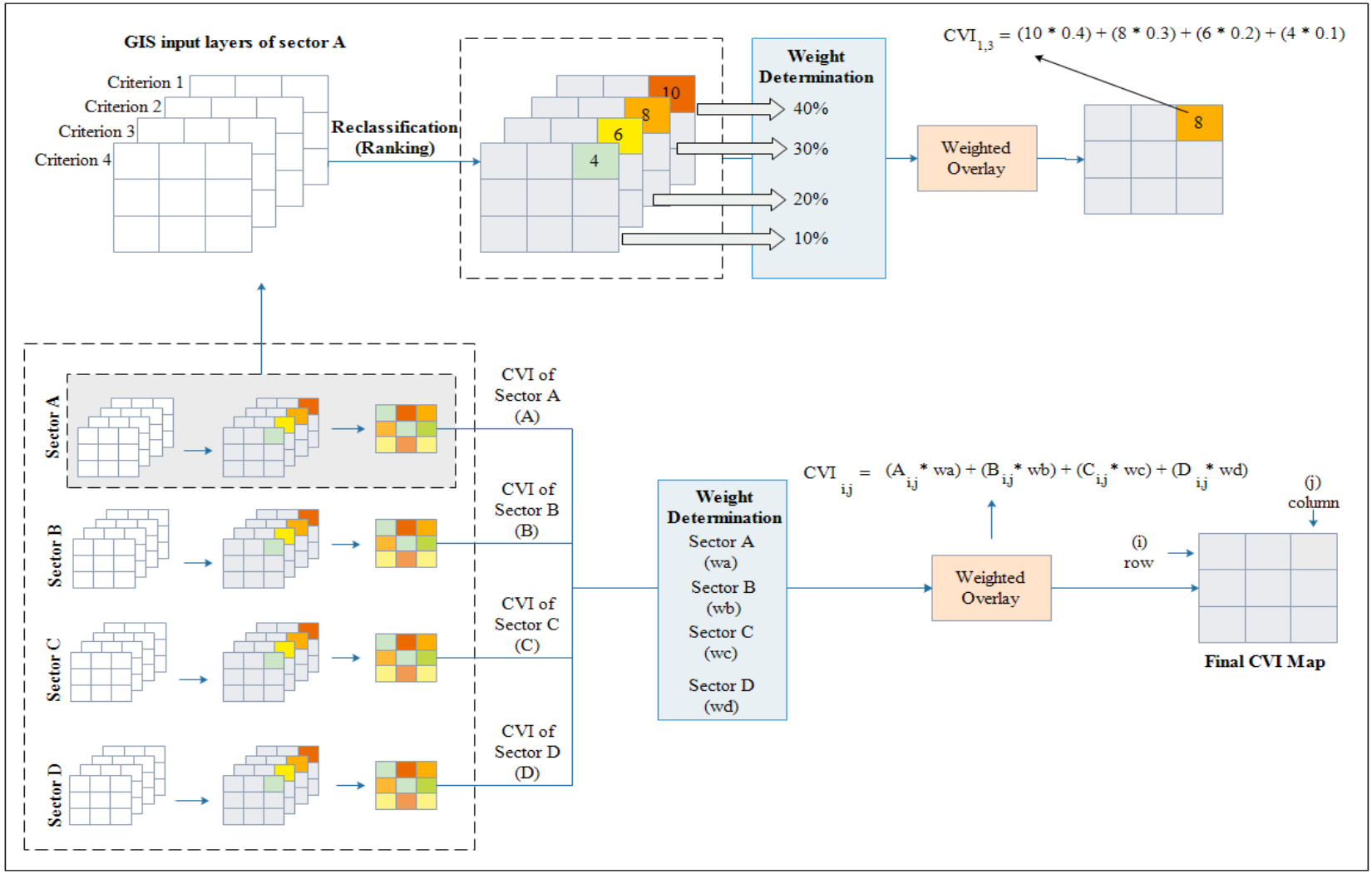


FIGURE 28: ILLUSTRATES THE OVERALL STEPS FOR CALCULATING CVI. THIS HYPOTHETICAL EXAMPLE REVEALED THE CALCULATION OF CVI FOR A CASE WITH FOUR SECTORS AND FOUR CRITERIA IN EACH SECTOR.

3.3.3 Ranking Climate Risks and Vulnerabilities

Assessing ranks of climate risks and vulnerabilities is a critical step in conducting CVI. It is also a fundamental component in prioritizing adaptation options and illustrating vulnerabilities of sectors to climate change in a comprehensive context. The ranking process is complex and subjective relying on qualitative analysis and experts' opinions (Aldababseh, et al., 2018). For instance, the climate risks and adaptation options were addressed in NAP of Sri Lanka with a context of prioritizing actions based on discussions of experts and working groups (Seneviratne et al., 2016). De Bruin et al. (2009) provided a systematic methodology for ranking and weights adaptation options for the Netherlands considering climate change risks on different sectors: The weights were based on experts' judgments. They stated that their methodology of ranking is interactive and can be used for another country with adjustments to that country conditions.

Following De Bruin et al. (2009), climate change risks and vulnerabilities of Kuwait have been ranked with adjustments in the context of ranking, criteria, and weights. The framework of ranking focused on climate change risks and vulnerabilities of Kuwait, whereas ranking adaptation options were not assessed: Such in-depth analysis is beyond the scope of this initial NAP. Also, the criteria and weights were adjusted based on data availability and differences in climate change risks. The proposed ranking method is fixable and should be reviewed and adjusted for future analyses based on data availability and input criteria.

The ranking of climate change risks and vulnerabilities consisted of five criteria:

(i) the level of damage that a climate change risk is expected to leave;
(ii) the level of a hazard on human health and food and water security,
(iii) the urgency of adaptation illustrating the necessity of immediate action,
(iv) the mitigation difficulty reflecting the incapability of controlling a climate change risk, and
(v) the level of impact across the sectors.

These criteria had weights of 30%, 20%, 20%, 15%, and 15%, respectively. The score of each criterion ranged from 1 (very low) to 5 (very high). The weights and scores were

chosen based on a subjective judgment drawn from the understanding and analyzing of multiple sources including De Bruin et al. (2009), Mwangi & Mutua (2015), UNFCC (2007), and Kunreuther et al. (2013). The weighted sum of climate change risk score (S) was calculated using the following equation:

$$S_j = \sum_{i=1}^{n} C_i * w_i,$$

where C_i is the criterion (i), and

$w_i$is its corresponding weight.

3.3.4 Scoring Assessment and Results

Marine fisheries sector has great importance to the country in providing about 50% of the seafood demand (AL-Yamani et al., 2004). The country extends in semi-arid environments where food and natural freshwater resources are very limited: The coastal and marine environments are the ultimate natural resources of food and fresh water for Kuwait (Al-Abdulrazzak et al., 2015). Thus, Kuwait is considered in a good position to tolerate the expected degradation of coastal and marine environments due to climate change risks (i.e., increased SST, increased salinity and ocean acidification). These risks can leave a severe impact on socio-economic components under limited mitigation options (e.g., the development of aquaculture). For these reasons, increased SST increased salinity and ocean acidification were given the highest score among the climate change risks. Increased SST was given the highest score (5) in all criteria because it is the most threating risks on coastal and marine environments as it has already reached intolerant levels (Table 12) (F. Al-Yamani et al., 2004; Glibert et al., 2002). Increased salinity was given a score of four in damage, risks and impact since organisms living near estuarine systems such as those living in coastal and marine environments of Kuwait exhibit a degree of tolerance to the salinity fluctuating (George & John, 1999). Ocean acidification was given a score of four in mitigation since it is caused by very complex factors including anthropogenic activities that can be controlled. Levels of pH within Kuwait seawater did not exhibit a significantly elevated trend. Thus, risks of ocean acidification were given a score of three.

Water resources sector mainly relies on desalinated water for freshwater demands. Thus, increased temperatures may have indirect effects on the water desalination, such as increasing seawater salinity and water irrigation demands. This climate change risk received a score of four in risks and impact, whereas its score in the mitigation difficulty was three since some mitigation options are feasible, such as controlling the population growth through restricted migration rules to decrease freshwater demands (Table 12) (Amery, 2015; Gulseven, 2016). The saltwater intrusion risk has a limited effect on the water resources sector since it mainly impacts groundwater, a minor source of freshwater in Kuwait. Controlling groundwater withdraw and restricting negative anthropogenic practices are some mitigation options to these risks (Al-Rashed et al., 1998; Kløve et al., 2011; Taylor et al., 2012). The saltwater intrusion risk was given these scores for these reasons.

The risk of inundation of low-lying areas due to SLR is expected to leave a significant impact on the coastal zone: Important infrastructure and facilities including power and desalination plants, ports, hospitals, and educational institutions are expected to be exposed to SLR risks. The monetary value of recovering damages on this infrastructure and facilities would be very high. One of the feasible mitigation options to this risk is to apply an adaptive coastal land use policy that restricts establishing major projects on vulnerable coasts. This risk received a weighted sum score of 4.35 due to the severe impact that can cause (Table 12).

The risks of increased dust events and heat waves on health sector were given a score of three in most of the criteria (Table 12). Although these risks are very serious and spatial comprehensive, they threaten certain susceptible population categories: Dust events affect children and elderly people; whereas heat waves affect outdoor workers. These risks can be minimized with mitigation options including adjusting the official working hours to avoid working during maximum temperatures in the day and establishing national health alerts for dust events and heat waves.

TABLE 12: RANKING OF CLIMATE CHANGE RISKS AND VULNERABILITIES

Climate Change Risks and Vulnerabilities	Sector	Damage (30%)	Risks (20%)	Urgency (20%)	Mitigation (15%)	Impact (15%)	Weighted Sum
Increased SST	Marine and Fisheries	5	5	5	5	5	**5**
Increased salinity	Marine and Fisheries	4	4	5	5	4	**4.35**
Ocean acidification	Marine and Fisheries	4	3	5	4	4	**4**
Increasing air temperature	Water resources	4	5	5	3	4	**4.25**
Salt water intrusion	Water resources	4	4	5	2	4	**3.9**
Inundation of low laying areas (SLR)	Coastal Zone	5	4	5	3	4	**4.35**
Increased dust events	Health	3	3	5	3	3	**3.4**
heat waves	Health	3	3	5	3	3	**3.4**

3.4 Climate Risks and Vulnerable Sectors

Kuwait's second national communication (SNC) consisted of three main sections: national circumstances; gas inventory and mitigation; and vulnerability and adaptation. The Kuwait National Plan (NAP) is mainly based on the vulnerability and adaptation work under the SNC. The vulnerability and adaptation section assesses the vulnerability of four sectors believed to be the most important sectors for the country and suggests immediate adaptation solutions (KEPA, SNC, 2019). The four main sectors identified by the stakeholders and the SNC are presented in detail in the following sections. Figure 29 illustrates climate projections and climate change impacts in Kuwait.

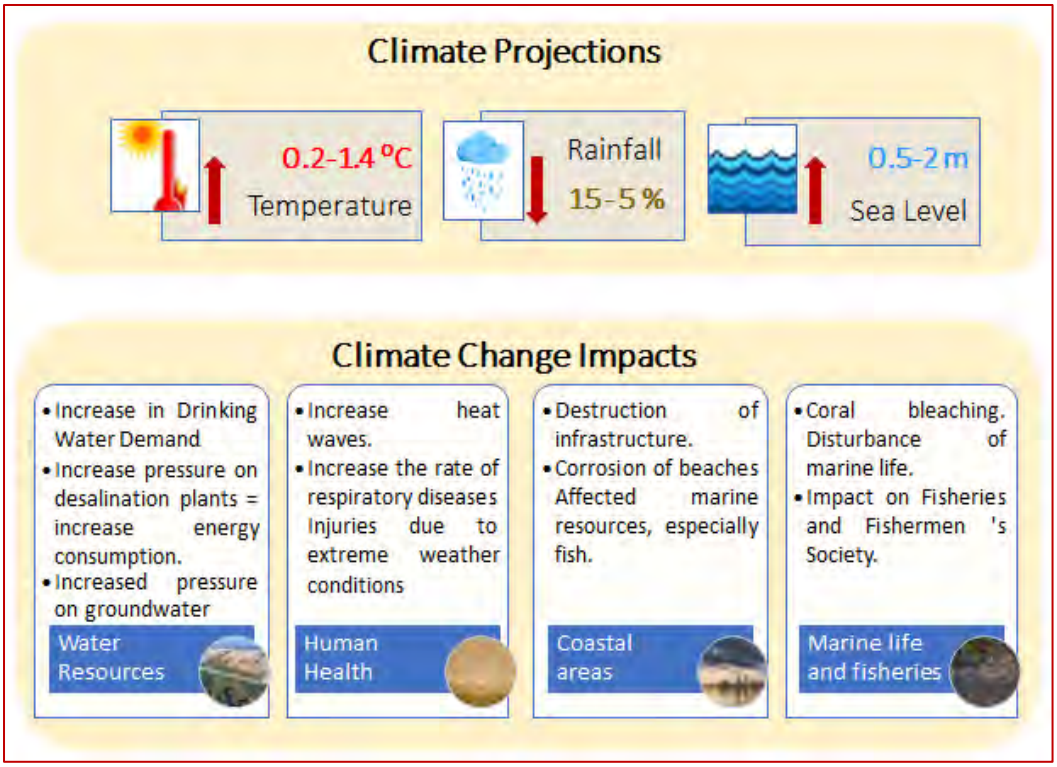


FIGURE 29; CLIMATE PROJECTIONS AND CLIMATE CHANGE IMPACTS- KUWAIT

3.4.1 Fisheries and Marine Life

Kuwait is in the northwestern bank of Arabian Gulf. It has a coastline of 495 km including its islands. Coastal and marine ecosystems of Kuwait are very productive that enrich with biodiversity: About 345 fish and shrimp species have been observed in Kuwait waters (Al-Husaini et al., 2015). These invaluable ecosystems provide the country with about 50% of the country seafood demand (AL-Yamani et al., 2004). Thus, fisheries are the second important sector after oil sector for Arabian Gulf countries, including Kuwait (Al-Abdulrazzak, Zeller, Belhabib, Tesfamichael, & Pauly, 2015). Kuwait marine and coastal environments have various habitats supporting a diversity of species: These habitats include intertidal mudflats, seagrass, algal beds, mangroves, and coral reefs. Among these habitats, coral reefs in the southern Kuwait waters that provide optimum habitats for many organisms and can serve as an indicator for the aquatic ecosystem status are the most stressful habitat because of complicated physical and anthropogenic factors.

One of these stresses is sea surface temperature (SST), one of the climate change consequences, Table 13.

Climate stressors and climate risks –Fisheries and Marine	
Stressors	**Risks**
Increased SST	Coral Reef Disturbance (Bleaching)
	Fish migration
	Effecting aquatic organisms' production
Ocean Acidification	Reducing the growth of many aquatic organisms
Increased Salinity	Negatively affects biotic and abiotic processes, disturbing microplankton, such as foraminifera.

TABLE 13: CLIMATE STRESSORS AND CLIMATE RISKS – FISHERIES AND MARINE

In Figure 30, the solid black line and the solid gray line represent SST derived from MODIS images, international airport station and in situ SST, respectively. Air temperatures clearly drive SST with a temporal lag of one month due to the thermal capacity of seawater: The highest SST occurs in August, while the highest air temperature occurs in July.

SST within Kuwait waters exhibited distinct spatial and temporal distributions. Overall, SST of north Kuwait waters including Kuwait Bay is lower than SST of southern waters: This spatial pattern persists in the winter, middle and later summer, and fall, whereas in spring, especially in March and April, this spatial pattern is totally reversed. May and June are a transition period between the two patterns. SST Kuwait waters increase from January (15.4 ^{o}C) and February (15.7 ^{o}C) to August (32.4 ^{o}C) and then decreased to December (18.1 ^{o}C) (KEPA, INC, 2012), Appendix A. This wide temporal range of SST significantly disturbs coral reef ecosystems (Carpenter et al., 1997) that relatively extend in warmer waters most of the year. The high SSTs in summer seasons and overall

increasing SSTs due to climate changes (Al-Rashidi, El-Gamily, Amos, & Rakha, 2009) would be a serious threat to these valuable ecosystems.

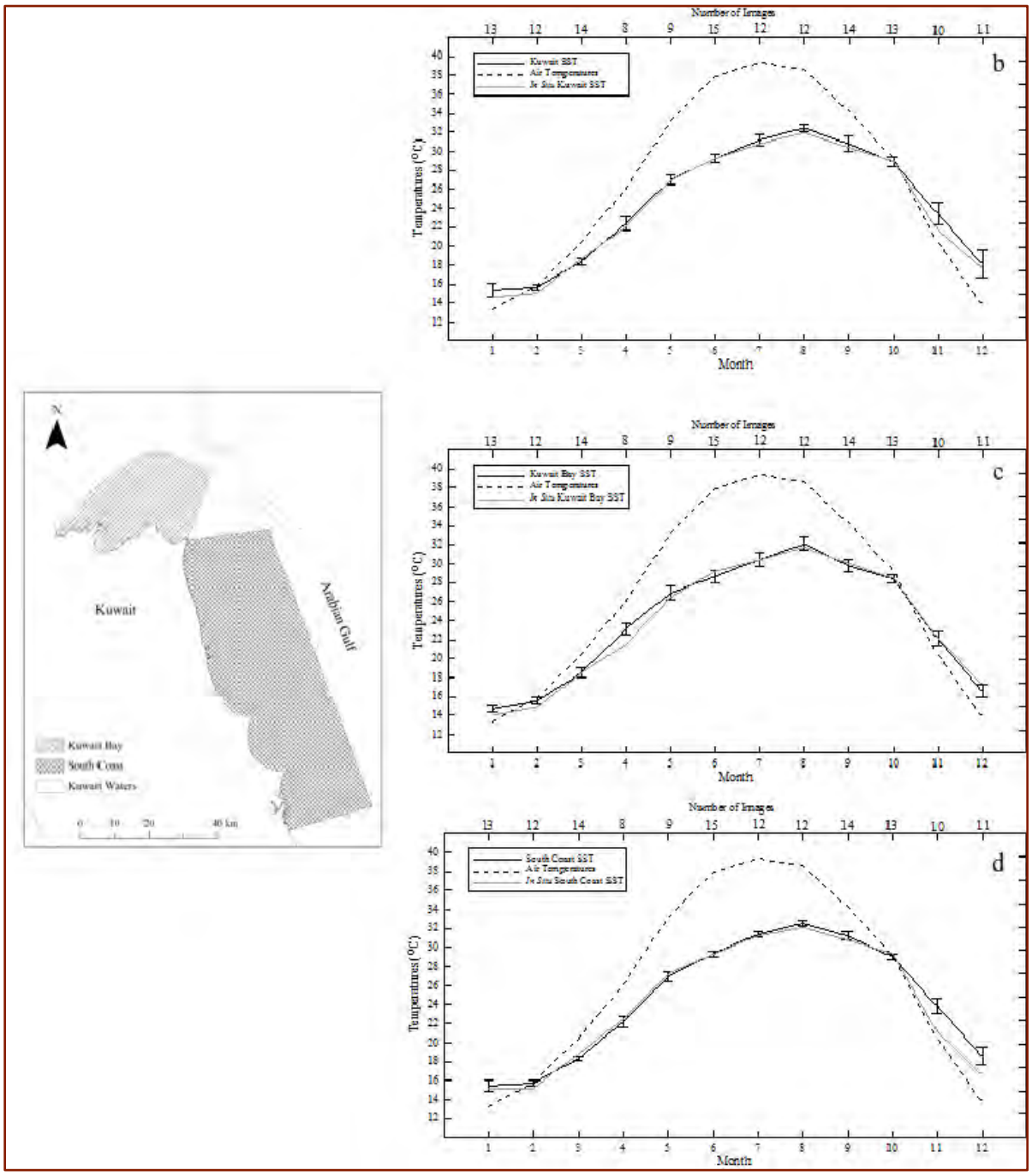


FIGURE 30: THE RELATIONSHIP BETWEEN AIR TEMPERATURES AND SSTS WITHIN KUWAIT SEAWATERS[32]

[32] Source: KEPA, INC, 2012

Average SST in January and August 2017 derived from Aqua MODIS level 2 images: SSTs were calibrated using KEPA, INC, 2012 model within an error of ± 0.7 oC (Appendix B). Coral reefs experience thermal stress during winter and summer seasons as the SSTs are off the optimism SST range for coral reefs.

Another factor expected to have an increasing impact on coral reefs and other marine and coastal ecosystems are increases of seawater acidity as pH decline. Seawater is a great atmospheric CO_2 absorber: As the concentrations of anthropogenic CO_2 are elevated in the atmosphere, oceans and other water bodies will absorb more CO_2. This process leads to ocean acidification, unhealthy status for aquatic organisms. Marine organisms are intolerant to a long-term ocean acidification that could substantially slow the growth of many organisms including reef-building corals, plankton and invertebrates and disturb the other trophic levels (Doney, Fabry, Feely, & Kleypas, 2009; Fabry, Seibel, Feely, & Orr, 2008; Hoegh-Guldberg et al., 2007). Normal pH values of seawater range from 7.8 to 8.3: pH values off this range for a long-term condition would be a stressful factor on aquatic ecosystems. Values of pH observed from 2009 to 2015 in the southern waters of Kuwait ranged from about 7.5 to 9.5 with a mean value of 8.4 (F. Al-Yamani, Bishop, Ramadhan, AL-Husaini, & Al-Ghadban, 2004).

The ocean acidification with other stressful factors, such as increasing seawater salinity, are expected to have serious negative effects on biotic and abiotic processes within Kuwait marine and coastal ecosystems. Kuwait seawater salinity ranges from 38.6 to 42.4 psu: This range is relatively high compared to the southern Arabian Gulf waters near the Strait of Hurmoz that has an average salinity of 36.5–37 psu (Carpenter et al., 1997). Increasing Kuwait salinity can be related to various factors including the decrease of Shatt Al-Arab discharge because of upstream water regulations (Lapshin, 2000; Rahi & Halihan, 2010) and high evaporation rates associated with weather temperatures and water shallowness. Coral species and other marine organisms exhibited difference salinity tolerance. Although some coral communities are salinity tolerance that can successfully live in some areas in the Arabian Gulf where water salinity exceeds 40 psu (George & John, 1999), Bauman et al., (2013) revealed that salinity ranges and other

physical parameters significantly explain the spatial distribution of coral reef communities in the Arabian Gulf. Thus, salinity fluctuations due to multiple factors including climate change are expected to disturb coral reef communities and other marine species leading to a general degradation in marine and coastal ecosystems.

Some microplankton species, such as foraminifera, are sensitive to changes in salinity and other factors, including pH and temperature (Fabry, Seibel, Feely, & Orr, 2008; Kurbjeweit et al., 2000; Segar, 2018). Al-Yamani et al. (2004) reported that the average salinity of Kuwait's sweaters is 41.6 psu: This range is relatively high compared to the southern Arabian Gulf waters near the Strait of Hurmoz that has an average salinity of 36.5–37 psu (Carpenter et al., 1997). Increasing Kuwait salinity can be related to various factors including the decrease of Shatt Al-Arab discharge because of upstream water regulations (Lapshin, 2000; Rahi & Halihan, 2010) and high evaporation rates associated with weather temperatures and water shallowness. Coral species and other marine organisms exhibited difference salinity tolerance). Although some coral communities are salinity tolerance that can successfully live in some areas in the Arabian Gulf where water salinity exceeds 40 psu (George & John, 1999), Bauman et al., (2013) revealed that salinity ranges and other physical parameters significantly explain the spatial distribution of coral reef communities in the Arabian Gulf. Thus, salinity fluctuations due to multiple factors including climate change are expected to disturb coral reef communities and other marine species leading to a general degradation in marine and coastal ecosystems.

3.4.2 Water Resources

Many developing countries experience an increasing demand for freshwater resources because of the exponential growth in population, urbanization, industry, and agriculture. Developing countries extending in arid and semi-arid regions, such as Kuwait, experience limited freshwater resources increasing the vulnerability of this important sector to climate change. Kuwait has a high daily per capita water use levels comparing to other countries. Kuwait relies on three water resources: desalinated water, brackish groundwater and treated wastewater to fulfill its water demand in domestic, agriculture, and industrial sectors. In the second national communication of Kuwait, the status and consumption of

these three water resources in Kuwait were reported based on the current and future demands (KEPA, SNC, 2019).

Kuwait relies on seven seawater desalination plants: Shuwaikh, Shuaiba North, Shuaiba South, Doha East, Doha West, Al-Zour South, and Sabiya (Figure 32). Ministry of Electricity and Water has increased the total desalination capacity for all units from 1.3 MM^3 to 2.4 MM^3 per day between 2000 and 2015 to fulfill the increasing demands on fresh waters (KEPA, SNC, 2019). Another freshwater resource is the groundwater, the only natural water resource in Kuwait. Most of the groundwater resources in Kuwait are brackish with total dissolved solids (TDS) ranges from 3,000–10,000 mg/liter. The other source of water is the treated sewage effluent (TSE) that becomes a valuable source of water with the high cost of water desalination. Ministry of Public Work collects wastewaters coming from all Kuwait areas and treats them in six wastewater treatment plants (Riqqa, Um Alhaiman, Kabd, Al-wafra, Kheran, and Sulaibiya). The TSE is mainly used for irrigation of highway landscapes, households' greening, public parks, and artificial wetlands (KEPA, SNC, 2019).

SST, pH, and salinity were recorded by KEPA from 2009 to 2015 at six nearshore sites in southern waters (KEPA, 2015). SSTs were off the optimum ranges for coral reefs in the winter and summer seasons. pH values varied from sites to another with an overall mean of 8.4. Monthly mean salinity ranged from about 40 to 43 psu. This high range of salinity is expected to increase in the future due to climate change **FIGURE 31**.

The water resources team in the second national communication projected the future demand of freshwater using Water Evaluation and Planning (WEAP) model based on the three scenarios: normal growth of demand, and the two climate scenarios (RCP 4.5 and RCP 8.5) (Box.1/ **FIGURE 33**). The model had three main inputs: water supply, water demand, and water transmission. The normal population growth (3.2%) was also considered in constructing the model. In the normal growth of the demand scenario, the total domestic sector water consumption would be 6,124 MCM in 2035 (2.24 times of the water consumption in 2017). In the RCP 4.5 and RCP 8.5 scenarios, the total domestic sector water consumption would reach 6,221 MCM and 6,233 MCM in 2035, respectively.

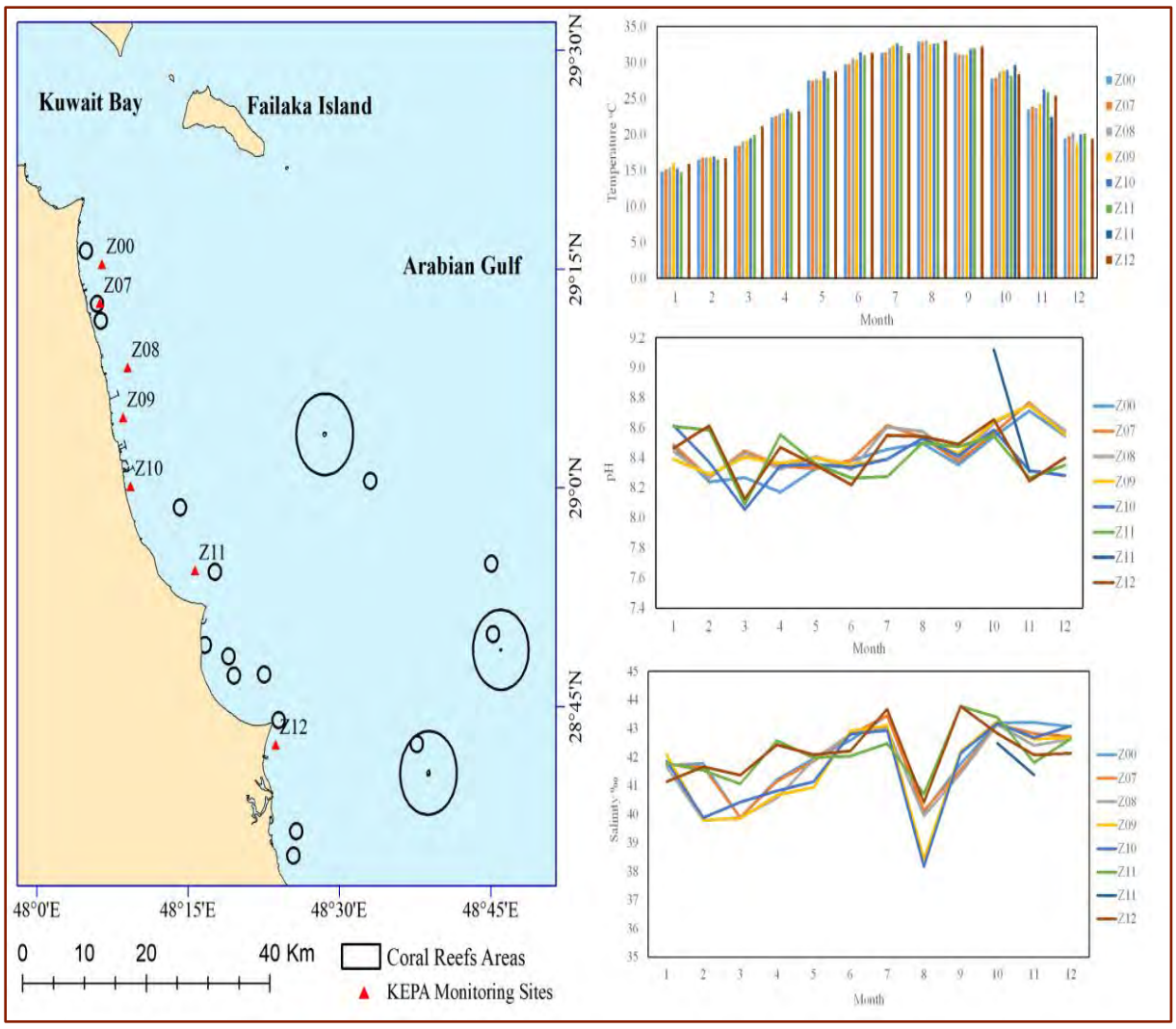


FIGURE 31: SST, PH, AND SALINITY 2009-2015[33]

[33]Source: KEPA, 2015

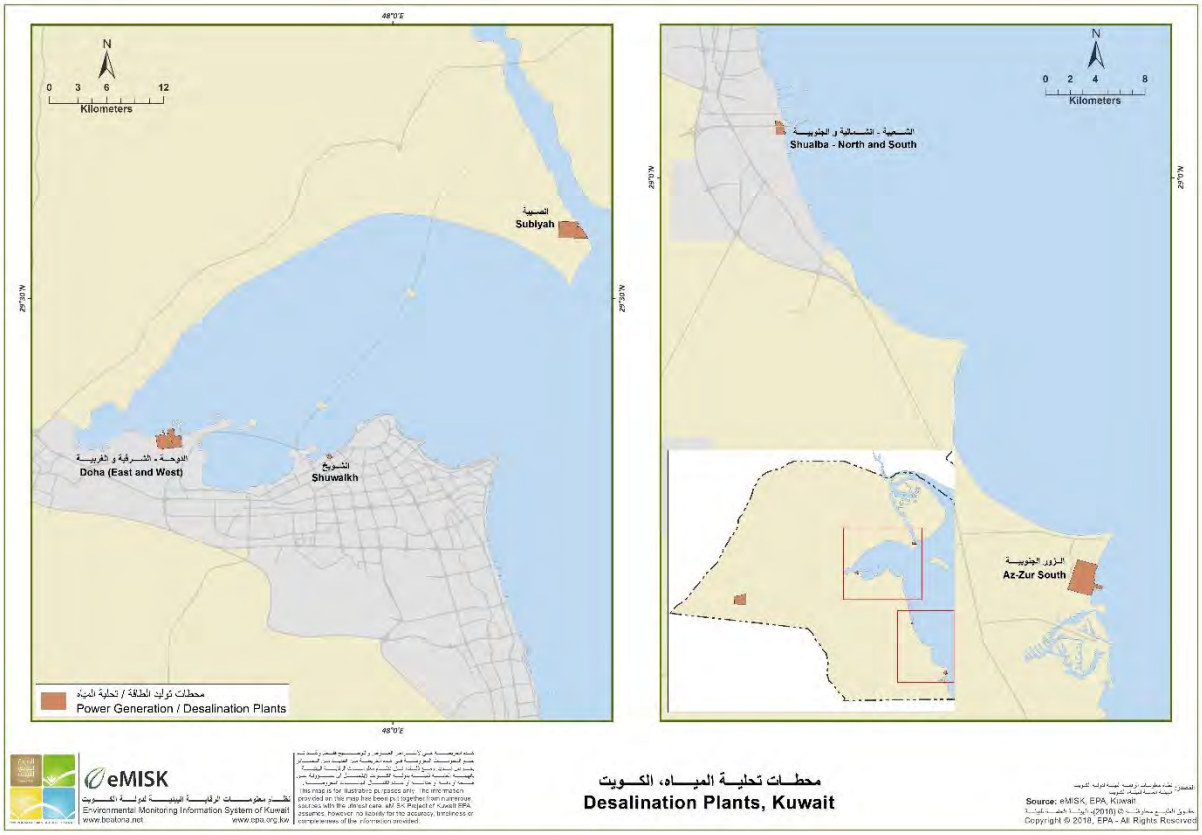


FIGURE 32: LOCATIONS OF KUWAIT DESALINATION PLANTS

The SNC highlighted some recommendations to reduce water consumption, including employing new water a block-tariff, and reducing physical leakages. Applying these recommendations was estimated based on the three scenarios as well as the cost in US dollars of the increasing demand for water resources under the three scenarios. Also, some important steps to mitigate the issue include capacity building, raising awareness, designing effective policies and supporting research and development were addressed.

Temperature and Precipitation Projections

Two scenarios of temperature rise were considered in the second national communication: The first scenario, called RCP 4.5, was estimated considering low to medium emission increases; the other, called RCP 8.5, was estimated considering intensive uses of fossil fuel in this century. The table below illustrates the expected temperatures based on the two scenarios. These temperatures were divided based on time intervals to draw detailed information of the future temperature trend for the next decades. Such detailed information would be a valuable mean in setting an adaption plan that imitates climate changes during each time interval. Overall, temperatures are expected to increase from 2.4 to 4.8 ºC at the end of this century.

An illustration of temperature changes in different time intervals (KEPA, SNC, 2019).

Scenario	Changes in Temperature (ºC)	Projected period
RCP 4.5	0.6-1.2	2031-2050
	1.2-1.8	2051-2070
	1.8-2.4	2071-2100
RCP 8.5	0.2-1.4	2031-2050
	2.4-3.0	2051-2070
	3.0-4.8	2071-2100

The same scenarios were used to predict precipitation changes over Kuwait. Both scenarios showed that precipitation values are expected to decrease due to climate change in this century. The table below illustrates the expected decreases in precipitation based on the two scenarios. The precipitation values are expected to fall from 25% to 30% comparing to the base line data recorded from 1986 to 2005. The expected temperature and precipitation values for the surrounding regions were also provided in the report. In conclusion, severe temperature increases and decreases in precipitation values would fundamentally change the ecosystem functions and socioeconomic aspects. Some recommended efforts to minimize the effect of these changes are tree plantings to decrease the albedo, educating citizens and raising public awareness about climate changes consequences.

An illustrates precipitation changes in different time intervals (KEPA, SNC, 2019).

Scenario	Changes in annual mean precipitation (%)	Projected period
RCP 4.5	5 - 15 to 20 - 25	2031-2050
	5 - 20 to 5 - 25	2051-2070
	5 - 25 to 5 - 15	2071-2100
RCP 8.5	0 - 5 to 5 - 15	2031-2050
	5 - 25 to 5 - 15	2051-2070
	5 - 15 to 25 - 30	2071-2100

FIGURE 33: TEMPERATURE AND PRECIPITATION PROJECTIONS

3.4.3 Coastal Zones

The coastal zone of Kuwait is enriched with biodiversity. For instance, Subkhas[34] extending along the northern coast of Kuwait and considered an ecotone between the terrestrial and marine environments are productive ecosystems that support a number of plant species and other organisms (El-Sheikh, El-Ghareeb, & Testi, 2006). Coral reefs in the southern offshore islands of Kuwait are unique environments that support various trophic levels. Kuwait islands are indeed fabulous environments where marine and terrestrial organisms interact. The coastal region of Kuwait can be divided based on urbanization into two regions. The northern coastal area that extends from the Kuwait-Iraq border in the north to the northern coast of Kuwait Bay is non-urbanized, but some mega developing projects on this area have already started, such as Mubarak Al-Kabeer Port on Boubyan Island (Al-Gabandi, 2011; Baby, 2014). The middle and southern coastal area of Kuwait that extends from the western and southern coast of Kuwait Bay to the Kuwait-Saudi border in the south is extensively urbanized.

THE MIDDLE AND SOUTHERN COASTAL AREA IS A VERY VITAL AREA IN KUWAIT WHERE MOST OF URBAN, COMMERCIAL, INDUSTRIAL, AND RECREATIONAL ACTIVITIES ARE CONCENTRATED: THIS URBANIZED AREA THAT LIES WITHIN ONLY 20 KM OF COAST IS SETTLED BY MOST OF KUWAIT POPULATION THAT REACHED 3.5 MILLION IN 2011 (ANNUAL STATISTICAL ABSTRACT (ASA), 2011). THE COASTAL AREA OF KUWAIT BAY HOSTS KUWAIT CITY, THE CAPITAL, AND THE MAIN COMMERCIAL PORT IN KUWAIT, SHUWAIKH PORT (

Figure 34). The southern coast includes residential, commercial and recreational areas, power plants, and desalination stations (Bakri & Kittaneh, 1998).

- Vulnerability assessment of Kuwait coastal zones to Sea Level Rise (SLR)

[34] Subkha is an Arabic word widely used in the scientific documents written in English to refer to coastal salt marshes of inland salt flat. The subakha is one of distinct coastal features in Arabic lands.

The estimation of IPCC-5 report to SLR reveals that sea level would rise from 0.26 to 0.82 m by the end of the 21st century (Intergovernmental Panel on Climate Change, 2014). As a baseline, the mid-range of this estimation, the 0.5 m SLR scenario, was adapted to assess the vulnerability of Kuwait coasts to SLR. The Coastal Vulnerability Index (CVI) of Kuwait coasts based on the other three scenarios (i.e., 1 m, 1.5 m and 2 m of SLR) were also calculated. The inundated areas at the four SLR scenarios were estimated by comparing the shoreline (high water tide) with elevations of the area adjacent to the coast. Areas with elevations below the projected SLR and connected with seawater were considered as inundated areas. The number of people at risk was estimated by multiplying the inundation area by its population density.

A CVI for Kuwait coasts was then computed using four physical parameters (i.e., elevation, coastal slope, geomorphology, and distance to 20 m isobath) and four socioeconomic parameters (i.e., population, land-use, cultural heritage, and transportation).

The total inundated area varied from about 214 km^2 at SLR of 0.5 m to 498 km^2 at SLR of 2 m. The geographic distribution of inundated areas at SLR of 0.5 m revealed that the northern islands of Kuwait, especially Boubyan Island, would be highly impacted: About 18.6% of the island would be inundated. Climate stressors and associated risk are presented in Table 14. The island would encounter a massive inundation when sea level rises 2 m: About half of the island would be inundated (Figure 35).

FIGURE 34: MAJOR PORTS IN KUWAIT

Climate stressors and climate risks – Coastal Zones	
Stressors	**Risks**
SLR	Damage to essential infrastructure
	Damage to private properties
	Disturbance of coastal ecosystems

TABLE 14: CLIMATE STRESSORS AND CLIMATE RISKS – COASTAL ZONE

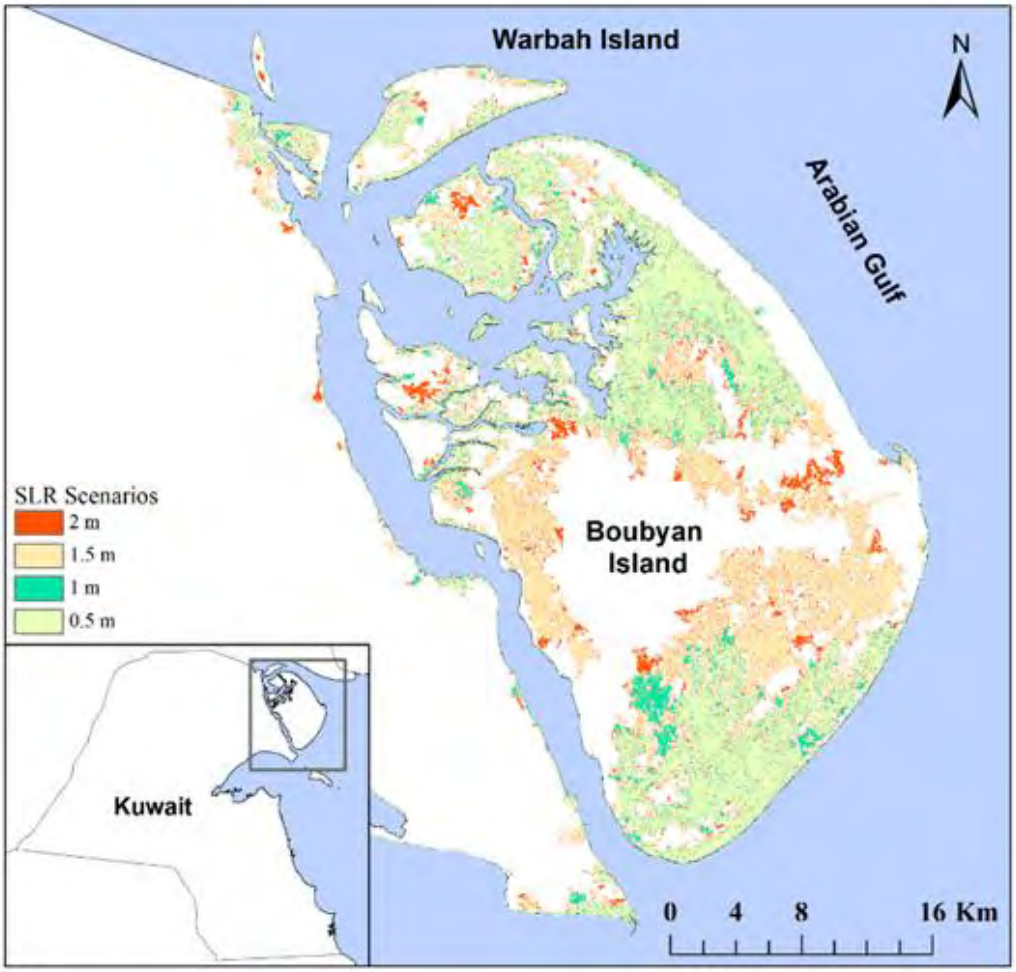


FIGURE 35: BOUBYAN ISLAND[35]

Boubyan Island is highly vulnerable to SLR at the four SLR scenarios. The island would encounter a massive inundation at the extreme SLR scenarios. Also, the coastal area along Kuwait Bay would be influenced by SLR, especially the western coast near Doha Port and populated areas (Figure 36). In the southern coast, the area near Shuaibah Port was the most influenced coast. In addition, the number of people at risk due to SLR is 30453 (about 0.8% of Kuwait population), whereas this number sharply increased to 527462 at SLR of 2 m (about 13.1% of Kuwait population). People exposed to the SLR impact are in the middle and southern coasts Kuwait Bay in the north to the Al-Khairan area in the south.

[35] Source: Draft SNC, 2018

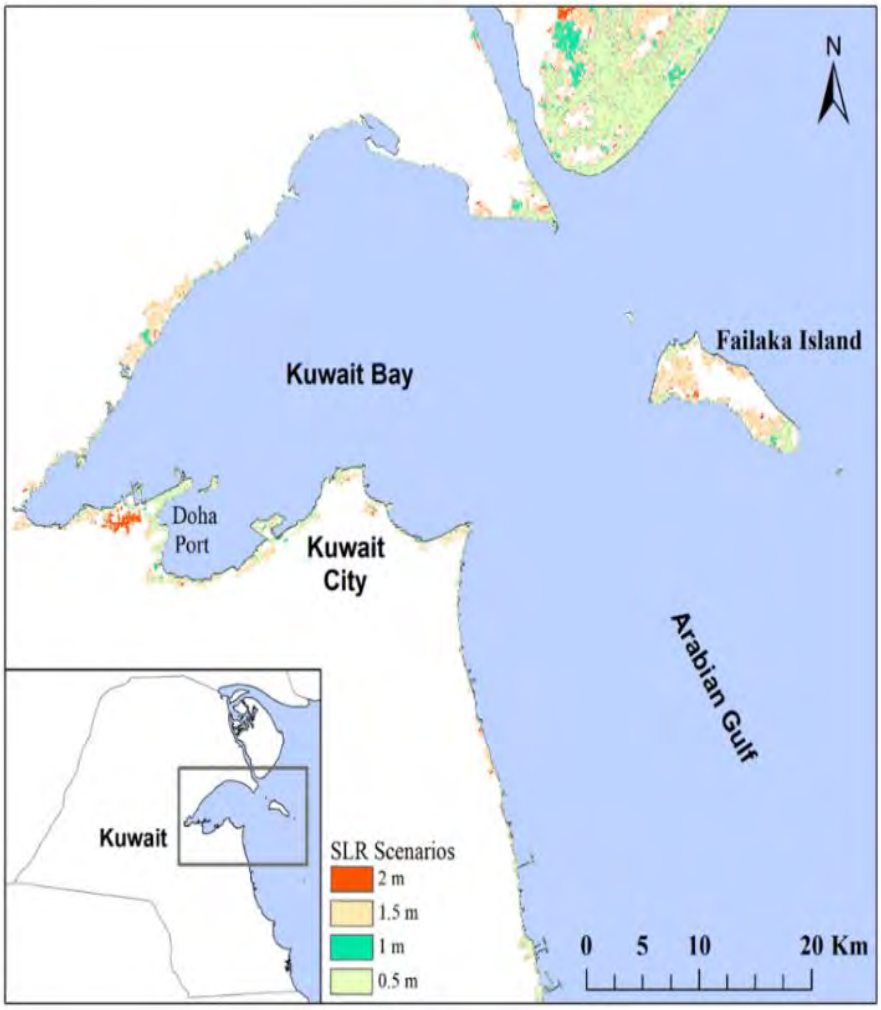


FIGURE 36: COAST FROM DOHA PORT TO KUWAIT CITY

Coast from Doha Port to Kuwait City is highly vulnerable to SLR at the four scenarios. These coasts host very important infrastructures and public services, such as hospitals and academic institutions.

- ***The baseline SLR Scenario (0.5 m)***

The CVI map, produced using eight parameters (i.e., elevation, coastal slope, geomorphology, and distance to 20 m isobath, population, land-use, cultural heritage, and transportation), illustrated that the coastal area under inundation risk in the 0.5 m SLR scenario varies from low vulnerability to very high vulnerability. Most of the coastal

area under inundation had a moderate vulnerability index that ranged in CVI score from 1.50 to 2.49 (Figure 37).

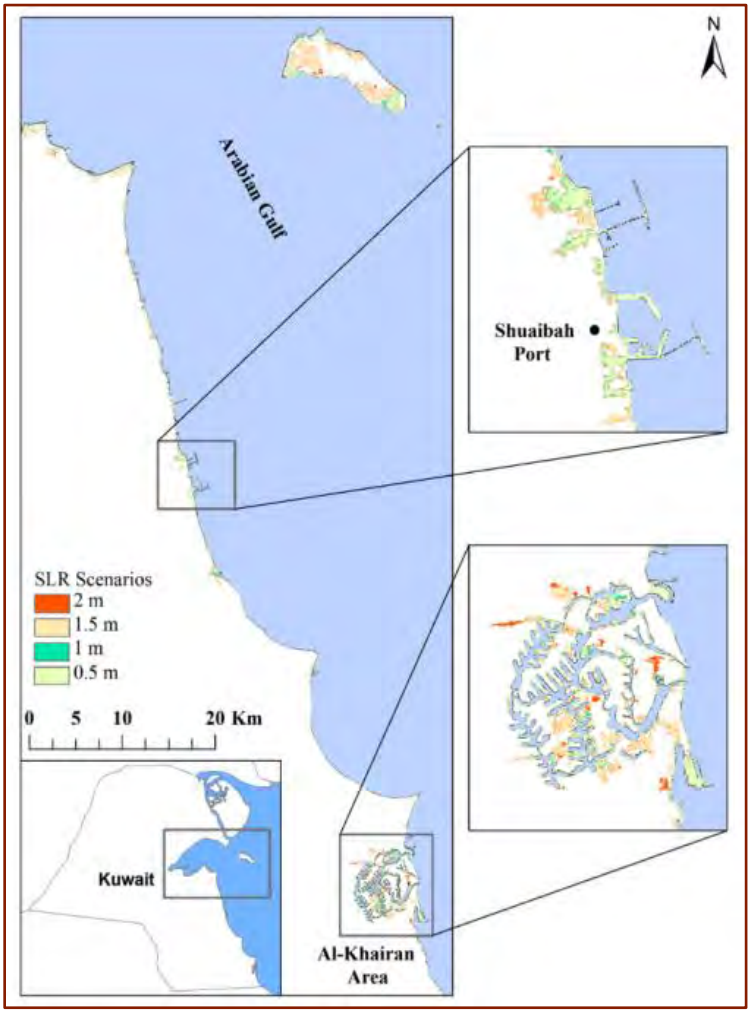


FIGURE 37: SHHUIBAH PORT AND AL-KHAIRAN AREA

Shuaibah Port and Al-Khairan recreational area are the most vulnerable coasts in the south. These areas occupy 150 km^2, about 81% of the area under inundation risk. Most areas with moderate CVI scores extend along the northern islands (Warbah and Boubyan): They received moderate scores because these areas are neither populated nor urbanized (Table 15). Also, Failaka Island facing Kuwait Bay had a moderate CVI score: The island has cultural heritage places, minor anthropogenic activities, and urban areas, but they were neglected when computing the island CVI due to the lack of data.

This lack of data should not affect the overall accuracy of Kuwait coastal vulnerability because these places extend in a very small area.

Most of the extensively urbanized area in Kuwait that extends in the western and southern coasts of Kuwait Bay exhibited high vulnerability to the 0.5 m SLR scenario including some areas in Kuwait City, the capital, Shuwaikh Port, one of the major ports in the Arabian Gulf, and several major hospitals in the country. Also, many recreational sites along the southern coast of Kuwait Bay occupied highly vulnerable areas. Areas with very high CVI scores were distributed in the western and southern coast of Kuwait Bay over limited areas (Table 15). Also, low CVI areas were very sparse along the Kuwait Bay coast. In the southern coast, most vulnerable areas had moderate CVI scores, such as Shuaibah Port and most of the Al-Khairan Area, an important recreational site in southern Kuwait. Areas with high CVI scores were very limited, whereas none of the vulnerable areas on the southern coast seemed to have very high CVI scores (Table 15).

This table shows the area of each class and corresponding CVI score at an SLR of 0.5 m. The percentage reveals the proportion of each class to the total vulnerable area.

TABLE 15: AREA OF EACH CLASS

	Vulnerability	CVI Score	Area (km^2)	Area (%)
0.5 m SLR Scenario	Low	1.00 - 1.49	0.203	0.11
	Moderate	1.50 - 2.49	149.997	80.99
	High	2.50 - 3.49	34.063	18.392
	Very High	3.50 - 4.00	0.941	0.508
			185.203	**100**
1 m SLR	Low	1.00 - 1.49	0.037	0.02

	Moderate	1.50 - 2.49	180.166	78.79
	High	2.50 - 3.49	47.183	20.63
	Very High	3.50 - 4.00	1.283	0.56
			228.670	**100**
1.5 m SLR Scenario	Low	1.00 - 1.49	0.04	0.01
	Moderate	1.50 - 2.49	298.138	78.01
	High	2.50 - 3.49	82.453	21.58
	Very High	3.50 - 4.00	1.529	0.4
			382.160	**100**
2 m SLR Scenario	Low	1.00 - 1.49	0.043	0.01
	Moderate	1.50 - 2.49	358.799	79.1
	High	2.50 - 3.49	93.011	20.5
	Very High	3.50 - 4.00	1.769	0.39
			382.160	**100**

- **The Severe SLR Scenarios (1 m, 1.5 m and 2 m)**

CVI scores of Kuwait coasts at SLR of 1 m were not very different from those scores at SLR of 0.5 m. The total inundation area at SLR of 1 m was about 229 km^2: Coasts with a moderate CVI score occupied about 180 km^2 (About 79% of the inundated area), whereas coasts with a high CVI score extended over about 47 km2 (About 20% of the inundated area). The inundation area at 1.5 m and 2 m SLR scenarios sharply increased to about 382 km^2 and 545 km^2, respectively. Also, the area of high CVI scores increased at these two scenarios illustrating that the Kuwait coastal area would be significantly disturbed at these extreme scenarios.

The geographic extent of potentially inundated areas at the four SLR scenarios revealed that the northern islands would be highly influenced reflecting the sensitivity of these coasts to the SLR.

SLR is expected to be a critical challenge on coastal zones that have already experienced a growing population accompanied by extending urbanization adding extensive pressure

on coastal environments. Designing long-term coastal management plans based on local and regional assessments of coastal vulnerability to SLR is a fundamental step to mitigate the impact of SLR. Two essential components in establishing effective SLR adaptation and mitigating strategies are adaptive coastal land-use policies that restrict establishing major projects on vulnerable coasts and protection of enriched coastal biodiversity.

Kuwait Bay, especially the western part near Doha Port and populated areas, had a high CVI score reflecting the sensitivity of these coasts to the SLR. These coasts host the most important infrastructure in the country.

Vulnerable coasts in the southern area of Kuwait extend generally at Shuaibah Port and most of the Al-Khairan Area, an important recreational site in southern Kuwait.

The Figures below Figure 38, and Figure 39 show fifteen figures of Coastline Sensitivity;

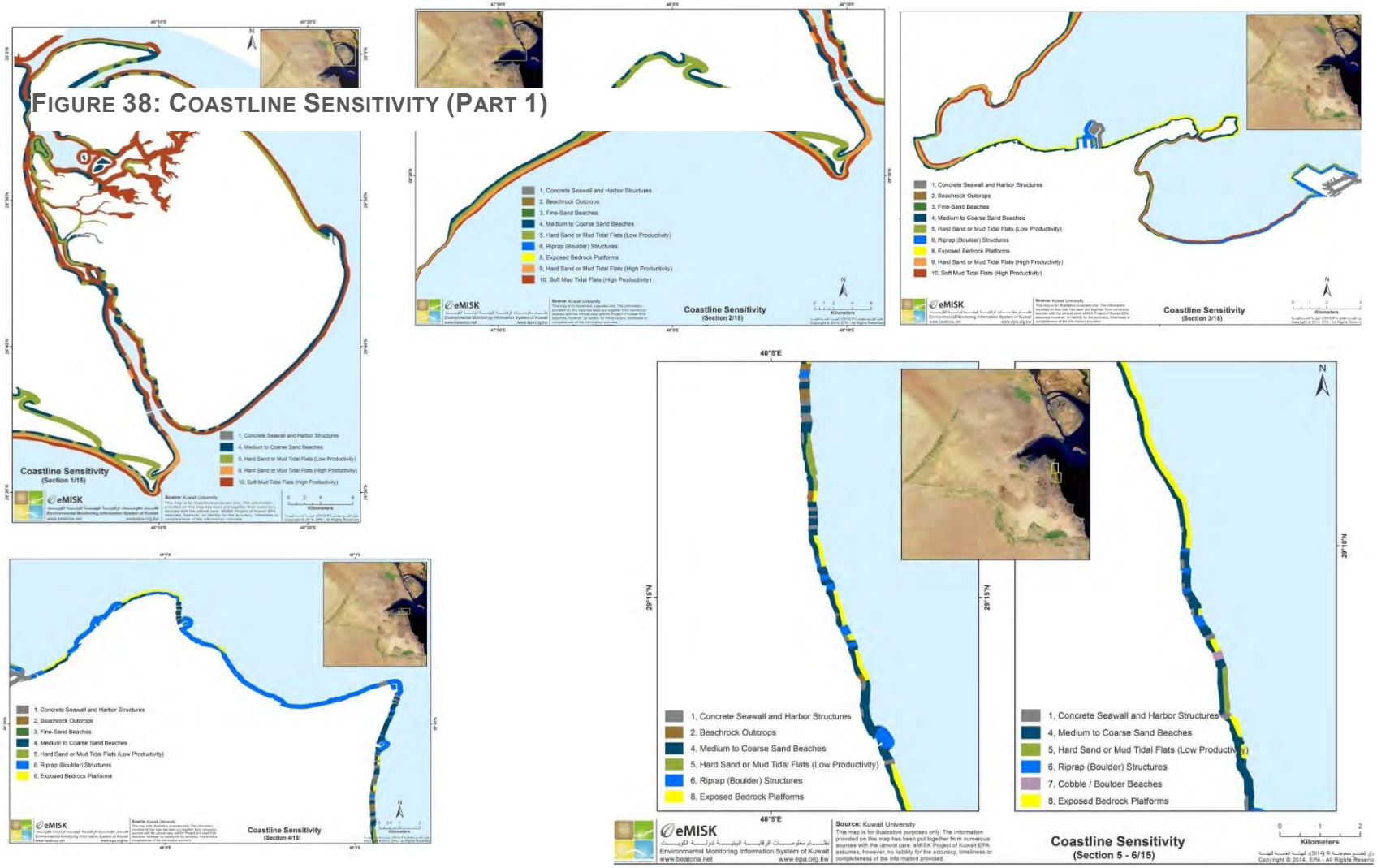


FIGURE 38: COASTLINE SENSITIVITY (PART 1)

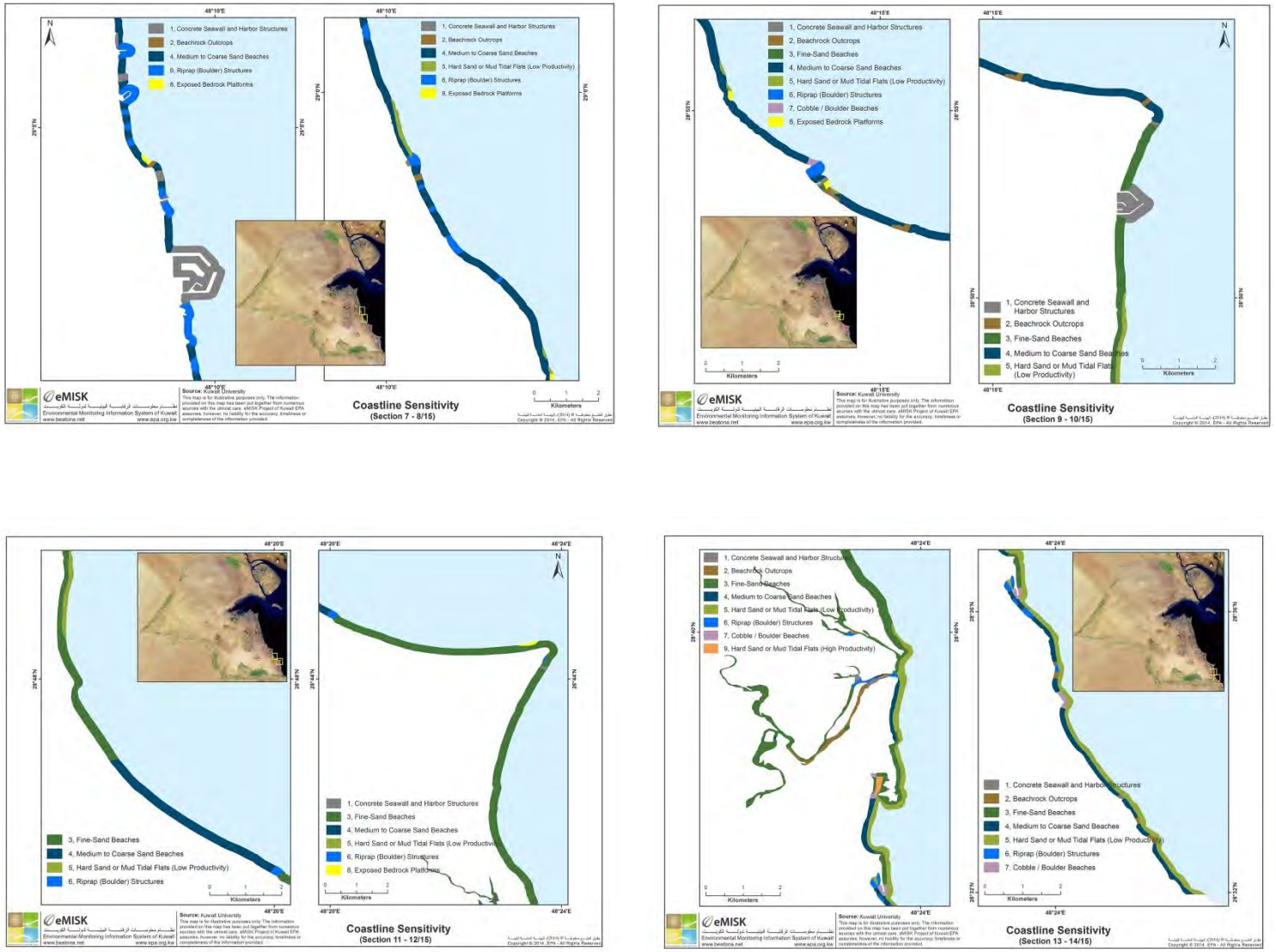


FIGURE 39: COASTLINE SENSITIVITY (PART 2)

3.4.4 Human Health

Kuwait population is young with an average age of 29 years and the natural growth of 2.6%. Kuwait population is exposed to harsh environmental conditions, such as heat wave and dust storms. These environmental conditions create degrade the quality of human environments and consequently expose people to lives to danger. The association between asthma and dust events and risks of heat waves are clear examples of harsh environmental impact on the human health on Kuwait. Dust storms and heat waves are expected to be severe and more frequent due to climate change (Table 16).

Climate stressors and climate risks – Human Health	
Stressors	**Risks**
Increases in occurrence and severity of dust storms	Threaten asthma patients
	Degradation of air quality
	Obstruction of human activities
	Increases health service expenditure
Increased Temperature	Threaten people's lives
	Increases health service expenditure

TABLE 16: CLIMATE STRESSORS AND CLIMATE RISKS - HEALTH

- **Dust storm effects on asthma patients**

Asthma is a serious, chronic epidemiological disease that degrades the general health of those suffering from it and even threatens their lives, especially under inappropriate healthcare. The World Health Organization estimates that 235 million people worldwide suffer from asthma (World Health Organization, 2013). As the number of asthma patients rises, this will not only increase pressure on healthcare facilities but also will lead to

various negative consequences, including increased mortality: Children and elderly people are the most vulnerable age category. In Kuwait, more than 15% of the children and 18% of the adults are suffering from asthma (KEPA, SNC, 2019): Females are more vulnerable than male. Factors contributing to asthma issue are believed to be related to the air quality (Gorai, Tuluri, & Tchounwou, 2014). Thus, climate change consequences depredating the air quality are expected to add more pressure to the vulnerable people in Kuwait. (Figure 40) illustrates the spatial distribution of asthma patients living in Kuwait urban area (KEPA, INC, 2012). The spatial distribution of asthma patients can be a useful mean to manage healthcare services and minimize climate change effects on asthma patients. For instance, hot spots illustrating in the map are expected to be highly vulnerable areas due to climate change. This geographic distribution of asthma patients is subject to changes over time: Thus, continuous monitoring of that distribution is mandatory.

The vulnerability assessment of this important sector must be established to assess decision makes in designing adaptation strategies of climate change in the health sector. Some recommendations that could improve the adaptation capacity in the health sector are adjusting the official working hours during the summer season, raising awareness on how to respond to extreme events and designing national health alert for dust storm (KEPA, SNC, 2019).

The geographic distribution of asthma patients in Kuwait's urban districts. The area shaded in the grey color are either residential areas with no patients' data recorded during the study time or non-residential areas (KEPA, INC, 2012).

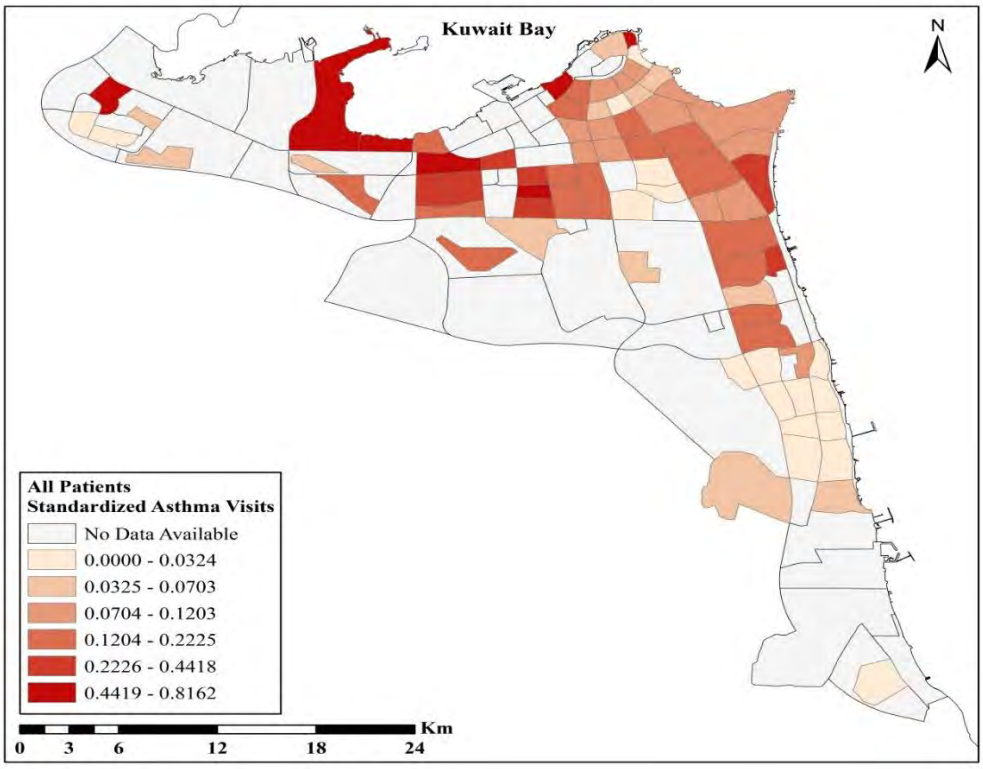


FIGURE 40: STANDARDIZED ASTHMA VISITS

CHAPTER 4: COORDINATION OF ADAPTATION ACTIONS

4.1 Introduction

As part of the NAP process, a stocktaking of the past and on-going climate change adaptation projects and initiatives that have been implemented in the State of Kuwait was prepared. This section helps to analyze the current adaptation projects as well as the gaps and needs of Kuwait. The section includes the adaptation projects and initiatives on the water resources, coastal zones, food security and public health sectors as presented. Also, the major adaptation policies and strategies that were ratified by Kuwait are presented in Table 17.

Kuwait has implemented several projects to adapt to climate change in the water resources sector. These projects include the construction of desalination plants, the application of water conservation technologies and utilizing the Treated Sewage Effluent (TSE) water for irrigation purposes. On the coastal zone sector, Kuwait has implemented projects such as constructing tidal barriers and establishing Coastal Information systems as a climate change adaptation measure. Meanwhile, awareness campaigns were conducted to the public and projects development among the coastal lines to take their precautions. The adaptation to climate change in the public health sector is one of the most important sectors for Kuwait, where frequent sandstorms hit the country causing many health problems. An annual average of 21 days of sand and dust storms were recorded (Al-Dousari et al., 2017). Sandstorms occur more frequently in the summer season specifically in the months of June and July. They can reach 100 km per hour (EPA, 2012). In response, Kuwait has undertaken some adaptation projects such as implementing green belts project and increasing the protected areas to adapt to a dust storm. The green belt projects consist of planted areas with trees and shrubs of 50-180 Km in length and 5-20 Km in width. These projects have started in 2015 for 5-year duration time.

4.2 Projects and National Initiatives

Many projects investing in the agriculture sector are taking place in Kuwait (Al Dosery et al., 2012). More than 50 types of trees for greenery and landscape that can reduce climate change effect, were introduced under the Agriculture Master Plan by Kuwait Institute for Scientific Research (KISR) and the Public Authority for Agricultural Affairs and Fish Resources (PAAFR). Development of new varieties of crops that can adapt to high temperatures and have high resistance to salinity and drought such as Conocarpus, Ficus, Prosopis, and date palm trees, were implemented in Kuwait (Al Dosery et al., 2012). These types of plants are mainly planted in Wafraa and Abdali, Kuwait.

Kuwait Environmental Public Authority (EPA) has established an electronic environmental Monitoring Information System of Kuwait (eMISK) and beatona. The eMISK aims at building and maintaining a comprehensive geo-environmental database of Kuwait and a GIS system to facilitate updating and analyzing environmental data. While beatona initiative aims to increase public awareness through sharing real-time environmental news and information. Many initiatives and campaigns were taken to increase public awareness about the adaptation to climate change. The following points provide a comprehensive summary of ongoing and past climate change adaptation projects and initiatives.

1. *Implementing green belts project and increasing the protected areas to adapt to dust storms.* Kuwait has undertaken some adaptation projects such as implementing green belts project and increasing the protected areas to adapt to a dust storm. The green belt projects consist of planted areas with trees and shrubs of 50-180 Km in length areas with trees and shrubs of 50-180 Km in length and 5-20 Km in width. These projects are the 5-year duration and started in 2015 (KUNA, 2015). Meanwhile, Kuwait has implemented a project called “Kuwait Green Wall Project. This project aims to increase the protected areas by planting 315,000 trees for 420 Km wall along the borderline to hold back the moving sand. The adaptation sector is the Public Health/ Dust Control, and the responsible parties are the governments and NGOs. This project started in 2015 and still ongoing.

2. *Kuwait's agricultural efforts to mitigate climate change in 2012*. Many agricultural projects have been undertaken by Kuwait Institute for Scientific Research (KISR) in order to develop crops that can adapt to high temperatures and different spans of seasons and crops resistant to salinity and drought (Al Dosery et al., 2012). More than 50 types of trees for greenery and landscape that can reduce climate change effect, were introduced under the Agriculture Master Plan by (KISR) and the Public Authority for Agricultural Affairs and Fish Resources (PAAFR). Development of new varieties of crops that can adapt to high temperatures and have high resistance to salinity and drought such as Conocarpus, Ficus, Prosopis, and date palm trees, were implemented in Kuwait (Al Dosery et al., 2012). These types of plants are mainly planted in Wafraa and Abdali, Kuwait. The adaptation sector is Agriculture and Public Health. The parties in charge were Kuwait Institute for Scientific Research (KISR) and Public Authority for Agricultural Affairs and Fish Resources (PAAFR).

3. In 2016, the project "*Food security*" was established. FAO in cooperation with the State of Kuwait planned to undertake twelve projects in the following fields:
    - Fisheries management;
    - Water resource management;
    - Natural resource management;
    - Animal production;
    - Animal health;
    - Technical capacity development.

    These projects have a time frame between 1-5 years under the Food Security Sector. Food and Agriculture Organization (FAO) were the responsible parties for this project, with a budget of $850,000. Some of FAO projects in Kuwait are highlighted in Items 3.1 and 3.2.

4. *Establishment of a regional database and information center to support the fisheries management and aquaculture development*, a joint project between PAAFR in Kuwait and FAO in December 2016. The project aims at establishing a regional database and information center to support the fisheries management and aquaculture development

in the region. Food and Agriculture Organization (FAO) and the Public Authority of Agriculture Affairs and Fish Resources (PAAFR) were the responsible authorities with a budget of $250,000/year.

5. *Fisheries Farms*. Fisheries are considered a vital source of food in Kuwait. The establishment of fisheries farms is an important step to adapt to climate change under the food security sector. Nile tilapia (Oreochromis niloticus) culture is implemented in agriculture farms where crops such as alfa alfa, tomatoes, potatoes, onions are cultivated. These farms are in the Al-Wafra, Abdali and Al-Sulybia areas. Brackish water with a salinity of 5–8 ppt pumped from underground wells is used in these farms. The budget for this project is also $250,000/year. And the responsible parties are the Food and Agriculture Organization (FAO) and the Public Authority of Agriculture Affairs and Fish Resources (PAAFR).

6. *Assessment of historic climate records and future projection*. The project aimed at assessing the historic climate records for the past 70 years and make future projection climatic scenarios until the year 2100. The project started in 2012 by the Kuwait University and UN Environment.
7. *Environmental Monitoring Information System of Kuwait (eMISK)*. eMISK is an electronic system established by the Environment Public Authority (EPA) of Kuwait and aims at building and maintaining a comprehensive geo-environmental database of Kuwait and a GIS system to facilitate updating and analyzing environmental data. The project starts in 2015 by EPA and is still ongoing.

8. *eMISK Industry*; this project aims at establishing a national program for collecting an environmental inventory of industrial facilities in Kuwait. The Adaptation Sector for this project is Public Health.

9. *eMISK Waste*; this project aims at finding and implementing a solution to be able to manage the fleet of industrial liquid waste vehicles and organizing the logistics process. The Adaptation Sector for this project is the Waste Sector.

10. *eMISK Marine*; The project aims at promoting and facilitating information management system in support of policies and programs that enhance integrated coastal and ocean management in Kuwait. The Adaptation Sector for this project is the Coastal Zones/SLR.

11. *Building desalination plants*. In the process of protecting freshwater sources and to maintain ecological stability. Kuwait has constructed several desalination plants in addition to water distribution systems via pipelines and irrigation systems to farmers. In 2016, Kuwait produced around 3.85 MCM/d of desalinated water. Eight additional plants were being commissioned by the government. Al-Zour North IWPP (capacity: 250 Million of Gallons per Day (MGD) for EUR 320 million), Al-Zour South Plant (capacity: 145 MGD), Al Khiran IWPP (capacity: 125 MGD), and Doha desalination plant (60 MGD) are examples of these projects. While, 4 more projects (Al-Nwaiseeb, New Shuaiba, New Doha, Doha RO phase 2) with an additional capacity of around 285 MGD are planned to be tendered as of 2019.

12. *Kuwait is investing USD 5.5 million jointly with MIT to conduct researches on updating the current desalination plants and next-generation desalination plants*. The adaptation Sector for this project is the Water Resources Sector, and the Government is responsible for the implementation of this project since 2016 and it is still ongoing. The budget is 320,000,000 EUR.

13. *Education on household desalination*. Kuwait jointly with United Nations taught the Kuwaiti people in rural areas the “in-house water desalination techniques”, where households can have freshwater at low cost and short time. The Adaptation Sector for this project is the Water Resources and the Awareness sectors. The UNDP started this project up in 2016.

14. *Kuwait Integrated Environmental Information Network Phase-IV*. The KIEIN-IV is an integrated GIS-based system that compiles the environmental indicator data and acts as a spatial decision support system tools (SDSS). This project can:
    - Compile data about environmental indicators for Kuwait.

- Expand and enhance the KIEIN GIS website as an environmental data dissemination tool.
- Promote awareness and usage of the KIEIN GIS website toward protecting Kuwaiti habitats.
- This system can act as a database to access the information, data and GIS maps, which are useful to assess and monitor the change in climate and the adaptation. This project was running from 2012-2014 by the UNDP and EPA with a budget of $1,200,000.

15. *Kuwait Environmental Governance Initiative (KEGI)*. The Project supports the design of the National Adaptation Plan (NAP) of Kuwait and the relevant initiatives linked to water, city planning, and other sectors. This project was running from 2017-2018 by the UNDP and EPA with a budget of $2,000,000.

16. *Establishment of land and marine nature reserves*. The project aims to establish a series of land and marine nature reserves in the State of Kuwait. National reserves were implemented to safeguard the Kuwait marine and land ecosystems. These natural reserves are in Sabah Al-Ahmed natural reserve area and Jahra pool natural reserve area. The Adaptation Sector for this project was the Coastal and Land Sector. This project was running from 2011-2016 by the EPA.

17. *Water Conservation (Partially implemented) Kuwait's Initial National Communications*; the application of water conservation technologies was also one of the adaptation options to reduce water consumption by 20 %. The Water Resources Sector was responsible, and the project started in 2012 and is still ongoing.

18. *Establishing a Coastal information system (CIS)*; Coastal Information System (CIS) was established to help in the protection of coastal zones and marine environments in Kuwait. CIS provides information about Kuwait's coastal area to planners and decision makers. The CIS system is an important initiative under the technology needs assessment of the coastal zones and shore protection sector as a climate change

adaptation measure. Technology Needs Assessment / Coastal Zones Sector was the responsible sector. The project was started in 2006 by KISR/CIS and is still ongoingg.

19. *Constructing tidal barriers in new developments*; Sabah Al Ahmad Sea City, which is located near the Saudi Arabia border, is a new development which constructed a tidal gate system and offshore breakwater was built to protect the artificial promenade from erosion of waves and to cope with the rising sea levels as the adverse impact of climate change. The project was completed in 2016 under the Technology Needs Assessment / Coastal Zones Sectors by different Developers.

20. *Conducting awareness campaigns and symposiums regarding Sea level rise*; the "Our Seas: Theories, Data, and Policies" Symposium highlighted the importance of human intervention regarding rising sea levels. International specialists, local researchers, and non-governmental organizations attended this symposium. This symposium aimed at increasing the awareness of the concerned stakeholders and the public about the adaptation to sea level rise as an impact of climate change. The project was completed in 2017 under the Technology Needs Assessment / Coastal Zones Sectors by the Kuwait Foundation for the Advancement of Sciences (KFAS).
21. *Coastal Management Program*; the CMP produces physical modeling, numerical modeling and field survey measurements. The CMP was responsible to produce Integrated Coastal Zone Management (ICZM) for Kuwait. The ICZM consists of two phases, Phase 1 has already completed. While phase 2 is still ongoing. The project aims at identifying the best practice guidelines for the development of the coastal zone of Kuwait. The project started in 1979, while phase 2 is still ongoing under the KISR and the Technology Needs Assessment / Coastal Zones Sector.

22. *Establishment of the Water Resources Program*; A water resources development and management program (WRDM) was initiated by the Kuwait Institute for Science and Research (KISR). This program helps to identify ways to optimize the water resources use and management through applied research. WRDM program was designed to develop integrated water policies, management options, and action plans to solve water scarcity problems and increase Kuwait's water security and resilience. The

project is still ongoing under the KISR and the Technology Needs Assessment / Water Resources Sectors.

23. *Constructing Desalination using Multi-Stage Flash technology*; Kuwait has a total of 40 operating Multi-Stage Flash desalination units (MSF), with a total production capacity of 234 MGD. The project was completed by the Government and the MEW under the Technology Needs Assessment / Water Resources Sectors.

24. *Wastewater Treatment and Reclamation Technologies Program*; this program has been initiated by KISR and it aims at conducting research on reclaiming and reusing Kuwait's wastewater to utilize it in irrigation purposes. This is a good example to adapt to climate change stresses on water resources. Ministry of Public Works (MPW) stated that about 65% of its treated wastewater is reused in irrigation already. The project is still ongoing and is under the KISR and MPW supervision and under the Technology Needs Assessment / Water Resources Sectors.

25. *Awareness Campaign* of KEPA Articles 76 and 79; an awareness campaign has been conducted to increase the awareness about Article No. 76 regarding the ambient air and Air Quality Zone Compliance actions and Article No. 79 regarding the emission sources and evaluation. The responsible parties for this project were the EPA and the UNDP and the adaptation sectors for this project were the Technology Needs Assessment / Public Health sectors. The project was completed in 2010.

26. *Beatona Initiative*; Beatona Initiative is a website established by EPA and aims to increase the public awareness of the health sector of the climate change adaptation through sharing real-time environmental news and information with the public. The beatona website includes multi-layers GIS maps such as the monitoring stations of air quality, the noise monitoring locations, the drainage streamlines, and water bodies. The project started in 2012 by the EPA and is still ongoing. The adaptation sector is the Public Awareness Sector.

27. *Tarsheed Campaign*; Tarsheed campaign was an Initiative made to reduce the per-capita consumption of electricity and water. This awareness initiative is a good adaptation step to climate change in water resources. The responsible parties were Kharafi National and the EPA. The project was completed in 2007 under the Public Awareness and Water resources sectors.

28. *Tarsheed Campaign II*; Tarsheed campaign II was an Initiative to encourage the implementation of the "Reduce, Reuse and Recycle" waste management. Such an initiative is useful as a climate change adaptation under the waste sector. The Kharafi National was able to complete this project in 2013 under the Public awareness sector.

29. *Utilizing TSE water generated from Umm Al-Hayman WWTP in Irrigation purposes*; TSE is utilized to irrigate the green areas and agricultural areas and serve the expected population growth of Kuwait, in addition, to mitigate the negative effects on the environment. The Ministry of Public Works (MPW) held this project from 2012-2018 under the Water Resources Sector.

30. *Adjust the official working hours Initiative Source*: the Ministry of Social Affairs and Labor of Kuwait issued a national law in 2005 to stop any outdoor work from 11:00 AM to 16:00 PM during the months of June through August. The EPA started this project in 2018 under the Public Health Sector.

31. *Enabling Kuwait to Prepare it's Second National Communication (SNC) and Biennial Update Report (BUR) to the UNFCCC*; the project aims at supporting Kuwait to prepare and deliver its Second National Communication and first Biennial Update Report. The project also enables Kuwait to fulfill its UNFCCC obligations. The Global Environmental Facility (GEF) started this project in 2014 with a budget of $1,517,000.

32. *The Environmental Pollution and Climate (EPC) Program*; this program aims at assessing the pollution and climate change challenges concerning the atmospheric, aquatic, and terrestrial environment of Kuwait. This project is still ongoing under the responsibility of KISR.

33. *Omniya Plastic bottles recycle*; an initiative to collect the empty plastic bottles and recycling it instead of sending to landfills which is one of few practical initiatives to adapt to climate change in waste sectors. The project started in 2015 by an NGO and is still ongoing under the Waste Sector.

4.3 Policies and Strategies on Climate Change Adaptation

In 1997, a meeting was held in Kyoto, Japan, between representatives from different nations around the world to discuss the establishment of international policy in response to human-influenced climate change. Since the late 1980s, policymakers and relevant stakeholders have devoted their attention and their resources to the global climate change issue. United Nations Framework Convention on Climate Change (UNFCCC) has been established in 1992 and ratified by 149 countries in 1996. In 1998, the World Meteorological Organization in the United Nations Environment Programme has organized the IPCC. IPCC has published several assessments and studies of climate change. The UNFCCC and IPCC comprise the international response to the climate change issue. Kuwait has ratified some agreements and policies in climate change adaptation such as UNFCCC, Kyoto Protocol, UN Convention on the Law of the Sea, FAO Compliance Agreement and Paris Agreement on climate change. Table 17 provides the main policies and strategies on adaptation to climate change that were ratified by Kuwait.

TABLE 17: POLICIES AND STRATEGIES ON ADAPTATION TO CLIMATE CHANGE IN KUWAIT.

No.	Policy	Content description	Adaptation Sector	Date	Responsible Party
1.	UNFCCC Ratification	Kuwait has ratified the UNFCCC.	General	1995	EPA/ Kuwait
2.	Kyoto Protocol Ratification	Kuwait has ratified the Kyoto protocol.	General	2005	EPA/ Kuwait

3.	UN Convention on the Law of the Sea	Kuwait is Party to the 1982 UN Convention on the Law of the Sea.	General	1986	EPA/ Kuwait
4.	FAO Compliance Agreement	Kuwait is Party to the 1993 FAO Compliance Agreement.	General	2002	EPA/ Kuwait
5.	Paris Agreement on climate change	Kuwait has ratified the Paris Agreement on climate change.	General	2016	EPA/ Kuwait
6.	CBD Ratification	Monitor the biological diversity of Kuwait. Build the necessary institutional structure to deal with biodiversity issues in Kuwait[36].	General	2002	EPA/Kuwait / UNDP
7.	UNCCD Ratification	Kuwait has ratified the UNCCD.	General	1995	EPA/ Kuwait
8.	The Montreal Protocol	The protocol concerning the Substances that Deplete the Ozone Layer. Kuwait has ratified it.	General	1992	EPA/ Kuwait
9.	The Unified Systems on Substances	The Unified Systems on Substances that Deplete the Ozone Layers of the Gulf Cooperation Council (GCC)	General	2015	EPA/ Kuwait
10.	Convention on the Protection and Conservation of Wild Life and Natural Habitats in the GCC countries	This convention took place in Amman, Jordan in 2001	General	2002	EPA/ Kuwait

[36] THE NATIONAL BIODIVERSITY STRATEGY FOR THE STATE OF KUWAIT Environment Public Authority, State of Kuwait, 1998, United Nations Development Programme (UNDP), Kuwait with Technical Assistance from IUCN – The World Conservation Union

11.	CITES	Convention on the International Trade in Endangered Species of Wild Fauna and Flora, in Washington	General	2002	EPA/ Kuwait
12.	Cartagena Protocol on Biosafety	It took place in Tunis in 2000.	General	2017	EPA/ Kuwait
13.	Nagoya Protocol	The protocol on Access and Benefit-sharing	General	2017	EPA/ Kuwait
14.	Basel Convention	The Convention was on the control of Transboundary Movements of Hazardous Wastes and their Disposal, in Basel	General	1993	EPA/ Kuwait
15.	Amendments to the Basel Conventions	Amendments to the Basel Convention on Control of Transboundary Movements of Hazardous Wastes and their Disposal, in Basel	General	2006	EPA/ Kuwait
16.	Rotterdam Convention	For the Prior Informed Consent (PIC) on hazardous Chemical	General	2006	EPA/ Kuwait
17.	Minamata Convention	A convention on Mercury	General	2006	EPA/ Kuwait
18.	POPs	Stockholm Convention on Persistent Organic Pollutants. It's been ratified	General	2006	EPA/ Kuwait
19.	MARPOL	The International Convention for the Prevention of Pollution of the Sea from Ships. Ratified.	General	1987	EPA/ Kuwait
20.	Vienna Convention	The convention was for the Protection of the Ozone Layer, in Vienna	General	1992	EPA/ Kuwait

21.	Montreal Protocol	The Protocol on Substances that Deplete the Ozone Layer, in Montreal	General	1987	EPA/ Kuwait
22.	Amendment to the Montreal Protocol	Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer, in Copenhagen, London	General	1994	EPA/ Kuwait
23.	The Convention on Wetlands	The convention was on Wetlands of International Importance especially waterfowl habitat, in Ramsar, Iran.	General	2014	EPA/ Kuwait
24.	ROPME	Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution	General	1978	EPA/ Kuwait
25.	Kuwait Protocol	This protocol concerns Regional Cooperation in Combating Pollution by Oil and Other Harmful Substances in Cases of Emergency	General	1978	EPA/ Kuwait
26.	ROPME Protocol	This Protocol for the Protection of the Marine Environment Against Pollution from Land-Based Sources	General	1992	EPA/ Kuwait
27.	ROPME Protocol	This Protocol on the Control of Marine Transboundary Movement of Hazardous Waste and Other Waste	General	2000	EPA/ Kuwait
28.	Law of the Sea	The United Nations Convention on the Law of the Sea	General	1986	EPA/ Kuwait
29.	Issuing new Articles No. 76 and 79.	Article No. 76 regarding the ambient air and Air Quality Zone Compliance actions and Article No. 79 regarding the emission sources and evaluation.	Air Quality /Public Health	2010	EPA/Kuwait

30.	Environmental Research National policy	National policy has been adopted for funding the Environmental Research Projects in Kuwait, especially the projects dealing with the impacts of oil pollution and burning oil wells.	General	1991	EPA/ Kuwait
31.	Environment Protection Law No. 42/2014	Adapting to the adverse impacts of climate change. The protection of land and soil, reducing desertification, management of natural reserves and water resources and creating plans for disaster management.	General/ Safety and Health	2014	The Environmental Public Authority / Environmental Supreme Council / / Kuwait
32.	Law No. 16/1996	Established the Kuwait Environmental Public Authority and gave it the power to regulate any activity that may pollute the environment	General / Environment	1996	EPA / Kuwait
33.	Article 3	Protects the Environment, evaluates the Environmental Impact Assessment Studies projects before implementation, controls activities that may lead to pollution, and combats and minimizes environmental pollution	Environmental		EPA / Kuwait
13.	Article 13	Enforces that the pollution, whether person or a factory, shall be responsible for and pay for any rehabilitation actions.	General		EPA/Kuwait
14.	Decision Number 6/2004	Tackles problems concerning the environment in the industrial area.	General	2004	EPA/ Kuwait

4.4 NAP Coordination and Implementation

4.4.1 Concerned National Institutions

For the coordination and implementation of the NAP's activities, the Government of Kuwait will put in place the needed intuitional arrangement, and financial and human resources. The implementation of the different actions in the NAP will require the involvement and contribution of all the stakeholders across the different sectors and levels. The specific roles are in line with these institutions mandate as summarized below:

4.4.1.1 National Public Institutions

The National governmental institutions will advance the implementation of the NAP by allocating the needed financial resources, integrating the NAP into sectoral strategies and action plans as well as into other projects and initiatives; designating staff or may be creating new unit(s) with adequate staff and resources to coordinate the mainstreaming and integration of the NAP and other relevant strategies into the national institutions' mandates. Main national public institutions mandated to advance its work in relation to climate change are presented below.

- **Environmental Public Authority (KEPA);** a governmental institution acting independently to carry out environmental actions in Kuwait. "The Environment Public Authority serves as the epicenter of governmental action regarding the preservation of the environment in Kuwait". The organization was founded in 1995 under law number 21. In 2014 KEPA established "Environment Protection Law" which ensures the passing of beneficial and relevant policies and regulations concerning the environment in Kuwait. The National Environmental Strategy was developed by KEPA among other several actions. There are several departments in KEPA that are dedicated to the planning and development of assessment plans such as the Planning and Environment Impact Assessment Department, The Office of Strategic Planning, Coastal and Desertification Monitoring Department, Research and Studies Office, Public Affairs and Environmental Awareness Department, Air Quality

Monitoring Department, Environmental Inspection and Environmental Emergencies Department, Water Pollution Department.

- **Ministry of Health** provides attention and healthcare to individuals in Kuwait. Advancements and development occur through interaction between all other sectors in Kuwait. The preparation, anticipation, and prevention of health issues related to climate change have been the responsibility of the Ministry of Health and other responsible sectors in Kuwait. The ministry plays a massive role in the assistance of improving the Health sector in Kuwait by hosting and sending experts to attend international conferences and workshops to improve the medical field in Kuwait. Conferencing concerning the nervous system diseases was held, along with workshops about epilepsy, Parkinson's, strokes and multiple sclerosis and the latest diseases and treatment methods in the world. Other responsibility and roles of the MOH are to improve health services and efficiency and effectiveness of the health system.
- **Ministry of Oil;** located in Kuwait City, it was formed in 1975. **The Supreme Petroleum Council** and **the Kuwait Petroleum Corporation** and the Ministry of Oil are all responsible for protecting and developing the country's natural resources. The ministry of oil assists the Supreme Petroleum Council in responsibility and tasks in maintaining and upholding its regulations and resolutions, as appointed by the Emiri Decree on the ministry's establishment. The Ministry of Energy is a part of this government body as of 2003. Another government company in charge of the oil fields in Kuwait is **The Kuwait Oil Company (KOC)**. KOC has developed Sustainable Environmental Economic Development (SEED), as a long-term sustainable development strategy. The main strategy of the Ministry of Oil in Kuwait is responsible for the supervision of the wealth and finances in Kuwait, and the development of this wealth. It is also the main governmental institution responsible for the information about oil and petroleum, the regulation of the laws to preserve revenues and wealth related to oil, conduct and hold plans and programs. The organization is also the backbone of the national economy and the main source of income. It is the official authority responsible for international organizations and relations

related to oil. The ministry oversees technical, financial, safety, monitory and regulatory control over the oil sector in Kuwait. The sharing of information about the location of oil fields, investments, opportunity and areas of work and any relevant information with the private and other government sectors is also a vital role of the Ministry of Oil.

- According to the Ministry of Oil of Kuwait, there are several Objectives to be implemented in Kuwait;
    - "Proposal to the public policy of the oil and gas sector on the basis of balance, maintaining the sources of oil wealth, achieve optimal development and exploration of resources in order to ensure the development of state revenues and increase national income".
    - "Maintaining the level of the price of Kuwait crude oil to meet the financial obligations of the state and development plans, and provide the needs of future generations, and the preservation of the status of oil as a strategy and a key source and strengthen the position of Kuwait in the global market".
    - "Highlighting the international standing of the state of Kuwait and to strengthen its role in organizations, regional bodies and relevant international spheres, such as the oil OPEC, OAPEC, the co-operation council for the Arab Gulf States, and organizations of the United Nations in the areas of Oil and Energy.
    - "Securing the needs of the domestic market of oil derivatives, gas, and its pricing proposals".
    - "Assisting the Supreme Petroleum Council in the tasks and responsibilities to oversee the implementations of its decisions".
    - "Activating the control of the plans, programs and activities of the representatives of oil sector, Petroleum Corporations and its subsidiaries and the foreign oil companies operating in the country, and direct rights of the state in order to increase performance and maximize the effectiveness of the financial benefits, and ensure the safety of workers and oil installations, the development of national experiences".

- "The application of laws and legislation on the environment, and to devote the concept of preserving the environment through the active participation of the work and programs of the Public Authority for the environment and review the operations and projects of the oil sectors to verify they meet the requirements of the environmental legislation of the state of Kuwait and the international standards."
- "Closer cooperation and coordination with the institutions, governmental and parliamentary bodies and the private sector in the affairs related to wealth and the oil industry, to promote the work and the exchange of information and the work of specialized studies and research to achieve the objectives of development plans of the state".
- "Increasing the contribution of the oil sector in supporting the national economy".
- "Contribute seminars and conference specializing in oil and energy, and the establishment of information center of oil, and to disseminate the culture of oil and petroleum industry awareness within the country and support the research work".

- **Ministry of Electricity and Water;** is a government organization established in 1952. It is responsible for all water bodies in Kuwait and the use of aquifer and groundwater. The 2010 - 2014 Kuwait Development Plan includes a great increase in the generation of desalinated Water and Electricity to better match the demand and supply of these two elements in Kuwait. It was studied and modeled by the Ministry of Electricity and Water that the prices accounted to facilitate these amenities does not match the revenues coming at US$ 2.84/1000 gal as of 2014. The responsibilities of this organization are vast, some of which are; general plan for water resources conservation, it's the data center of all water-related information in Kuwait, it conducts frequent studies, surveys, and assessments to find and develop the best methods to help the natural resource and the citizens of Kuwait, it is responsible for monitoring and evaluating networks, the construction of new wells according to regulations in Kuwait, provide technical assistance and training and education in the sector.

4.4.1.2 Research Institutions

Academic and research institutes play a critical role in building Kuwait's capacity in relation to climate change adaptation and mitigation. Academia supports the government with the needed scientific evidence for knowledge-based decision-making. Academic can orient its research to support decision-making processes by improving the understanding of climate change and variability in Kuwait in the present and in the future. Providing scientific information, conducting downscaling climate modeling, calculating the climate risks and vulnerability help the Kuwaiti governments in designing the appropriate adaptation actions. Main academic institutions in relation to climate change work in Kuwait are presented below.

- **Kuwait University;** the Vice-president's office for Research provides the financial support and research projects management. Funding for master's and Ph.D. students carrying out their graduation projects through the Graduate Studies Department. The Department of Earth and Environmental Sciences also participates in projects and studies concerning Environment and Climate Change.
- **Kuwait Institute for Scientific Research (KISR);** is an independent organization founded in 1967 through Japan's Arabian Oil Company Limited. It funds and carries out major Environmental research projects such as Biodiversity, Climate Change, Conservation, etc. projects. One of the Research Centers of KISR is the **Environment and Life Sciences Research Center (ELSC)** where research is undergoing about multiple environmental issues such as the assessment and management of pollution risks, restoring the ecosystem, preserving the natural resources, poor air quality due to erratic sand movement and dust storms, water resources management, coastal line protection.
- **Kuwait Foundation for the Advancement of Science (KFAS);** the main organization that funds research institutions, scientists and projects, mainly Kuwait University and KISR. Shareholder companies in Kuwait supply the funding coming from KFAS. The organization also encourages students to

participate in contests concerning environmental research by proving and offering monetary prizes and funding for young researchers.

- **Public Authority for Applied Education and Training (PAAET);** the program was established to meet the country's needs in Education and training. The Department of Environmental Science offers full educational scholarships for bachelor's degrees since 2008.

4.4.1.3 Non-Governmental Organizations (NGOs)

There are several NGOs in Kuwait that are involved in aiding environment programmes and projects, like the Kuwait Environmental Protection Society (KEPS). Better incorporation between the NGOs would go a long way to better benefit Kuwait.

4.4.2 Proposed Implementation Roles

The institutional structure to advance the work in relation to climate change and the implementation of the NAP can be described in **FIGURE 41**, as follows:

- The ***Kuwait Environment Public Authority (KEPA)*** as the principal government institution acting as independently to carry out environmental actions in Kuwait, the lead agency of the government on national climate change actions, and delivery of operational coordination, shall report to the Cabinet through the Director of KEPA. Among other several actions, KEPA is working on setting targets and coordinate actions for building resilience to climate change and enhancing adaptive capacity; developing the National Determined Contribution (NDC) Report and preparing and submitting the SNC report.
- The KEPA shall, among others, provide technical support to the implementation of the different actions of the NAP (cooperate with ministries and agencies responsible for the water, oil, coastal areas, marine, and fisheries sectors), and oversee the climate change adaptation activities that KEPA is responsible for.

- The ***General Secretariat of the Supreme Council for Planning and Development (SCPD)*** was established by in 2008, under the Decree Number 323. It is chaired by the Prime Minister or his Delegate and the membership of the Deputy Minister and Foreign Minister, Deputy Prime Minister and Mister of State for Cabinet Affairs, and Ministers of Health, Finance, State for Housing Affairs, State of Development Affairs, Oil, Electricity and Water, Public Works, State for Municipal Affairs, Education and Higher Education, Social Affairs and Labor, Information, and Governor of the Central Bank of Kuwait in addition to knowledgeable members to represent the private sectors and civil society organizations.
- The SCPD shall, among others, ensure the mainstreaming of climate change adaptation actions by other national agencies, ensure that climate change adaptation plans are mainstreamed in the State's strategic goals and the designed development strategies and plans, and propose an appropriate financial mechanism to ensure implementation of the sectoral adaptation plans.

- ***Cabinet of Kuwait:*** The Cabinet of Kuwait is the chief executive body of Kuwait. Gives update regularly to Parliament on the status of implementation of international agreements and obligations on different environmental issues including climate change. The Cabinet is given the needed powers and duties, through the KEPA, to provide technical support on climate change adaptions and related work.

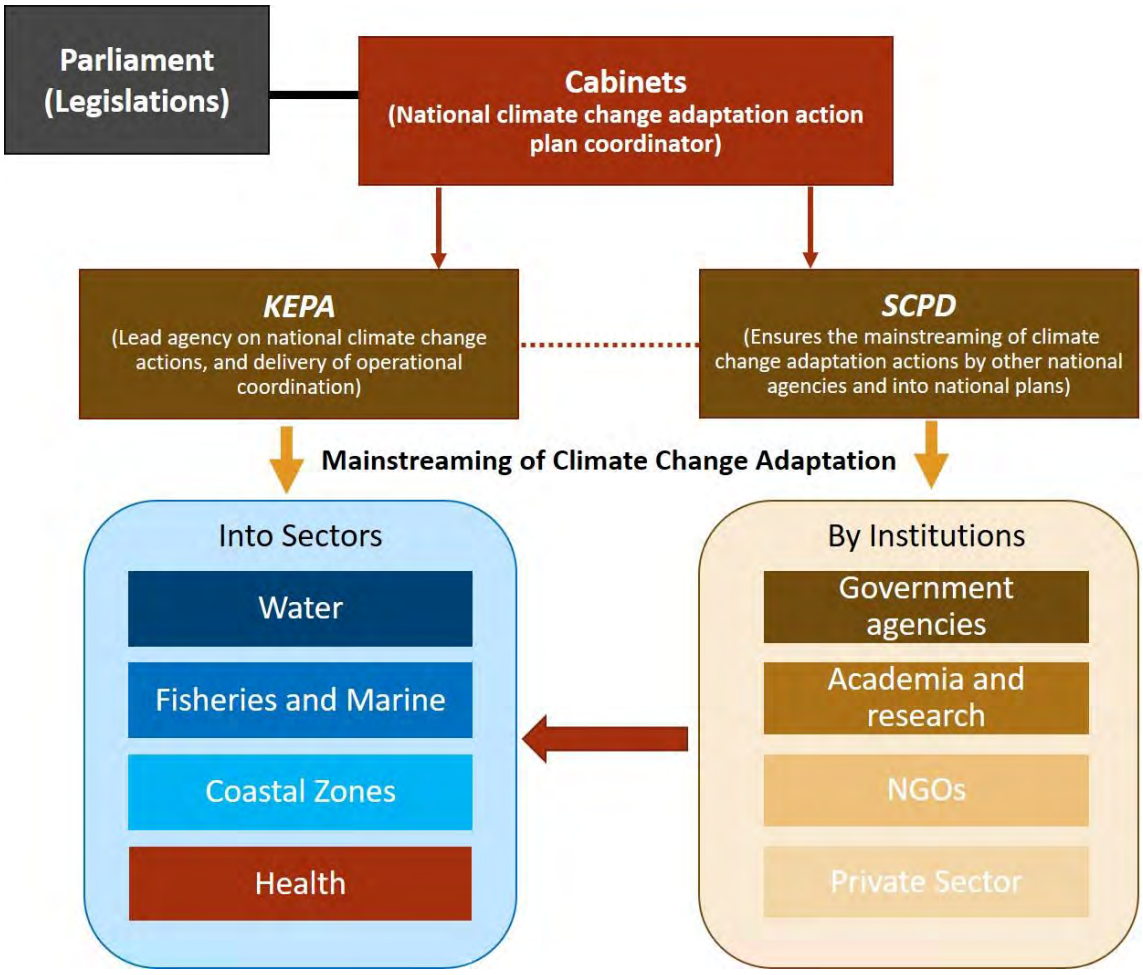
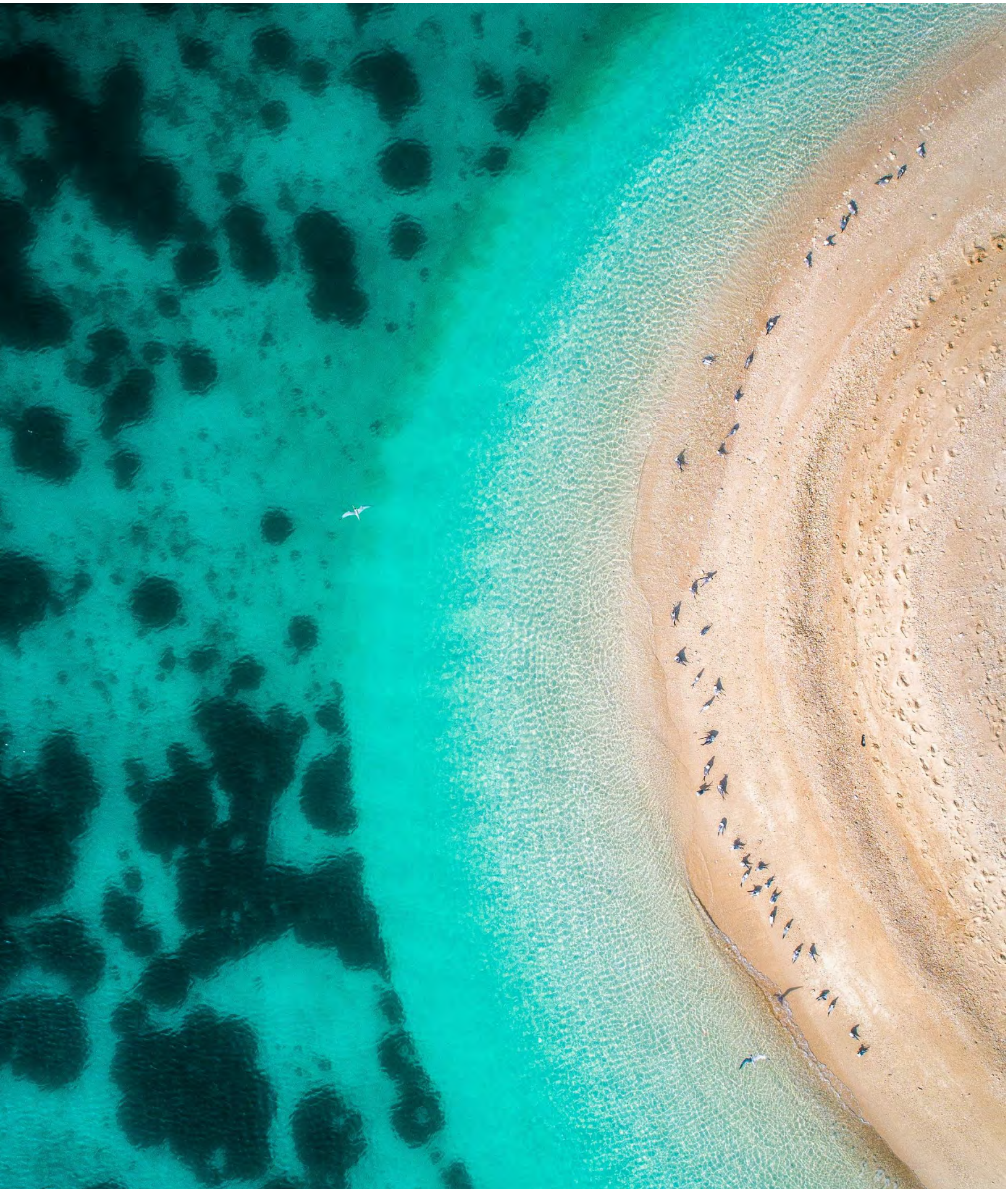


FIGURE 41: PROPOSED CLIMATE CHANGE ADAPTATION PLANS IMPLEMENTATION INSTITUTIONAL COORDINATION STRUCTURES



CHAPTER 5: ADAPTATION ACTION PLAN

5.1 Introduction

Adaptation to climate change is the response to the global warming phenomenon. It aims at reducing the vulnerability of social and biological systems and adapting to the change of climate. The extreme weather events to occur in Kuwait such as the heat waves, precipitation reduction, heavy rain, sea level rise, and the frequent dust storms are induced climate change disasters.

5.2 Gaps Identification

Kuwait has implemented key adaptation measures to cope with climate change impacts. Kuwait has invested in the water, health, food security, marine and coastal zone sectors in their adaptation to climate change impacts. The adaptation measures comprise building designation plants under the water sector, construction of natural reserves, green belt and protected areas under the health sector, fisheries management and farms under the food security and marine sectors, and the establishment of coastal information system and building tidal barriers in the new coastal developments under the coastal sector.

However, there are major gaps and still more to do in all sectors according to the First and Second National Communications of Kuwait and based on interviews conducted with representatives from several local authorities. The climate change adaptation gaps, among other things like the development of national and local strategies on climate change and carbon abatement, have been made possible as of recently with the aid of a national emissions inventory system. The national emission factor and national waste inventory database, insufficient inclusion of health sector in Kuwait's climate change adaptation programs, scarcity of the drought-resistant vegetation that reduce the dust effect and land degradation, inefficient water management and bad consumer behavior for the water resources and lack of reverse osmosis desalination modern technologies, the coastal information systems (CIS) are not regularly updated, and low public awareness as well as insufficient investment in policy development to include the assembly of useful information to analyze the adaptation policies and incentives.

The Climate Change Department/Directorate at the Kuwait Environment Public Authority (KEPA) is coordinating national activities in the field of climate change and is in need for more capacity development investments in all aspects of climate change. This will ensure high-quality management and coordination performance of the climate change unit parallel to the on-going technical and institutional capacity building process at the Ministry of Environment. Specific issues in capacity development include improve GHG inventory in the 6 related emissions and sink sources, improve the quality of future national communication reports, enforce and sustain GHG inventory process, energy evaluation and emission factors, adaptation and mitigation programs.

The major gaps that need to be bridged in order to adapt to climate change in different sectors such as waste, health, water resources, coastal zones, and fisheries, are listed below as follows:

5.2.1 Major Gaps in the Fisheries and Marine Sector

One of the main sectors highlighted in the second national communication of Kuwait is the fisheries sector, which is considered as a main food source in the country. The following gaps shall be considered to adapt to climate change in this sector:

1. Lack of integration of fisheries and marine sectors into adaptation and development plans and projects in Kuwait to help in meeting the local food security requirements as well as the absence of a strategic adaptive framework capable to respond to the emergency situations and hazardous crises.
2. Insufficient information and studies on the impact of the change in seawater temperature on the biodiversity and marine ecosystem.
3. Inadequate control of grazing in the natural reserved areas and low public awareness about the importance of the natural reservation areas and their role to adapt to climate change.
4. Lack of erosion and sedimentation control measures nearby the marine environments along the Kuwait coasts.

5.2.2 Major Gaps in the Water Sector

Despite many projects were implemented in the water resources sector in order to adapt to the climate change such as building desalination plants and applying water conservation measures, however, the following gaps are still required to be covered:

1. Poor water resources management and threats of water scarcity due to the bad consumer behavior in consuming the water resources are of major gaps facing the climate change adaptation in Kuwait. This is because of the lack of awareness, technical knowledge, policies, and strategies on climate change adaptation in the water resources sector.
2. Lack of modern technologies in the desalination of the seawater, noting that seawater desalination is the main source of freshwater in Kuwait.
3. Inadequate infrastructures networks and facilities to treat and transmit treated sewage effluent (TSE) water all over the country to cover all the irrigation needs of water, which increase the stresses on the freshwater resources.
4. Lack of information and studies on the groundwater resources, wells, and aquifers including their quality, quantity, extraction and safe yield. Meanwhile, lack of rehabilitation and remediation projects to polluted wells and aquifers because of oil or seawater intrusion.
5. Lack of knowledge to harvest rainfall water and use it for domestic, agriculture purposes or groundwater recharge instead of wasting it as runoff to the sea. Moreover, inadequate stormwater drainage systems in the new cities and developments.

5.2.3 Major Gaps in the Coastal Zone Sector

Kuwait is a coastal country and the adaptation to the sea level rise is a major concern. Protection of the livelihood, coastal developments and establish buildable areas at a safe distance inland from coastal inundation zones are of the main needs of Kuwait. The following gaps to adapt to the sea level rise are critical:

1. Lack of communication, access to data and updated information and data on the coastal characteristics, dynamics, and patterns of human behavior in Kuwait, which are necessary to understand the potential consequences of climate change.
2. Inadequate consideration of decision makers to include sea level rise scenarios into adaptation and development projects, plans and policies in Kuwait.
3. Lack of restrictions, legislation and policies to limit and control building new constructions within the coast of Kuwait under risk.

5.2.4 Major Gaps in the Human Health Sector

The adaptation with the climate change in the health sector was highly emphasized in the initial and second national communications of Kuwait. Several projects and initiatives were implemented in this sector as highlighted in the projects and initiatives section, however, the following gaps are still required to be addressed:

6 Insufficient climatic information and early warning systems to provide alerts before extreme weather events such as dust storms.

7 Lack of awareness of the public and the media about climate change impacts on health, and adaptation measures.

8 Lack of communication, access to data and information on climate change caused diseases such as their life cycle, distribution and geographical spread in Kuwait.

9 Inadequate integration of health into adaptation and development plans and other sector plans and policies in Kuwait.

10 Lack of financial and physical capacities among health-care units and practitioners as well as a lack of public awareness in addressing and understanding climate change impacts on health.

5.2.5 Major Gaps in the Waste Sector

The waste sector was one of the main concerns of the EPA to adapt to climate change and it was highlighted in the Second National Communication (SNC) of Kuwait. The major gaps in the waste sector can be identified as follows:

1. Lack of information and absence of a national waste inventory database including the national emissions inventory system and national emission factor.
2. Inefficient utilization of the landfill areas after being closed as well as the poor maintenance for the existing landfills and. Also, the absence of sanitary and e-waste landfills in Kuwait.
3. Lack of awareness, technical knowledge, policies, and strategies are major issues for waste management and climate change adaptation. In addition to the weak public participation and poor public attitude.
4. Insufficient knowledge of modern waste-management options in municipalities to include all kind wastes such as e-waste, solid waste, industrial waste and wastewater disposal in Kuwait.

5.2.6 Major Gaps in the Policy Making and Programs Development

NAPs shall have a connection with national visions and need to derive legitimacy through instruments such as policies, parliament acts, national directives, and decrees.

Investment in the new policy development and updating the existing ones by including climate change information in analyzing the adaptation policies and incentives shall be considered. In addition, Integration between the development needs and adaptation objectives, policies, plans, and programmes is essential. The following are some general items that can bridge the gaps to climate change adaptation:

1. Lack of financial and political support for the implementation of adaptation policies and strategies as well as low awareness of the public about climate change adaptation, in general, starting from schools through to universities.
2. Weak Institutional and technical capacity development for the Climate Change Department/Directorate at Kuwait Environmental Public Authority.

3. Inefficient communication, collaboration, and integration between the research institutions and the different authorities of the government regarding climate change adaptation in all sectors.
4. The absence of a specialized research center for climate change studies including adaptation and mitigation studies in all relevant impacted sectors

5.3 Sectoral Adaptation Actions

Adaptation to climate change can be in different forms depending on national context. It may include; water reuse for domestic purposes as an adaptation measure to save water resources; using the treated sewage effluent for irrigation purposes; implementing cropping systems that can reduce water runoff and increase the water retention capability of soil which decreases the negative impacts of droughts; constructing dikes and dams to adapt to the extreme flood events; investing in the shore protection of the coastal areas by building groins trap sediments to protect the coastline against erosion, constructing breakwater coastal structures that act as shelters from waves and currents, and establishing artificial reefs to reduce wave energy and protect the shore from erosion; applying soft adaptation measures in urban planning and design by issuing standards and codes that can be introduced for more sustainable design and construction of buildings; and promoting the awareness level for the altered conditions under climate change adaptation.

The following subsections present the sectorial adaptation options and highlight physical effects, vulnerabilities, impacts and socio-economic outcomes for each sector. The adaptation actions are divided into three categories: i) short-term actions, which should be implemented in less than a year; ii) medium-term actions, which needs 1-3 years to be achieved; and iii) long-term actions, which needs between 3 and 5 years to be achieved.

5.3.1 Adaptation Plans to enhance the resilience of the Fisheries and Marine Sector.

Climate change stressors are expected to affect the marine and fisheries sector: The potential risks threaten coral reef communities and other aquatic communities. The susceptibility of these invaluable ecosystems to climate change is increasing due to non-climate change stressors. The coastal and marine ecosystems degradation is expected to multidirectional socio-economic outcomes: for instance, poor seawater quality would require sophisticated pretreatments that increase the coast water (Andrianne & Alardin, 2003). Thus, controlling these non-climate change stressors is a mandatory adaptation option to increase the resilience of this sector to climate change. Other adaptation options are initiating researches to assess the impact of spatial and temporal distributions of SST, salinity. pH and SDD on coastal and marine ecosystems and enhancing the existed coastal and marine monitoring systems by integrating remote sensing technologies.

Increase the resilience of the fisheries and marine sector to climate change	
Summary	The shorelines of Kuwait are being threatened by Sea Level Rise due to changes in the climate. The recent estimation of IPCC to SLR reveals that sea level would rise from 0.26 to 0.82 m by the end of the 21st century. A CVI for Kuwait coasts was computed using four physical parameters; elevation, coastal slope, geomorphology, distance and four socioeconomic parameters, like; population, land-use, cultural heritage, and transportation. The area near Shuaibah Port, in the south coast, as is the coastline from Doha City to Kuwait By, are the most influenced by SLR. In addition, the number of people at risk due to SLR is 30,453 (about 0.8% of Kuwait population). Fisheries are the second important sector after oil sector for Arabian Gulf countries, including Kuwait.
Physical effects	▪ Increased Sea-Surface Temperature. ▪ Increased salinity. ▪ Ocean acidification.
Physical hazards/ vulnerabilities	▪ Coral reef disturbance (bleaching). ▪ Fish migration. ▪ Effecting aquatic organisms' production. ▪ Reducing the growth of many aquatic organisms. ▪ Negatively affects biotic and abiotic processes. Disturbing microplankton, such as foraminifera
Impacts	▪ Reducing the aquatic biodiversity. ▪ Reducing the reproduction of fish and other organisms. ▪ Decreasing seawater quality.
Socio-economic risks	▪ Loss of income of fishermen. ▪ Increase seafood cost. ▪ Increase the cost of water desalination (indirect impact)

Ongoing projects and initiatives	▪ KEPA has established an electronic environmental Monitoring Information System of Kuwait (eMISK). ▪ KEPA has established the eMISK: Marine. ▪ Establishment of a regional database and information center to support the fisheries management and aquaculture development (FAO/PAAFR). ▪ Establishment of land and marine natural reserves (EPA).
Gaps	▪ Limited integration of agriculture, fisheries and marine sectors into development plans; ▪ Insufficient information and studies on the impact of the change in seawater temperature on the biodiversity and marine ecosystem; and ▪ Low awareness concerning climate change and its impact on the sector. ▪ Limited studies on the impact of climate change on marine life and fisheries in Kuwait.
Short-term actions	▪ Enhance awareness by involving the local community in the protection and sustainable consumption of marine life. ▪ Provide financial and technical support to institutions and sectors responsible for marine life protection. ▪ Increase awareness about the Marine Ecosystem and the impact of climate change on it. ▪ Undertake risk and vulnerability assessment of the fishers' value chain. ▪ Enhance technical (individual and institutional) capacities on the impact of climate change on fisheries.
Medium-term actions	▪ Designation of new marine protected areas. ▪ Develop and implement local marine conservation and restoration options.

	▪ Develop adaptation and development plans for Marine life and Fisheries. ▪ Support research and initiatives to gather and obtain enough information on the impact of Climate Change on the marine ecosystem in Kuwait. ▪ Develop medium-term initiatives to conserve marine biodiversity in the rapidly changing climate.
Long-term actions	▪ Prepare of marine ecosystem-based adaptation strategy measures in areas at risk of climate change impacts. ▪ Develop adaptive management to rapidly changing marine regimes with Climate Change. ▪ Develop prediction capacity to anticipate possible future consequences of Climate Change and most threatened ecosystems in the marine. ▪ Develop monitoring capacity to prevent overfishing. ▪ Model of the impact of climate change on marine life and fisheries for use in policymakers for conservation, recovery and sustainable use of marine resources. ▪ Develop a crisis plan and management to confront climate change effects.
Budget	3.4 million USD
Responsibility	• Public Authority for Agricultural Affairs and Fish Resources (PAAFR). • Kuwait Environment Protection Authority (KEPA) • Kuwait Institute for Scientific Research (KISR). • The General Secretariat of the Supreme Council for Planning and Development (SCPD)

5.3.2 Adaptation Plans to enhance the resilience of the Water Resources

Water resources sector relies on three water resources: desalinated water, brackish groundwater and treated wastewater to fulfill its water demand in domestic, agriculture, and industrial sectors. The desalinated water is the main source of freshwater in Kuwait. Increased air-water temperature, saltwater intrusion, decreasing seawater quality (the ultimate source of desalinated water), and decreasing the quantity of groundwater due to increasing drought events are the main physical effects of climate change on this sector. These effects are expected to decrease the availability of freshwater for human consumption and increase demands of water for irrigations. Potential impacts of these physical effects are the decline in safe water availability for human consumption, loss of green areas due to limited water for irrigation and increases in CO_2 emissions due to increased demand of desalinated water.

Climate change risks are expected to cause significant negative socio-economic outputs: Increased cost of water desalination and loss of farmers' income are the most potential socioeconomic outcomes. Thus, enhancing the resilience of systems for water supply and management is a mandatory adaptation step to minimize the impact of climate change on this sector. Increasing water block-tariff to control unnecessary water consumptions, reducing physical leakages, utilizing technologies to reduce water consumption, and adopting efficient irrigation methods to reduce water losses are short-term adaptation options that can minimize the effects of climate change on this sector.

Improve the resilience of systems for the water sector	
Summary	Kuwait extends in arid and semi-arid regions. It relies on three water resources: desalinated water, brackish groundwater and treated wastewater to fulfill its water demand in domestic, agriculture, and industrial sectors. The TSE is mainly used for irrigation of highway landscapes, households' greening, public parks, and artificial wetlands. The SNC highlighted some recommendations to reduce water consumption, including employing new water a block-tariff, reducing physical leakages, utilizing water conservation technologies, improving irrigation systems one project was initiated to identify ways to optimize the water resources use and management through applied research. WRDM program was designed to develop integrated water policies, management options, and action plans to solve water scarcity problems and increase Kuwait's water security and resilience. The second model was based on the three scenarios: normal growth of demand, and the two climate scenarios (RCP 4.5 and RCP 8.5). The model had three main inputs: water supply, water demand, and water transmission.
Ongoing projects and initiatives	- Water Resources Development Program (WRDM)/ KISR; - Building desalination plants. - Water Conservation (Partially implemented) - Combined Water tariffs and water conservation (Partially implemented) - Technology Needs Assessment: Water Resources - Utilizing TSE water generated from Umm Al-Hayman WWTP in Irrigation purposes (MPW)

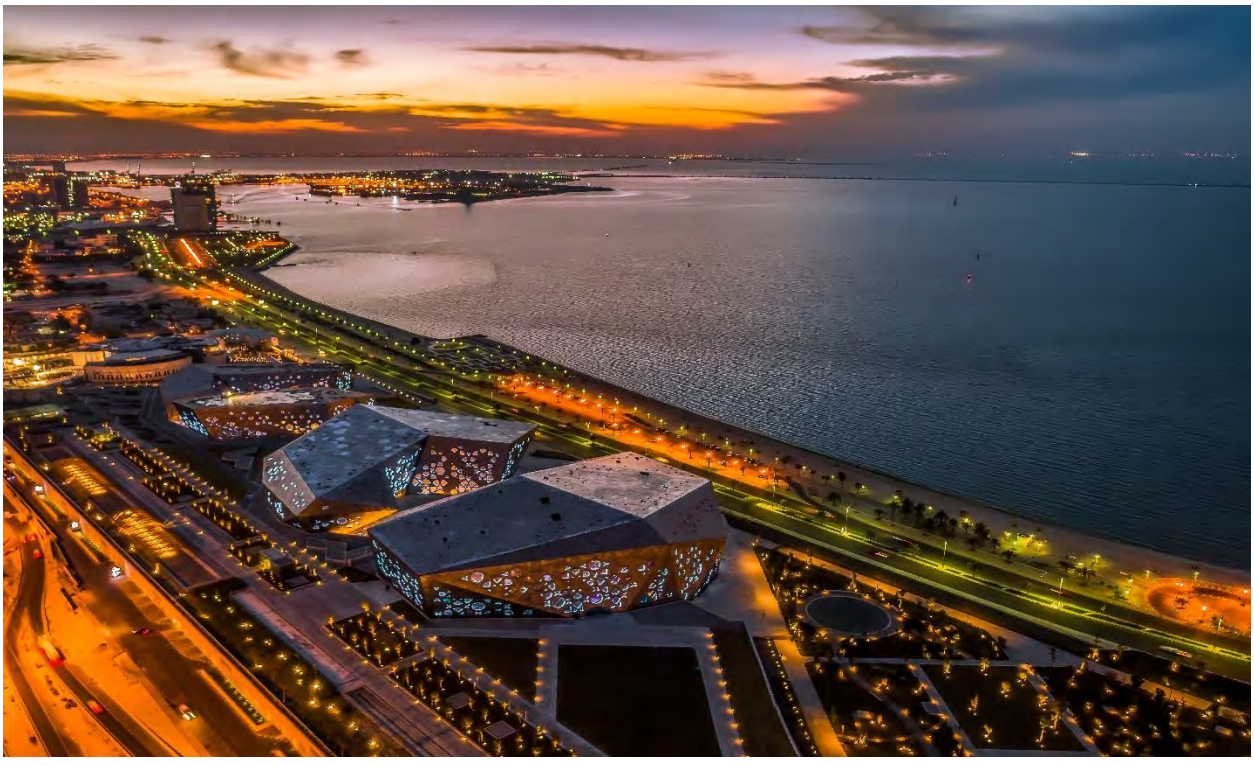
Gaps	• Insufficient water resources management and threats of water scarcity due to the unsustainable consumer behavior, this is because of the limited awareness, technical knowledge, policies, and strategies on climate change adaptation in the water resources sector; • Inadequate infrastructures networks and facilities to treat, transmit, and reuse treated sewage effluent (TSE); • Limited information and studies on the groundwater resources, wells, and aquifers including their quality, quantity, extraction and safe yield; • Limited plans and initiatives to harvest rainfall water and use it for domestic, agriculture purposes or groundwater recharge. • Inadequate stormwater drainage systems in the new cities and developments.
Physical effects	▪ Increased air temperature. ▪ Saltwater intrusion. ▪ Decreased seawater quality (the ultimate source of drinking water). ▪ Decreased the quantity of groundwater due to increased drought events.
Physical hazards/ vulnerabilities	▪ Decreased the availability of fresh water for human consumption. ▪ Increased the demand of water for irrigation.
Impacts	▪ Decreased the availability of safe water for human consumption. ▪ Decreased the availability of water for irrigation. ▪ Loss of green areas due to limited water for irrigation. ▪ Increased use of energy for water desalination.

	▪ Increased CO_2 emission due to increased demand for water desalination.
Socio-economic risks	▪ The increased cost of water desalination. ▪ Loss of farmers' income.
Short-term actions	▪ Raise awareness of Climate Change Effects on Water Resources in the country. ▪ Utilize water conservation technologies. ▪ Develop risk assessment on water resources depletion in the face of Climate Change conditions in Kuwait.
Medium-term actions	▪ Incorporate measures for adaptation to climate change into actions carried out by the Ministry of Electricity and Water. ▪ Invest in high end and accurate programs to refer to information about water level based on hydraulic models. ▪ Control water prices such as water consumption are fair and reasonable by all consumers. ▪ Increase water block-tariff to control unnecessary water consumption. ▪ Utilize technologies to reduce water consumption. ▪ Adapt efficient irrigation methods to reduce water losses. ▪ Improve irrigation systems to help utilize and conserve water in a more sustainable way, like bio-diverse planting, hydro-zoning, and PO irrigation.
Long-term actions	▪ Design effective policies to preserve and protect water resources. ▪ Support research and development to model the impact of climate change on water resources.

	▪ Involve more environmentally sustainable methods of water treatment like Reverse osmosis, where the net energy consumption is lower than other methods. ▪ Invest in the installment of water-efficient devices in homes, where the consumption of water is better regulated and limited. ▪ Develop integrated climatic and hydrological models and assess climate change impacts on water resources management.
Budget	6.2 million USD
Responsibility	• Ministry of Electricity and Water • KISR. • Kuwait Environment Protection Authority (KEPA) • The General Secretariat of the Supreme Council for Planning and Development (SCPD) • Kuwait Municipality • The oil sectors.

5.3.3 Adaptation Plans to enhance the resilience of the Coastal Zone

Inundation of low lying areas due to SLR will have a great influence on human settlements and terrestrial and aquatic ecosystems of the coastal zone. Damage of infrastructure and important facilities, saltwater intrusion, loss of terrestrial habitats, disturbance of coastal and marine ecosystems, increase in coastal erosion, decrease in water transparency due to increasing coastal erosion, and shoreline retreat are significant SLR hazards and impacts. Designing adaptive long-term coastal plans to restrict establishing major projects on vulnerable coasts is very urgent action that must be taken. to establish such adaptive plans, more researches assessing the impacts of SLR on the coastal zone of Kuwait are needed. Also, raising awareness among decision-makers in Kuwait to incorporate SLR scenarios into upcoming development plans is an important adaptation step. SLR risks are expected to disturb the coastal wildlife: An adaptation option to enhance the resilience of coastal wildlife is to legislate laws that restrict negative anthropogenic activities in the coastal zone.



Enhancing the resilience of coastal zones to face SLR risks	
Summary	The non-urbanized coast of Kuwait bay in the north, and the middle and southern coast, where urbanization is more extensive, are the coastal lines of Kuwait and are vulnerable to sea level rise. The Coastal Vulnerability Index (CVI) of Kuwait was based on the calculations of three scenarios, 1m, 1.5m and 2m, especially the Boubyan Island, and the coastline from Doha Port to Kuwait City. Coastal Information System (CIS) was established to help in the protection of coastal zones and marine environments in Kuwait. CIS provides information about Kuwait's coastal area to planners and decision makers. The CIS system is an important initiative under the technology needs assessment of the coastal zones and shore protection sector as a climate change adaptation measure. The projects aim at identifying the best practice guidelines for the development of the coastal zone of Kuwait.
Ongoing projects and initiatives	- Establishing eMISK Marine (KEPA). - Establishing a Coastal information system (CIS); - Coastal Management Program (KEPA) - Establishment of land and marine natural reserves (KEPA)
Gaps	▪ Lack of communication, access to data and updated information and data on the coastal characteristics, dynamics, and patterns of human behavior in Kuwait; ▪ Inadequate consideration of decision makers to include sea level rise scenarios into adaptation and development projects, plans and policies in Kuwait;

	▪ Lack of restrictions, legislation and policies to limit and control building new constructions within the coast of Kuwait under risk.
Physical effects	▪ Inundation of low-lying areas (SLR)
Physical hazards/ vulnerabilities	▪ Shoreline retreat ▪ Increased coastal erosion ▪ Loss of terrestrial habitats ▪ Decreased water transparency due to increased coastal erosion
Impacts	▪ Damages to coastal protection structures ▪ The decline in beach stability ▪ Loss of lands ▪ Disturbance of coastal and marine ecosystems
Socio-economic risks	▪ Damage of infrastructure and important facilities (power and desalination plants, ports, hospitals, and educational institutions) ▪ Damage of recreational areas
Short-term actions	▪ Develop vulnerability and risk assessment reports ▪ Provide open access for information and communication networks for parties and sectors responsible ▪ Capacity-building for government and non-government stakeholders on the deployment of adaptation activities. ▪ Increase decision-makers awareness of the risks of SLR and the damages to nearby urban areas. ▪ Review existed projects and update them based on SNC and NAP findings.

Medium-term actions	▪ Provide financial aid for preventative and protective actions for coastal damage. ▪ Make sure that the required resources to undergo projects and initiatives concerning the construction, research or communication are available. ▪ Raising awareness among decision-makers in Kuwait to incorporate SLR scenarios into development plans ▪ Legislating laws to restrict negative anthropogenic activities in the coastal zones to maintain the coastal wildlife
Long-term actions	▪ Establish a specialized center for coastal management and build and organize information and tools for climate risk modeling and generation of qualified responses within the Coastal Zone. ▪ Protect coastlines from SLR by constructing protection barriers. ▪ Develop better and more intensive laws and policies regarding coastline protection and conservation. ▪ Prepare for better adaptation potential for future setbacks and scenarios (i.e. new construction projects near the high-risk coastline should withstand SLR scenario in the future).
Budget	7.8 million USD
Responsibility	• Kuwait Environment Protection Authority (KEPA) • The General Secretariat of the Supreme Council for Planning and Development (SCPD). • KISR • Kuwait University • Ministry of Municipal Affairs.

	• Municipalities. • Ministry of Electricity and Water. • Kuwait Ports Authority. • Kuwait National Petroleum Company - KNPC • Ministry of Public Works. • Ministry of Finance. • Kuwait Integrated Petroleum Industries Company-KIPIC.

5.3.4 Adaptation Plans to enhance the resilience of the Human Health Sector

Increasing dust events and heat waves are the most significant physical effects of climate change on the health sector. Dust events significantly contribute to degrading the air quality increasing risks of chronic diseases and deaths. Also, heat waves are expected to increase risks of injuries and deaths. The potential socio-economic outcomes of these risks are the loss of work capacity and productivity and an increase in the treatment cost of chronic diseases, such as asthma. Enhancing the building capacity of the health sector to be prepared for increased risks due to climate change must be set as an objective of climate change adaptation for this sector. Immediate adaptation actions should be taken to ensure the achievement of this objective. These adaptation actions include but not limited to initiating researches to investigate the risks of climate change induced diseases, adjusting the office working hours to avoid working during maximum temperature in the day, raising the awareness of how to respond to dust and heat waves events and establishing national health alerts for dust and heat wave events.

Enhance and building the capacity of the health sector to be prepared for increased health risks due to climate change	
Summary	The association between asthma and dust events and risks of heat waves are clear examples of harsh environmental impact on the human health on Kuwait. Dust storms and extreme weather events (thunderstorms, heavy rainfall, heat waves, and flash floods) are expected to be severe and more frequent due to climate change. Factors contributing to asthma issue are believed to be related to the air quality. The project helps to adapt the climate change impacts in the public health sector. The project aimed to collect the previous data of air quality and weather data and to evaluate and review them against existing air regulations. Gaps and improvement opportunities were identified. The project has created the National Emissions Database Implemented an Air Quality Management Information System (AQMIS).
Ongoing projects and initiatives	- eMISK Industry. - Warning systems for sand storms. - Kuwait Integrated Environmental Management System (KIEMS);
Gaps	▪ Insufficient climatic information and early warning systems to provide alerts before extreme weather events such as dust storms; ▪ Lack of awareness of the public and the media about climate change impacts on health, and adaptation measures; ▪ Lack of communication, access to data and information on the climate change caused diseases;

	▪ Inadequate integration of health into adaptation and development plans and other sector plans and policies in Kuwait; ▪ Lack of financial and physical capacities among health-care units and practitioners as well as a lack of public awareness in addressing and understanding the climate change impacts on health.
Physical effects	▪ Increased dust events. ▪ Increased heat waves. ▪ Heavy rain and flash flood ▪ Thunderstorms and associated Asthma events.
Physical hazards/ vulnerabilities	▪ Increased risks of food and water-borne diseases ▪ Decreased air quality
Impacts	▪ Increased risks of injuries and deaths due to heat waves ▪ Increased risks of chronic diseases, such as asthma
Socio-economic risks	▪ Loss of work capacity and productivity ▪ The increased cost of asthma treatment due to the increasing number of patients. ▪ Increased energy & economic demand for cooling.
Short term actions	▪ Increase public awareness of climate changes effects and impacts on general health. ▪ Conduct risk assessments and vulnerability to Climate Change on the general public. ▪ Involve the media in carrying the message of issues of Health, as people get more influenced and receive the message more directly and subconsciously through advertisement and social media sites.

	▪ Adjust the official working hours to avoid working during maximum temperatures in the day (study and issue a new threshold). ▪ Raising awareness of how to respond to dust and heat waves events. ▪ Establishing national health alerts for dust storms and heat waves.
Medium-term actions	▪ Develop warning systems for extreme weather conditions combined with a communication strategy for alerts. ▪ Increase drought-proof vegetation to reduce dust fallout from dust storms.
Long-term actions	▪ Include information and instructions about Climate Change Effects on Health in the early education curriculum. ▪ Establish a research and monitoring network on climate and health, with a focus on analyzing the expected climate change impact on health.
Budget	4.1 million USD.
Responsibility	Ministry of Health Ministry of Higher Education Ministry of Electricity and Water KEPA. Ministry of Finance. Ministry of Services Affairs. Ministry of Information

	Meteorological department – Civil Aviation

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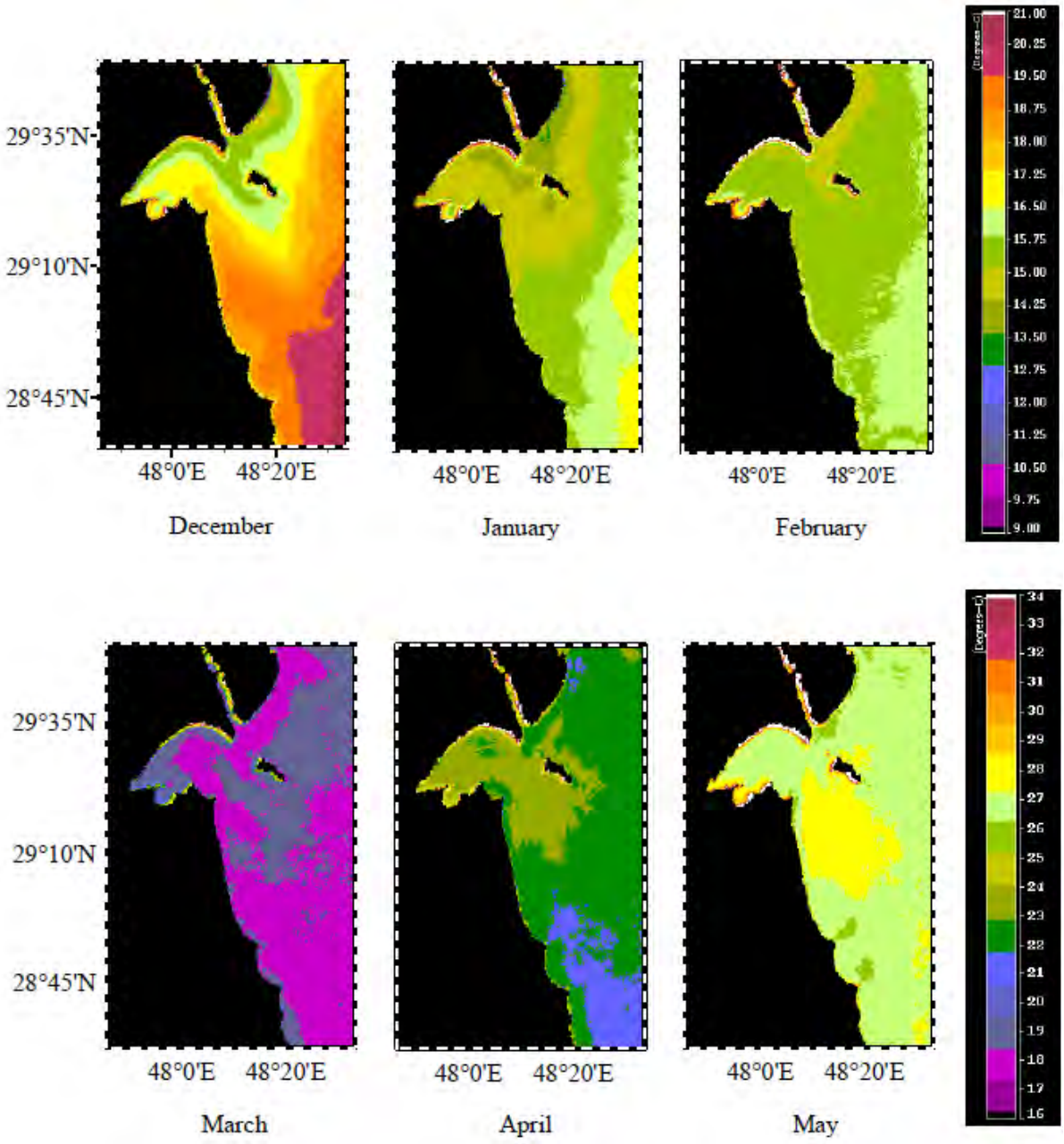
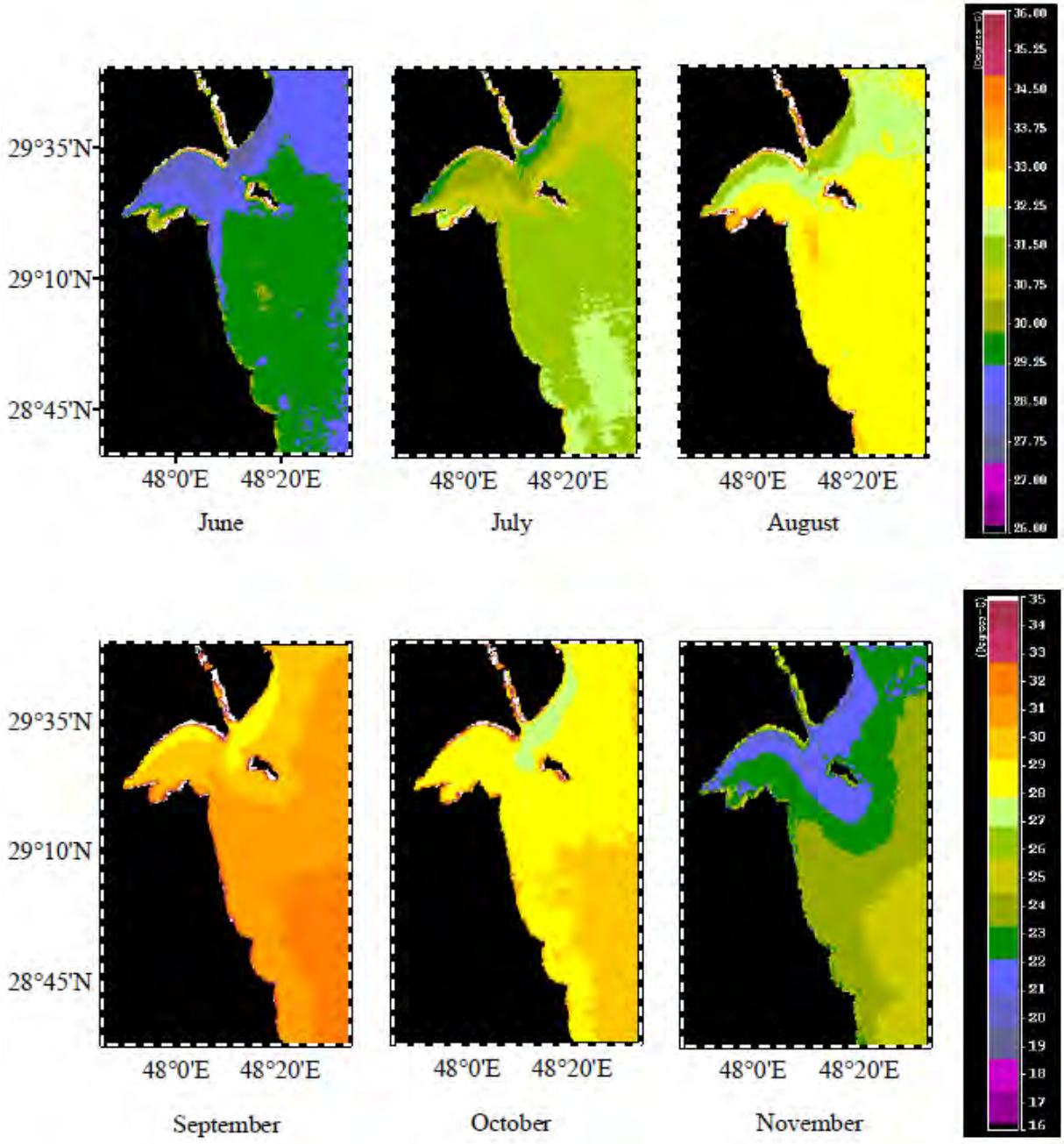
Appendix A

Spatial and temporal distributions of SST within Kuwait waters were calculated using MODIS level-2 images (2003 – 2007). The remotely sensed SST images were calibrated using in situ data (KEPA, INC, 2012).




29°35'N
29°10'N
28°45'N
48°0'E
48°20'E
June
July
August
September
October
November

Appendix B

MODIS (Aqua) images (downloaded from NASA website: https://oceancolor.gsfc.nasa.gov/) acquired in January and August 2017 were used to model SST within Kuwait Waters. MODIS Aqua launched in May 2002 is covering the entire Earth's surface in one to two days with a varying spatial resolution of 250 m to 1000 m and an image swath width of 2330 km. MODIS Aqua overpasses Kuwait waters approximately at 1:00 P.M. (local time) (Franz, Kwiatowska, Meister, & McClain, 2008). MODIS level-1 images were processed to level-2 using SeaWiFS Data Analysis System (SeaDAS 7.5) software to derive the level-2 SST ocean product. SST images were then calibrated within an error of ± 0.7 oC (r2= 0.98) using the KEPA, INC, 2012 model:

Calibrated SST = 1.0194 * MODIS SST - 0.731