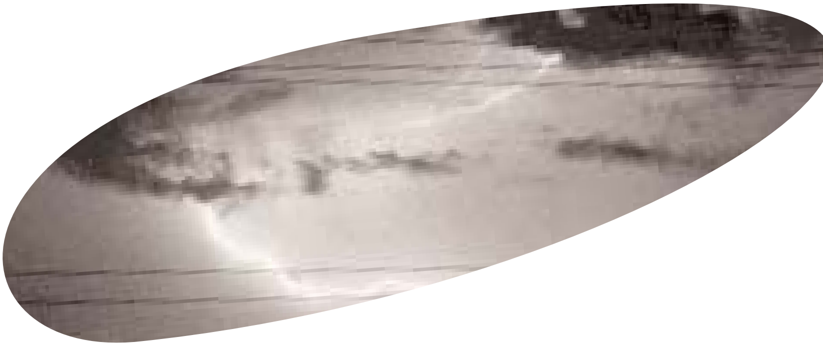
CERTIFICATION

The Attorney General and Minister of Legal Affairs of The Commonwealth of The Bahamas certifies that the documents listed below and annexed to The Bahamas' Written Statement are true and accurate copies of the originals of these documents. These documents are provided in digital format on the USB accompanying this Written Statement.

LIST OF ANNEXES

Annex 1

THE
COMMONWEALTH
OF THE BAHAMAS



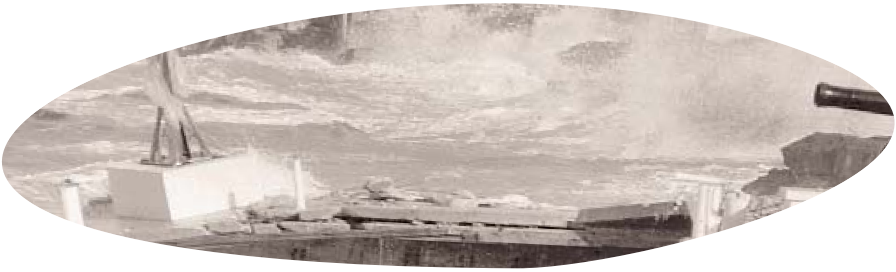
NATIONAL POLICY

FOR THE

ADAPTATION

TO

CLIMATE CHANGE



March 2005

Developed by:
The National Climate Change Committee &
The Bahamas Environment, Science and Technology Commission
Nassau, The Bahamas

CONTENT

PREAMBLE

The Government of the Commonwealth of The Bahamas accepts the findings of the Inter-Governmental Panel on Climate Change (IPCC), and of other expert scientific bodies, that global temperatures are increasing due to the release of so-called "greenhouse gases" (GHGs) into the atmosphere as a result of the burning of fossil fuels and other human activities. Government further accepts the scientific predictions that this trend of global warming is likely to continue for several decades, even if the causative activities were to cease immediately. It is further accepted that global warming will result in Climate Change, which may be manifested, inter alia, by:

— Sea level rise, leading to loss of coastal lands, seasonal flooding and expansion of wetlands;

— Changes in local and regional temperature regimes resulting in changing weather patterns;

— Changes in rainfall patterns, leading to uncertainties in crop production and possibly increased flooding; and

— More frequent and more severe weather events, such as droughts, hurricanes and tornadoes.

The Government of The Bahamas recognizes that, as a Small Island Developing State, The Bahamas is characterised by:

— Vulnerability to sea level rise and changes in marine conditions, due to its archipelagic nature and the consequent extended coastline, and low elevations;

— Limited human and economic resources to

PREAMBLE

address adverse impacts;

- Location of settlements and critical infrastructure on coastal low lands;
- Location within the North Atlantic hurricane belt.

The Bahamas recognizes that the country will be highly vulnerable to the anticipated impacts of global Climate Change given its generally low land elevations. Scientific research has indicated that these impacts are likely to include:

- Submergence of coral reefs and flooding of wetlands and coastal lowlands, resulting from sea level rise;

- Loss of marine biodiversity and fisheries productivity consequent upon rises in ocean temperatures and damage to coral reefs;

- Loss of terrestrial biodiversity resulting from rises in temperatures and changes in the seasonality of rainfall;

- Depletion and pollution of potable ground water supplies;

- Loss of agricultural land and reduced agricultural productivity from salinity;

- Introduction of alien pests and diseases and increases in the incidence of pests and diseases of crop plants;

PREAMBLE

- Introduction of insect vectors of diseases of livestock and humankind, and of contagious diseases and heat stress-related syndromes;

- Increased coastal erosion and infrastructure damage as a result of increased frequency and intensity of tropical storms, hurricanes and storm surges.

The scientific evidence suggests that many of the manifestations of global Climate Change are already occurring. Such evidence includes:

- Bleaching and loss of coral reefs in the Seychelles, The Bahamas, Belize, Jamaica and the Caribbean in general, as a result of increases in coastal water temperatures, though temperature rise may not be the only factor involved;

- Submergence of low-lying islands in the Maldives due to sea level rise;

- Melting of the polar ice caps contributing directly to sea level rise;

- Increased frequency of cyclonic events in the North Atlantic and the Caribbean Basin over the past two decades.

PREAMBLE

The Government of The Bahamas therefore recognizes that Global Climate Change is an environmental phenomenon with serious implications for the country, and indeed for all countries and especially for Small Island Developing States. Government also recognizes that although The Bahamas, and other Small Island Developing States, contribute only a very small amount of total greenhouse gas emissions, they face an overwhelmingly disproportionate level of risk from the impacts, due to their inherent vulnerability.

The Bahamas signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992 and ratified in March 1994, and Government remains committed to meeting the goals of the Convention, namely to reduce global greenhouse gas emissions and address the impacts of Climate Change.

Government therefore proposes to take all necessary and feasible actions at the national, regional and international levels to meet the UNFCCC goals. Government is convinced that The Bahamas, given its limited capacity to reduce emissions, and its vulnerability to the impacts of Climate Change, must place the emphasis on adapting to global Climate Change.

PREAMBLE

Government also recognizes that, while not all the processes relating to global Climate Change are fully understood, and that further research is required and is ongoing, there is already sufficient evidence to merit urgent action: ***incomplete knowledge is not an acceptable basis for delay or for taking no action***.

Accordingly, Government perceives the need for a policy to guide national action to address the impacts of Climate Change. Such a policy must create an environment for the development of a country-wide coordinated and holistic approach, which addresses the needs and concerns of all sectors of society in a manner which will ensure the continued sustainable development of the country.

EXECUTIVE SUMMARY

There is increasing scientific evidence that the Earth's Climate is changing as a result of anthropogenic activities that have led, and are leading to, changes in the composition of the Earth's atmosphere. Considerable uncertainty remains with regard to the magnitude of these impacts, but there is growing realization that they are likely to be particularly severe for Small Island States, such as The Bahamas. Impacts are likely to include increased air and sea temperatures, progressive rises in sea-level, greater variability and seasonality in precipitation, and changes in the frequency and strength of tropical storms and hurricanes. There is also uncertainty as to the timescale.

The Bahamas would appear to be highly vulnerable. The relatively small size of the country, and its dependence on the tourism industry, make the country vulnerable to economic fluctuations in its major tourism markets. Human settlements and tourism developments are mainly located along the coast, and are high risk for coastal erosion and catastrophic events. The small size of the economy means that the country lacks the financial and technical resources for reducing projected levels of risk. The terrestrial and marine environments, and their biological resources, are already under stress from pollution, urbanization, and other non-sustainable impacts. Climate Change is likely to add to these impacts and increase the risks and vulnerabilities. Given the uncertainties as to the dimensions and timing of Climate Change impacts, it is vital that adaptive measures are practical both in terms of effectively responding to present day climate risks, and to projected risks, as well as advancing the wider issue of sustainable development.

In this regard, the Government of The Bahamas has prepared this National Policy for Adaptation to Climate Change. Specifically, it provides an assessment of the degree of vulnerability of The Bahamas to the projected impacts of Climate Change by sectors; of the capacity for adaptation to anthropogenic climate change;

EXECUTIVE SUMMARY

and proposes strategies for anticipating and ameliorating or avoiding the negative impacts. In addition, it examines some of the possible impacts on: coastal and marine resource and fisheries, terrestrial biodiversity resources, agriculture and forestry, human settlements and human health, water resources, the energy and transportation sector, as well as on tourism and the finance and insurance sectors. The policy provides a plan of action for addressing such impacts.

The National Policy identifies Government as the major facilitator of the implementation of the policy directives. It also provides a framework for not only advancing the capacity and capability of The Bahamas to effectively adapt to Climate Change impacts but also contributes significantly to the conservation and preservation of The Bahamas' natural resources for present and future generations of Bahamians. The First National Communication on Climate Change provides a valuable summary of progress to date (BEST Commission, 2001).

BACKGROUND

The Commonwealth of The Bahamas is an archipelago of islands that extends some 50 mi (80 km) from east of Florida to about 50 mi (80 km) northeast of Cuba. The archipelago is low-lying and surrounded by coral reefs and extensive sand flats. The highest point in the country is Mount Alvernia, on Cat Island, at 207 ft (63 m) above mean sea level. The highest point on New Providence Island is only 125 ft (38 m) above mean sea level. Much of the land area is only a few feet above mean sea level.

Total population is about 305,000 (Department of Statistics, 2000 Census), with a total of about 88,000 households. There are some 700 islands and cays and 22 inhabited islands. Nearly 70% of the population reside on New Providence Island, in fact one of the smaller islands, where the capital city of Nassau is located. Freeport in Grand Bahama Island is the second major population centre, with just under 9% of total population. The other islands are collectively referred to as the "Family Islands".

Total area of The Bahamas is approximately 124,000 mi2 (321,159 km2) with a total land area of 5,382 mi2 (13,939 km2). There are no rivers but several islands are deeply penetrated by tidal creeks. The structure of the archipelago consists of several submerged plateaux, such as the Great Bahama Bank and the Little Bahama Bank, separated by deep oceanic troughs. The islands are the exposed portions of these banks, formed from limestone created from the skeletal remains of marine and plant life. Around the islands, notably on the windward sides, are fringing coral reefs: the total area of reef is estimated at about 780 mi2 (about 2,000 km2). The landscape is one of rolling ridges with flat rock lands and extensive wetlands. The natural vegetation is Caribbean pine forest in the four northern islands, and broadleaf hardwood coppice woodland in the southeastern islands.

The Bahamas is separated from the temperate North American

BACKGROUND

continent by the warm, northerly flowing, Gulf Stream. The climate is sub-tropical, with two distinct seasons: a hot wet summer season from May to October, and a warm but drier winter season from November to April. Rainfall is locally variable, but there is a gradient from about 60 in. (1500 mm) per annum in the north, to about 30 in. (750 mm) in the southeastern island of Inagua. The southern islands are rainfall deficient and droughty, and this is reflected in the natural vegetation. Most of the rainfall occurs during the hurricane season, from June to November. Heavy rain during this season often causes flooding, and storm surges and hurricane-force winds can cause extensive damage to property and to the landscape. Recent hurricanes that have impacted The Bahamas since 1990 are: Andrew in 1992 (Category 4), Bertha in 1996 (Category 1), Lili in 1996 (Category 4), Floyd in 1999 (Category 4) and Michelle in 2001 (Category 1).

Tourism is the major industry in The Bahamas, with some 4 million visitors in 2000. The sector has shown sustained growth over several decades. About 60% of tourists arrive by sea, and the remainder by air. Several cruise ship lines call at Nassau, and a smaller number at Freeport. A few small islands have dedicated facilities for particular cruise lines for day visits. Tourists contribute some $1.5 billion to the Bahamian economy annually. Tourism relies heavily on aclean, healthy and beautiful environment, particularly the marine environments as well as beautiful beaches. With ecotourism projected to increase, preservation of the environment is essential to the economy.

Financial services account for about 15% of the Gross Domestic Product (GDP), contributing to the economy in salaries, fees and other local overheads. This sector includes offshore banking and asset management for wealthy individuals. A number of gated communities provide luxury first or second homes, marina facilities and golfing for many such individuals.

BACKGROUND

Agriculture is a small sector contributing between one and two percent of GDP: some 90% of the food consumed by the population and visitors is imported, mainly from the USA. Only about 19,760 acres (8,000 ha) of land are presently used for agriculture, with large-scale mechanized crop production carried out mainly in Abaco, Andros and Grand Bahama. Small-scale agriculture is practised in the other islands, often using traditional methods of crop production. Export crops include citrus, avocadoes and pumpkins. There are a number of large poultry farms on New Providence, Grand Bahama and Abaco. Sheep and goats are found mainly on the drier Family Islands. Intensive pig production is found mainly in Abaco, Grand Bahama and New Providence.

Biodiversity is important to The Bahamas for several reasons: ecosystems provide services such as air and water cleansing; the diverse marine ecosystems, attract tourists; and the terrestrial ecosystems provide building materials, foods and medicines. Threats to biodiversity include lack of appreciation, habitat destruction and fragmentation, overharvesting (especially of marine species), pollution, and invasion of alien species. Climate Change is expected to impact biodiversity not only by catastrophic events leading to habitat destruction, but also directly by modification of habitats.

The Exclusive Economic Zone (EEZ) of The Bahamas includes some highly productive fishing grounds, including sea grass beds, coral reefs, and deep ocean. Spiny lobster, conch and Nassau grouper are the major species fished. Commercial fishing generates about $70 million a year, and exports of spiny lobster alone contribute just over 2% of GDP. Fishery regulations include size limits and closed seasons for spiny lobster, conch, grouper, and stone crabs. Government has designated five “no take” marine reserves in 2000. The Exuma Cays Land and Sea Park has been a “no take” zone since 1986, and has demonstrated the effectiveness of such zones.

BACKGROUND

Long-line fishing is forbidden. Poaching continues to be a problem. Sports fishing attract a number of boats each year. Bonefishing is becoming an increasingly popular sport in many of the Family Islands.

In The Bahamas, industry is mostly located in and around Freeport on Grand Bahama Island, which was originally designed to attract industrial concerns. Activities have included the manufacture of cement, an oil refinery (currently a bunkering facility), and pharmaceuticals (this has changed hands several times). At present there is a major container transhipment terminal and a ship dry-dock and repair facility located in Freeport harbour. New Providence Island is home to a Bacardi rum distillery and a brewery. A number of smaller companies serve the domestic market with paper and plastic products, purified water, soft drinks, ice cream, jams, jellies and sauces, bakery products and mattresses. Manufacturing contributes some 4% of GDP.

Vulnerability assessments generally assume that Climate Change will occur steadily and linearly, and that impacts, both positive and negative, will be measurable, and that both the resources and the knowledge for mitigation and adaptation, are available and within the capacity of The Bahamas to implement. Catastrophic changes are generally not factored into vulnerability assessments. The Government of The Bahamas commissioned a preliminary study of the impacts of Climate by Global Change Strategies International (GCSI) of Canada in 2000 (Martin, H. and J.P. Bruce. 2000). This preliminary study identifies the sectors sensitive to both direct and indirect impacts, but does not address the costs of adaptation, nor does it address the matter of human resources. Recent past experiences of hurricanes and storm surges, suggest that Climate Change will have profound adverse impacts on The Bahamas, exacerbating many of the existing socio-economic and environmental difficulties that already exist. The islands' terrestri-

BACKGROUND

al and marine biodiversity is already under stress from a number of human activities. The ultimate objective of adaptation programmes must be the integration of Climate Change considerations into the planning, development and implementation of virtually all activities and programmes at all levels. Such programmes will allow for reduced vulnerability to existing Climate Change stresses and promoting sustainable development.

POLICY STATEMENT

The aim of this National Climate Change Adaptation Policy is to foster and guide a national plan of action, formulated in a coordinated and holistic manner, to address short-, medium- and long-term effects of Climate Change, ensuring to the greatest possible extent that the quality of life of the people of The Bahamas and opportunities for sustainable development are not compromised.

POLICY GOALS AND OBJECTIVES

The goals and objectives of this policy are to:

1. Foster the development of plans, processes and strategies to:

    - Avoid, minimize, adapt to, or mitigate, the negative impacts of Climate Change on The Bahamas' natural environment including ecosystems, ecological processes, biotic

POLICY GOALS AND OBJECTIVES

resources, lands and water;

- Avoid, minimize, or respond to, the negative impacts of Climate Change on economic activities;

- Reduce or avoid damage to human settlements and infrastructure resulting from Climate Change;

- Encourage efficient use of energy, reduce dependency on imported fossil fuels, and develop the use of renewable energy sources;

- Avoid or minimize the negative impacts of Climate Change on human health;

- Improve knowledge and understanding of, and conduct systematic research and observations on Climate Change issues;

- Explore and access mitigation and adaptation technologies currently under development, and yet to be developed, to meet the development objectives of The Bahamas.

2. Foster the development of appropriate and innovative legislative and regulatory instruments, which will promote effective implementation of this policy, and the enforcement mechanisms needed.

POLICY GOALS AND OBJECTIVES

3. Foster the development of appropriate institutional systems and management mechanisms to ensure effective planning for and responses to Climate Change.

4. Foster the development of appropriate economic incentives to encourage public and private sector investment in adaptation measures.

5. Institutionalize the National Climate Change Committee.

POLICY PRINCIPLES

The Government of The Bahamas, in collaboration with the relevant national, regional and international entities, will:

1. Fulfil, to the fullest extent possible, its commitments under the United Nations Framework Convention on Climate Change, to which The Bahamas is party;

2. Participate to the fullest extent possible in negotiations on various aspects of the Convention, its protocols, articles etc., insofar as these will impact on the ability of The Bahamas to address issues pertaining to Climate Change and to sustainable development in general;

3. Collaborate, as appropriate and feasible, with Regional and International Conventions and Organizations and with states pursuing confluent agendas with regard to Climate Change, and in particular the Caribbean Community Climate Change

POLICY PRINCIPLES

Centre (CCCCC) and the Caribbean Disaster Emergency Response Agency (CDERA);

4. Integrate Climate Change adaptation policies, plans, and projects into the national planning and budgetary processes;

5. Ensure that adaptation responses are consistent with the national social, economic, and environmental developmental goals;

6. Endeavour to obtain, to the greatest extent possible, the involvement and participation of all stakeholders at the national level in addressing issues related to Climate Change;

7. Endeavour to ensure that such involvement and participation is planned and coordinated, thus minimizing conflicts and duplication of effort, and ensuring the creation of positive synergies and efficient use of resources;

8. Endeavour to foster and create an institutional, administrative and legal environment, which engenders and supports effective implementation of Climate Change adaptation activities;

9. Promote and support research and information gathering at the national and regional levels on aspects of Climate Change and its impacts as they pertain to The Bahamas;

10. Ensure that society, at all levels and in all sectors, is adequately informed on Climate Change

POLICY PRINCIPLES

issues and their implications for the nation through a programme of Public Education and Outreach;

11. Ensure that adequate physical and socio-economic planning is undertaken on a continuing basis to address the impacts of Climate Change: such planning will be undertaken in the wider context of sustainable development;

12. Endeavour, where possible and necessary, to develop national human and institutional capacity in all aspects of Climate Change research, response, and planning;

13. Create an enabling environment for the adoption of appropriate technologies and practices that will assist in meeting national and international commitments with respect to the causes and effects of Climate Change;

14. Procure and allocate adequate financial and other resources to ensure that Climate Change issues are effectively addressed;

15. Recognizing that the resilience of the natural environment is key to coping with Climate Change, do everything possible to enhance, maintain, and where necessary, restore, the integrity of ecological processes;

16. Recognizing also that economic resilience is key to coping with Climate Change, do all possible to promote the development of a strong and diversified economy.

POLICY DIRECTIVES

Agriculture

Agricultural production is important for national food security as well as for the generation of employment and foreign exchange. It is recognised that Climate Change may seriously impact agricultural production. Impacts are likely to include:

- Increased water demand for irrigation and other uses, coupled with reduced supplies due to increased temperatures and raising of the freshwater lenses;

- Increased occurrence of crop pests and diseases and introduction of invasive of alien pest and disease species;

- Reduced production of some crops due to changes in rainfall seasonality, droughts, and agro-climatic regimes;

- Losses of agricultural land due to elevated water tables, seasonal inundation, and increased soil salinization;

- Possible increases in the incidence of livestock pests and diseases, and in the invasion of alien livestock pests and diseases;

- More frequent economic setbacks and prolonged recovery periods due to damage to, or destruction of, agriculture and agricultural infrastructure, due to more intense hurricanes and storm surges.

POLICY DIRECTIVES

To address these impacts of Climate Change on agriculture, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Develop a sound basis for decision-making, by conducting studies to assess, inter alia, the risks posed by Climate Change to the productivity of agricultural crops and to food security; the expected impacts on the availability of water for agriculture, and possible use of brackish water for trickle irrigation and the planting of saline tolerant crops; the expected impacts of Climate Change on pest- and disease-crop interactions; and the expected impacts of Climate Change on livestock production;

2. Develop a National Adaptation Strategy for Agriculture, both crops and livestock, to address impacts in the short-, medium- and long-term;

3. Incorporate the National Adaptation Strategy for Agriculture into the National Land Use Management Plan and into the planning process;

4. Adoption of appropriate adaptation measures to address areas of immediate need where this does not jeopardise or contradict the development of long-term sustainable strategies for the agricultural sector. Such measures may include soil conservation measures, and construction of water storage

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and irrigation facilities for crop production; and

5. Formulate and implement any other such strategies and measures which will help to enhance food security and sustainable food production.

Coastal and Marine Resources and Fisheries

The Government of The Bahamas recognizes that coastal and marine resources are at great risk from the impacts of Climate Change, due primarily to the facts that coastal ecosystems are very sensitive to changes in ocean temperature. Additionally, sea level rise, which is one of the anticipated impacts of Climate Change, will affect numerous ecosystems as well as the coastline itself. Impacts are expected to include:

- Inundation of tidal flats, mangrove swamps, and wetlands as sea levels rise;

- Erosion of beaches and coastal lands, and some of the smaller cays, due primarily to hurricanes and storm surges, though sea level rise and changing coastal processes may also play a role;

- Loss of fisheries production due to increased ocean temperatures, sea level rise, increased severe weather events limiting time spent at sea by fishermen, and changes in ocean currents;

- Fish kills and coral die-off ("bleaching") due in part to increased seawater temperatures (though coral species may differ in temperature sensitivity), and the propagation of so-called "red tides".

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To address these impacts of Climate Change on coastal and marine resources and fisheries, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Continue, expand and strengthen coastal monitoring and data collection so as to facilitate decision making;
2. Promote and facilitate a national assessment of coastal areas and of coastal and fishery resources at risk;

3. Adopt short-, medium-, and long-term measures to protect coastlines and increase the resilience of coastal ecosystems. Such measures may include construction of coastal defence structures, enforcement of setbacks, and restoration of coastal wetlands;

4. Promote the restoration of damaged or destroyed coastal resources and ecosystems where possible and technically feasible;

5. Develop a comprehensive National Land Use Management Plan, which, inter alia, incorporates Climate Change concerns and which, based upon such concerns, makes prescriptions regarding the location of coastal developments;

6. Identify and promote alternative fishery and resource use activities where impacts on ecosystems and natural resources preclude

POLICY DIRECTIVES

the continuation of traditional activities;

7. Foster increased awareness and knowledge on the part of the general public regarding Climate Change impacts on the coastal and marine environment, through Public Education and Outreach (PEO) activities; and

8. Establish a Coastal Zone Management Unit to integrate coastal activities and compile Geographical Information System data sets for all the major islands of The Bahamas.

Energy

While several gases are responsible for altering the planet's climate, the largest single source is carbon dioxide. The primary source for carbon dioxide is the combustion of fossil fuels. Electrical power in The Bahamas is generated by the importation of liquid fossil fuels, and this accounts for some 65% of The Bahamas' emissions of carbon dioxide. These imports consume a considerable quantity of foreign exchange. The two major agencies responsible for energy production in The Bahamas are the privately owned Grand Bahama Utilities Company and the publicly owned Bahamas Electricity Corporation.

The demand for electricity is likely to increase as a response to rising temperatures and a demand for air-conditioning, and rising populations. Government recognizes that Climate Change is likely to impact the energy sector, and impacts are expected to include:

- Oil price fluctuations and consequent fluctuations in costs of production of electricity; and

POLICY DIRECTIVES

 A move to reduce emissions of carbon dioxide emissions and a search for new technologies and alternative sources of power.

To address these impacts of Climate Change on energy consumption the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Develop a National Energy Policy to include the use of renewable energy resources, such as solar, wind and wave energy, and provide tax incentives to promote these;

2. Encourage the deployment of energy-efficient technologies so as to meet Climate Change goals, such as solar water heating by the domestic, commercial and tourist sectors through appropriate tax incentives, and waste heat from electricity generators for the desalination of seawater; to reduce the drain on foreign exchange;

3. Promote the use of less carbon intensive fuels; and

4. Ensure compliance with the Kyoto Protocol.

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Financial and Insurance Sectors

The Government of The Bahamas recognises the potential impacts of Climate Change on the financial and insurance sectors, including:

- The effects of catastrophic events, such as severe hurricane damage on lending institutions, such as banks and mortgage institutions, and on insurers, re-insurers and property owners;

- The diversion of financial resources from productive investment, such as agriculture, fisheries, tourism and industry, to restorative activities.

To address these impacts of Climate Change on the financial and insurance sectors, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Implement fiscal and financial measures in order to achieve equitable distribution of the economic burden between stakeholders;

2. Ensure the adoption and implementation of building codes and other standards in order to minimise risk from Climate Change;

3. Sensitise stakeholders about the effects and implications of Climate Change through a programme of Public Education and Outreach;

4. Collaborate with the financial sector to develop appropriate risk management meas-

ures and regimes to address the impacts of Climate Change.

Forestry

Forest resources occupy approximately 6,250 mi^2 (1,620 kha) of the area of The Bahamas. Of this total, some 880 mi^2 (228 kha) is pine forest, some 2,705 mi^2 (702 kha) is hardwood coppice forest, and 2,665 mi^2 (690 kha) is mangrove forest. Forests provide habitat for the native fauna and flora, including several endemic birds and orchid. Forests also provide much-needed erosion and storm water control and provide protection for the potable water resources of The Bahamas There are three main categories of forests in The Bahamas: Northern Bahamas Pine Forests, Central Bahamas Broadleaf Hardwood Forest and Southern Bahamas Drought-Resistant Woodland. Most of the blue holes, an important ecotourism resource and of scientific value, occur in forested areas. Mangroves are also important in maintaining forest systems as they protect inland forests and natural communities from storms and erosions. Red mangrove (*Rhizophora mangle L.*) is a prime example, as it provides protection against coastal erosion, and may be able to adjust to sea level rise. Forests also act as sinks for carbon dioxide. Currently, it is estimated that 15 to 20% of atmospheric carbon dioxide emitted by human activities results from deforestation or, more generally, from changes in land use. Therefore, the impacts from Climate Change on forestry are likely to include:

- Changes in growth patterns and species composition resulting from salinization of soils and rising water tables;

- Increased risks of soil erosion as forested areas lose their tree cover as a result of the above;

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To address these impacts of Climate Change on forestry, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Enact forestry legislation to provide for the efficient management, utilization, and protection of all the forest resource of The Bahamas;

2. Develop a National Adaptation Strategy for Forestry to address impacts over the short-, medium- and long-term;

3. Maintain the integrity of existing forests and encourage tree-planting initiatives, which will serve as a protection of soil and freshwater resources, and habitats for animals;

4. Introduce if and as necessary, and with the proper protocols, salt-tolerant tree species to ensure adequate erosion control on exposed coastal sites, and to maintain forest cover;

5. Amend the Conservation and Protection of the Physical Landscape Act to include additional plant species.

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Human Health

The Government of The Bahamas recognizes the fact that Climate Change is likely to have direct implications for human health in The Bahamas. It also recognizes that a healthy population is fundamental to sustainable development; and therefore efforts to promote appropriate and adequate adaptation to the health implications of Climate Change are essential. Climate Change is expected to result in, inter alia:

- An increased incidence of mosquito-borne and other vector borne diseases (such as dengue fever), as higher temperatures favour the proliferation of mosquitoes and other disease carriers, and increased rainfall and flooding in the Northern Islands provides increased breeding area;

- Other diseases attributed to Climate Change include lyme disease, hantavirus, and cholera, resulting from higher temperatures, greater humidity and rainfall;

- A higher occurrence of heat-stress related illnesses and conditions, particular among the old and the poor;

- An increase in water-borne diseases, particularly following extreme rainfall events, and flooding. Cryptosporidiosis is one of many waterborne diseases whose prevalence could increase with increased precipitation and flooding triggered by climate change; and

- Indirect impacts of Climate Change on agriculture and fisheries and on the food and freshwa-

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ter supplies, and indirect impacts on various economic sectors and employment, are also likely to impact human health.

To address these impacts of Climate Change on human health, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Promote the necessary health related research and information gathering in order to strengthen the basis for sound decision-making;

2. Ensure that appropriate short-, medium- and long-term measures to address health-related Climate Change issues are incorporated into national health plans;

3. Inform, sensitise and educate health personnel and the public-at-large about Climate Change related health matters;

4. Ensure that to the extent possible that preventative measures and resources for treatments, such as vaccines and medications, are available.

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Human Settlements

Both government and the private sectors have made significant investments in the development of human settlements around the islands, and government has also invested heavily in the development of infrastructure. It is recognised that Climate Change is likely to impact negatively on human settlements, especially as most major settlements are situated in low-lying coastal areas, and many roads are located close to the coastline. Possible impacts include:

- Damage to coastal property, including private residences, hotels and tourism infrastructure, and business premises, resulting from wind and storm surges;

- Damage to coastal infrastructure, such as piers, docks, roads and public utility facilities, resulting from wind and storm surges.

To address these impacts of Climate Change on human settlements, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Develop the basis for sound decision-making by further developing the capacity to undertake research into relevant Climate Change processes which may affect coastal human settlements;

2. Undertake a comprehensive assessment of human settlements and related infrastructure at risk from the effects of Climate Change, using, inter alia, risk mapping, and

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incorporation of the findings into the National Land Use Management Plan, and into the planning processes of the National Emergency Management Agency (NEMA) of the Cabinet Office;

3. Develop a comprehensive National Land Use and Management Plan, which inter alia, incorporates Climate Change concerns and which, based upon such concerns, regulates the location of future settlements and urban developments without compromising water supply and other such requisites for sustainability;

4. Develop and implement plans for the relocation or protection of settlements and infrastructure most at risk from the effects of Climate Change;

5. Ensure the incorporation of Climate Change considerations into existing or proposed national disaster planning;

6. Promote the development and enforcement of a building code, which addresses Climate Change considerations including hurricane (wind) and flood resistance, and energy efficiency;

7. Ensure that national infrastructure standards for jetties, piers, docks, roads, bridges, overhead utility lines, etc., are adequate to withstand the expected impacts of Climate

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Change;

8. Integrate Climate Change considerations into the physical planning process including the implementation of Environmental Impact Assessment requirements;

9. Implement fiscal measures where appropriate to encourage the adoption of building codes and other relevant measures;

10. Foster increased public awareness of Climate Change and its effects on human settlements through Public Education and Outreach programmes; and

11. Encourage the financial and insurance sectors to develop mechanisms aimed at assisting human settlements affected by Climate Change.

Terrestrial Biodiversity

The soils and the biological diversity, both fauna and flora, of The Bahamas are key resources supporting human existence on the islands, and are vital for ecotourism development. Government accepts the scientific evidence indicating that Climate Change may have significant impacts on these resources, including, inter alia:

- Changes in the composition of natural vegetation and loss of terrestrial biodiversity, due to changing climatic, hydrological and soil conditions;

- Increased soil erosion and soil salinity, and

POLICY DIRECTIVES

expansion of saline wetlands;

 Changes in ecosystem processes and in the capacity of ecosystems to deliver services that are essential for the continued existence of human populations.

To address these impacts of Climate Change on terrestrial biodiversity and resources, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Enhance the basis for sound decision-making by further developing the capacity to undertake research into relevant Climate Change processes, including forecasting and data collection;

2. Undertake measures in the short-, medium-, and long-term to increase the resilience of terrestrial ecosystems, including soil conservation, agro-forestry and the establishment of special conservation, protected and management areas;

3. Develop a comprehensive National Land Use Management Plan, which, inter alia, incorporates Climate Change concerns and governs the location of future settlements and urban development without compromising water supplies and other requisites for the sustainability of settlements;

4. Ensure the inclusion of Climate Change

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considerations during the implementation of strategies and action plans under the Convention on Biological Diversity (CBD), the Convention on Wetlands of International Importance (Ramsar), and the United Nations Convention to Combat Desertification UNCCD).

Tourism

Tourism is the key economic sector in The Bahamas and its contribution to the national GDP has grown rapidly over the last several years. Government recognises that Climate Change is likely to impact the tourism industry negatively. Impacts are expected to include:

- Possible damage to, and destruction of, hotels and other tourism infrastructure, which is mainly located in coastal areas that are susceptible to storm surges, erosion of beaches and sea-level rise;

- Possible loss of, and damage to, coral reefs, beaches, natural forests and other natural resources, that are tourism attractions and generate revenue;

- Reduced visitor arrivals as a result of a higher frequency of extreme weather events, such as hurricanes, as well as reduced inducements to travel resulting from higher temperatures and less benign weather;

- Negative changes in water and food availabil-

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ity arising from changes in seasonality of rainfall, and even greater dependence on imported foods.

To address these impacts of Climate Change on tourism, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Conduct the necessary research and information gathering in order to strengthen the basis for sound decision-making;

2. Introduce and enforce the requirement for Environmental Impact Assessments which incorporate Climate Change issues;

3. Ensure that appropriate physical planning guidelines, such as protection of dunes and coastal setbacks, are enforced for new tourism developments;

4. Work with stakeholders in the tourism sector to develop a strategic plan, which incorporates Climate Change considerations and appropriate measures such as water conservation programmes, as well as general sustainability concerns.

Transportation

The transport sector is very dependent on fossil fuel imports and consumption and is therefore a major contributor to carbon emissions. In The Bahamas, this dependency is observed in the private and public road transportation, fishing and agricultural sectors

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and for aviation and maritime bunkering. The emissions of gases and particles into the atmosphere by aircraft have an impact on atmospheric composition. These gases and particles alter the concentration of atmospheric greenhouse gases, including carbon dioxide CO_2), ozone (O_3), and methane (CH_4); Omni bus (jitney) transport has to date dominated the provision of public passenger transport services, and the use of relatively low-grade diesel fuels has contributed, not only to Greenhouse Gas emissions, but also to air pollution at ground level. While emissions of Greenhouse Gases by The Bahamas are miniscule on a world scale, this is no reason for not taking steps to reduce these emissions. Climate Change is expected to impact this sector by:

- Increasing the demand for fossil fuels, with possible fluctuations in prices;
- Increasing the costs of aviation transport and maritime bunkering;
- Increasing incidents of vehicular, maritime and air transport mishaps due to reduced mobility as a result of flooding, and visibility;
- Increasing delays and hazards within the transportation sector.

To address these impacts of Climate Change on the transportation sector, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Promote the adoption of environmentally-friendly transportation technologies wherever possible, by means of tax incentives;

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2. Explore the use of synthetic (non-fossil) fuels so as to reduce greenhouse gas emissions;

3. Regulate motor vehicle emissions by setting and enforcing standards, and enforcing proper maintenance of private and public vehicles;

4. In the short–term, reduce as far as is possible and by all appropriate means, traffic congestion, which is a major cause of emissions and pollution, (including the introduction of "flexitime", and rationalization of the public transport (jitney) system);

5. Sensitize the public to the need for proper vehicle maintenance, for fuel efficiency and reduction of emissions; and

6. Support, and cooperate with, the initiatives of the International Civil Aviation Organization (ICAO) and of the International Maritime Organization (IMO).

Water Resources

Water is the basis of all life and a vital resource and, as such, protection of the freshwater resources of The Bahamas is of critical importance. In The Bahamas, the freshwater lenses or aquifers "sit" atop saltwater and rise and fall with the tides. Sea level rise will therefore directly impact the fresh water lenses, raising them progressively nearer the soil surface, more so in those islands with narrow and thinner aquifers than in those islands with larger and

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thicker aquifers. Scientific research and international discussions indicate that water resources worldwide will become an increasingly scarce commodity, and will be impacted by Climate Change. Likely impacts include:

- Changes in the seasonal availability, and spatial distribution, of freshwater resources due to increased climatic variability, and the occurrence of severe weather events such as hurricanes and droughts;

- Contamination of ground water due to saltwater intrusion as a result of sea level rise;

- Water shortages due to increased frequency and severity of droughts;

To address these impacts of Climate Change on water resources, the Government of The Bahamas, in collaboration with other relevant entities, will:

1. Enact a revised Water and Sewerage Act to empower the corporation to undertake all necessary steps to ensure more efficient use of water;

2. Undertake further studies to provide a scientific basis for, inter alia, a comprehensive inventory of all water resources including surface and ground waters, brackish and fresh, throughout The Bahamas in order to support a National Water Management Plan;

3. Develop a long-term National Water

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Management Plan, which incorporates Climate Change concerns including "worse case " scenarios of sea level rise, saltwater intrusion, and storm surges leading to inundation of well fields, and the need to regulate water supplies to the different sectors (domestic, tourism, agriculture and industry);

4. Assess and address needs for water storage and distribution infrastructure to ensure water availability during drought periods, and for more efficient use of freshwater;

5. Prepare emergency plans for water distribution during periods of drought;

6. Given that reverse osmosis will be necessary to augment groundwater supplies, ensure that the brine produced is disposed of efficiently;

7. Enact legislation to ensure that golf courses line their ponds and use grasses and other plants tolerant to the use of brackish water for irrigation purposes, to the extent possible, and to provide for the utilization of storm water runoff for groundwater recharge;

8. Encourage the use of waste heat from the Bahamas Electricity Corporation, and other appropriate entities, for the desalination of seawater;

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9. Encourage the use of water saving devices that are water efficient or are low flow to reduce wastage; and

10. Ensure synergies with the Caribbean Basin Hydrogeological Cycle Observing System (CARIB-HYCOS).

PLANNING AND MANAGEMENT

The Government of The Bahamas will ensure that the following steps are taken in order to achieve the fulfilment of the goals, objectives, principles and directives of this policy:

1. Establishment of an effective legal and institutional framework for the maintenance and enhancement of the nation's natural environment;

2. Development of a National Land Use Management Plan for the entire Bahamas;

3. Establishment of a National Climate Change Database and Information System to be used by all relevant agencies;

4. Development and enforcement of building codes which incorporate Climate Change concerns;

5. Development and application of appropriate engineering standards for roads, jetties and other such structures which include Climate Change considerations;

6. Incorporation of Climate Change considerations into Government's budgetary process;

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7. Establishment of a Coastal Zone Unit, or similar body, to undertake appropriate monitoring and risk assessment and mapping, to formulate appropriate response adaptation measures;

8. Endorsement of the Public Education and Outreach (PEO) Strategy in order to ensure that all stakeholders are kept informed of Climate Change issues, and of national adaptation plans and activities;

9. Development and implementation of joint programmes for the monitoring and conservation of coastal ecosystems and resources through collaboration between the Department of Fisheries and communities and resource users;

10. Development and use by the Public Health Department, of appropriate monitoring methods and indicators to determine the impacts of Climate Change on human health;

11. Development of a National Adaptation Strategy for Agriculture by the Ministry of Agriculture, Fisheries and Local Government, which embraces Climate Change concerns in the short-, medium-, and long- term;

12. Incorporation of Climate Change issues into the national disaster planning and response process of the National Emergency Management Agency (NEMA), of the National Oil Spill Contingency Committee; and of the National Disaster Preparedness Committee (it is noted that the latter are in the process of preparing a comprehensive

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plan;

13. Strengthening of the Department of Meteorology in order to improve data collection, management and analysis, and the accessibility of such data;

14. Development of mechanisms to ensure that the information generated through research and monitoring is incorporated into the decision-making process; and

15. Participation and collaboration to the fullest extent possible in the United Nations Framework Convention on Climate Change (UNFCCC) and its Subsidiary Bodies, and in the Caribbean Community Centre for Climate Change (CCCCC) and its programmes.

ACCOUNTABILITY

The Bahamas Environment, Science and Technology (BEST) Commission shall have administrative oversight and responsibility for Climate Change initiatives. All Ministries, departments, and statutory corporations shall have responsibility for implementing specific activities or programmes falling within their portfolios to address Climate Change, and shall report as required to the National Climate Change Committee (NCCC) and the BEST Commission.

Adaptation to Climate Change is a concern and responsibility of all citizens of The Bahamas and, as such, civil society is encouraged to collaborate with Government in the development of appropriate measures for accountability.

MONITORING AND REVIEW

The National Climate Change Committee (NCCC), or its successor body shall monitor implementation of this National Climate Change Adaptation Policy. Government shall review the mandate, terms of reference and composition of the NCCC with a view to better equipping it to fulfil its monitoring role. The NCCC shall report to the Cabinet of Ministers through the Ambassador for the Environment and the Minister responsible on a semi-annual basis, as well as at any other time deemed necessary. The NCCC shall keep this policy under regular review, and shall monitor implementation of the directives of this policy, and shall present to Cabinet and the House of Assembly an annual report on measures that have been undertaken to implement this policy. On the fifth anniversary of the date of this policy, the NCCC shall conduct a public review of this policy to determine its effectiveness in achieving its goals and objectives.

APPLICATION

This policy shall guide the work of all Government, Statutory, Non-governmental and Civic entities which are involved in, or seek to become involved in, addressing Climate Change issues as they affect The Bahamas.

ACKNOWLEDGEMENTS

This policy shall guide the work of all Government, Statutory, Non-gThanks are due the following for participating in and contributing to the development of this policy document:

Members of the National Climate Change Committee:

H.E. Keod Smith, M.P.
Ambassador for the Environment
Chairman of the BEST Commission (ex officio)

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Department of Physical Planning

Ex-officio National Climate Change Committee Member:

Mr. Philip Weech
United Nations Framework Convention on Climate Change (UNFCCC) Secretariat

REFERENCES

Legislation, regulations, policies, administrative decisions, etc.

ACTS TAKEN FROM THE STATUTE LAW OF THE BAHAMAS 1799-1987:

Title II	No. 5	Continental Shelf
Title V	No. 26	Public Works
	No. 37	Local Government Administration
	No. 28	Out Islands Utilities
	No. 29	Freeport Bye-laws
Title XIV		Immovable Property (Acquisition by Foreign Persons) *(Repealed by no. 41 of 1993, International Persons Landholding Act)*
	No. 141	Time sharing
Title XIX	No. 194	Electricity
	No. 195	Out Islands Electricity
	No. 196	Water and Sewerage Corporation
	No. 197	Water Supplies (Out Islands)
	No. 198	South Eleuthera Water Supply
	No. 199	Housing
	No. 200	Building Regulation
Title XXII	No. 201	Roads
	No. 204	Coast Protection
Title XXV	No. 218	Liquefied Petroleum Gas
	No. 219	Petroleum

REFERENCES

Title XXVI No. 223 Derelict Motor Vehicles (Disposal)

Title XXVII No. 231 Health Services

No. 232 Environmental Health

Environmental Health (Collection and Disposal of Solid Waste) Regulations 1998

Title XXVIII No. 242 Agriculture and Fisheries

No. 243 Agricultural Manufactories

No. 244 Fisheries Resources (Jurisdiction and Conservation) (Amended by #38 of 1993)

No. 248 Wild Animals Protection

No. 249 Wild Birds Protection

No. 250 Plants Protection

Title XXXI No. 251 Land Surveyors

No. 252 Acquisition of Land

No. 253 Out Islands Dilapidated Buildings

No. 255 Town Planning

No. 256 Private Roads and Sub- divisions

No. 257 Private Roads and Sub-divisions (Out Islands)

No. 258 Sub-divisions (Local Improvement Associations)

No. 259 Reclamation and Drainage

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No. 270 Abutments

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No. 275 Merchant Shipping (Oil Pollution)

No. 278 Water-Ski-ing and Motor Boat Control

Title XXXIV No. 289 Hotels Encouragement

Title XLII No. 325 Bahamas Free Trade Zone

No. 326 Industries Encouragement

Title XLIV No. 357 The Bahamas Development Bank

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Annex 2

First Biennial Update Report (BUR1) of The Commonwealth of The Bahamas to the United Nations Framework Convention on Climate Change (UNFCCC)

December 2022

The Commonwealth of The Bahamas'

First Biennial Update Report (BUR1)

in fulfilment of its commitment under the

United Nations Framework Convention on Climate Change (UNFCCC)

Publisher:

Department of Environmental Planning and Protection (DEPP)
Ministry of Environment and Natural Resources
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First Biennial Update Report of The Commonwealth of The Bahamas under the United Nations Framework Convention on Climate Change (UNFCCC)

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1) Coordinated by:
    a. Department of Environmental Planning and Protection – DEPP (formerly The BEST Commission) — Executing Entity
    b. United Nations Environment Programme — Implementing Entity
    c. The Bahamas National Climate Change Committee (NCCC)

The climate crisis is an enormous threat to The Bahamas and other vulnerable Small Island Developing States (SIDS). If global emissions are not slowed, our country and many other nations will look different from the country we love today. Rising seas levels will cause our islands and other SIDS to disappear, drought will impact our food security, and warmer waters are likely to bring more catastrophic storms like Hurricane Dorian.

The Bahamas contributes less than 0.01% of global greenhouse gas (GHG) emissions, and despite this minimal contribution, our country has prioritized providing the domestic and international community with the required reports highlighted in the Paris Agreement, that adhere to TACCC principles, in an effort to demonstrate leadership and commitment to action to combat this global issue.

The realities of war, economic headwinds, the hangover from the pandemic, and competition among world powers, cannot be used as justification not to confront the imminent danger of the climate crisis.

At COP27, The Bahamas called on other nations to get real about tackling the climate crisis. We are not sitting still. The Bahamas has committed to the implementation of 41 mitigation actions in this BUR, to achieve an economy-wide reduction of GHG emissions of 30% when compared to Business as Usual (BAU) by 2030. This is mirrored in our recently submitted NDC. These actions will improve the lives and livelihoods of Bahamians. And we will continue our drive for innovation and ingenuity.

Our needs are clear. Review this BUR. And whoever you are, wherever you are, bring your climate solutions to The Bahamas. Help us convert our front-line vulnerabilities into cutting-edge solutions for all!

Hon. Philip Edward Davis, K.C., M.P,
Prime Minister and Minister of Finance
Commonwealth of The Bahamas

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Acronyms/Abbreviations

5Cs	Caribbean Community Climate Change Centre
AD	Activity Data
AFLOU	Agriculture, Forestry and Other Land Use
AR5	IPCC Fifth Assessment Report
BAHFSA	Bahamas Agricultural Health and Food Safety Authority
BAMSI	Bahamas Agriculture & Marine Science Institute
BAU	Business as Usual
BBSQ	Bahamas Bureau of Standards and Quality
BCCEC	Bahamas Chamber of Commerce & Employers Confederation
BDB	Bahamas Development Bank
BEST	Bahamas Environment Science and Technology Commission
BDM	Bahamas Department of Meteorology
BHTA	Bahamas Hotel and Tourism Association
BIS	Bahamas Information Services
BMA	Bahamas Maritime Authority
BNSI	Bahamas National Statistical Institute (formerly the Department of Statistics)
BNT	Bahamas National Trust
BPL	Bahamas Power and Light Company Limited
BPAF	Bahamas Protected Area Fund
BREEF	Bahamas Reef Environment Educational Foundation
BSD	Bahamian Dollar
BTR	Biennial Transparency Report
BTVI	Bahamas Technical and Vocational Institute
BUR1	First Biennial Update Report
C2EAU	Climate Change and Environmental Advisory Unit
CAAB	Civil Aviation Authority Bahamas
CARICOM	Caribbean Community
CBB	Central Bank of The Bahamas

CCARR	Climate Change Adaptation and Resilience Research Centre (University of The Bahamas)
CCCCCC	Caribbean Community Climate Change Centre
CCREEE	Caribbean Community for Renewable Energy and Energy Efficiency
CDB	Caribbean Development Bank
CFL	Compact Fluorescent Light
COP	Conference of the Parties
COVID-19	Coronavirus disease of 2019
CRF	Common Reporting Format
CTF	Common Tabular Format
DEHS	Department of Environmental Health Services
DEPP	Department of Environmental Planning & Protection (formerly the BEST Commission)
DFID	United Kingdom's Department for International Development
DMR	Department of Marine Resources
DOA	Department of Agriculture
DRA	Disaster Reconstruction Authority
ECLAC	Economic Commission for Latin America and the Caribbean
EB	Energy Balance
EE	Energy Efficiency
EF	Emission Factor
ESCO	Energy Service Company
EST	Environmentally Sound Technologies
EIB	European Investment Bank
EU	European Union
EV	Electric Vehicle
FAO	Food and Agriculture Organization of the United Nations
FNC	First National Communication
FOCOL	Freeport Oil Company/Sun Oil Limited
GBPA	Grand Bahama Port Authority
GBPC	Grand Bahama Power Company

GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GOB	Government of The Bahamas
GHG	Greenhouse Gas
GHGI	Greenhouse Gas Inventory
GHGMI	Greenhouse Gas Management Institute
GIZ	German Development Agency
GWP	Global Warming Potential
ICA	International Consultation and Analysis
IDB	Inter-American Development Bank
IE	Included Elsewhere
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IICA	Inter-American Institute for Cooperation on Agriculture
INDC	Intended Nationally Determined Contribution
IPCC	Inter-governmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IUCN	International Union for Conservation of Nature (IUCN)
JICA	Japanese International Cooperation Agency
KCA	Key Category Analysis
KfW	German Development Bank
LAC	Latin America and Caribbean
LEAP	Low Emissions Analysis Platform
LED	Light-emitting diode
LPG	Liquefied petroleum gas
LULUCF	Land Use Land Use Change and Forestry
MEAs	Multilateral Environmental Agreements
MOEH	Ministry of Environment & Housing
MOHW	Ministry of Health and Wellness
MOT	Ministry of Tourism

MOWU	Ministry of Works and Utilities
MPG	Modalities, Procedures and Guidelines
MRV	Measurement, Reporting and Verification
MRV Hub	Caribbean Cooperative MRV Hub
MSW	Municipal Solid Waste
NA	Not Applicable
NBSAP	National Biodiversity Strategy and Action Plan
NC	National Communication
NCV	Net Calorific Value
NCCC	National Climate Change Committee
NDC	Nationally Determined Contributions
NDP	National Development Plan
NE	Not Estimate
NEA	National Executing Agency
NEMA	National Emergency Management Agency
NGO	Non-Governmental Organization
NHI	National Health Insurance
NHSSP	National Health System Strategic Plan
NO	Not Occurring
NOAA	National Oceanic Atmospheric Administration
NPAC	National Project Advisory Committee
NPEP	New Providence Ecology Park
NPC	National Project Coordinator
OAS	Organization of American States
OLADE	Latin American Energy Organisation
OPM	Office of the Prime Minister
OTEC	Ocean Thermal Energy Conversion
PAHO	Pan American Health Organization
PEO	Public Education & Outreach
PM	Project Manager
PMU	Project Management Unit

PV	Photovoltaic
QA	Quality Assurance
QC	Quality Control
RE	Renewable Energy
REDD-plus	Reducing Emissions from Deforestation and Forest Degradation plus enhancing forest carbon stocks
RER	Renewable Energy Rider
RET	Renewable Energy Technologies
RSO	Research and Systematic Observation
SDG	Sustainable Development Goal
SEV	SEV Consulting Group
SGP	Small Grants Programme
SIDS	Small Island Developing States
SLOSH	Sea, lake and overland surges from hurricanes
SLR	Sea Level Rise
SNC	Second National Communication
SSP	Shared Socioeconomic Pathways
TEG	Technical Expert Group
TNA	Technology Needs Assessment
TNC	Third National Communication
TOR	Terms of Reference
UB	University of The Bahamas
UCL	University College London
UN	United Nations
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
URCA	Utilities Regulation and Competition Authority

USAID	United States Agency for International Development
USD	United States Dollar
V&A	Vulnerability and Adaptation
WB	World Bank
WHO	World Health Organization
WMO	World Meteorological Organization
WSC	Water & Sewerage Corporation

Units and Chemical Elements

Units

g	Gram
Gg	Gigagram
ha	Hectare
kg	Kilogram
km	Kilometre
km^2	Square Kilometre
kW	Kilowatt
kWh	Kilowatt-hour
m^2	Square metre
MW	Megawatt
MWh	Megawatt-hour
t	Tonne
TJ	Terajoule
W	Watt

Chemicals/Chemical Related Terms

BOD	Biological Oxygen Demand
CH_4	Methane
CO_2	Carbon dioxide
CO_2–eq	Carbon dioxide equivalent
EF	Emission Factor
HFCs	Hydrofluorocarbons
MCF	Methane correction factor
N_2O	Nitrous oxide
PFCs	Perfluorocarbons
SF_6	Sulphur hexafluoride

Executive Summary

a) National Circumstances

According to the Intergovernmental Panel on Climate Change (IPCC), global climate change impacts are evident, particularly for Small Island Developing States (SIDS) like The Bahamas, which was ranked third on the Climate Risk Index. Further, the Global Circulation Model (GCM) provides grime projected outlined of The Bahamas' vulnerability to temperature rise, changing precipitation patterns, and increased intensity of tropical storms the country may face throughout its archipelago. To address these concerns, The Bahamas has taken strong national and diplomatic approaches.

Located on the Western North Atlantic, The Bahamas' lowline coastal biogenic limestones rockland and oolitic sand landmass lies less than 1.5 meters above sea level on the Great and Small Bahama Banks. The subtropical summer months usually reach 90 degrees Fahrenheit, and the winter months typically reach 75 degrees Fahrenheit. The Bahamas' dry and wet seasons are distinct, with the seasonal effect of tropical cyclones having a pronounced effect on annual rainfalls across The Bahamas. Consequently, projections show a decline in rainfall in the Southeast Bahamas in contrast to the North and North Central Bahamas. The decreased rainfall, the sole natural means of recharging the aquifers, may affect the country's hydrogeology systems. The Bahamas will face several challenges with respect to its water security due to climate change impact.

The population of The Bahamas was estimated to be approximately 295,000 in 2000, compared comparison to the 2025 projection of 408,930, which is progressing at an annual rate of 0.92%. Most of the infrastructure and settlements of the islands are located along or near the coast, where they are particularly vulnerable to flooding and sea level rise that will have socioeconomic implications for residents and sectors, particularly the tourism sector.

The tourism sector is the primary driver of the Bahamian economy, accounts for approximately 50% of the GDP. Prior to Hurricane Dorian's landfall in 2019, more than

7.2 million visitors visited The Bahamas. Subsequently, due to the devastating impact of Hurricane Dorian on the islands of Grand Bahama and Abaco, along with the global onset of COVID-19, The Bahamas experienced a significant decline of 75% in 2020 in stopover visitors.

The energy sector of The Bahamas is heavily dependent on fossil fuels. The dependency on imported oil, almost 100%, has made energy production in The Bahamas vulnerable to global oil price fluctuations. The electricity and transport sectors are the country's primary users of fossil fuels. To address these concerns, the Government of The Bahamas has established and implemented The Bahamas National Energy Policy 2013 – 2033, which aims to achieve a diversified efficient energy sector, affordable energy supplies, and long-term energy security. In addition, The Bahamas' Government established the Ragged Island Microgrid and the Solar Car Park and is embarking on further efforts to expand renewable energy generation and electric vehicle utilization across the archipelago.

Water resources within The Bahamas vary between islands, and the supply-demand balance is highly dependent on population density. Having the highest population density, the island of New Providence has far less aquifer capacity and faces challenges with water quality and water resources. The water sector is identified as a national priority for climate change adaptation in the first and updated Nationally Determined Contribution (NDC).

Agriculture and fisheries are vital to The Bahamas Family Islands' socioeconomic security. The Agricultural sector land use is classified as arable land, permanent corps, permanent pasture, forestry, and others. Approximately 90% of the available agricultural land is owned by the government and leased to farmers. Major crops for export are grapefruit, limes, avocados, papaya, okras, and pineapples. Moreover, the fisheries sector contributes approximately US$80 million in foreign currency annually in export earnings. It provides full-time employment to 9,300 commercial fishers and thousands more jobs in recreational fisheries, vessel maintenance, fish processing, retail, and trade.

The Bahamas' financial sector accounts for about 15% of the GDP that consists of commercial banks, savings banks, trust companies, offshore banks, insurance companies, a development bank, a publicly controlled pension fund, a housing corporation, a public savings bank, private pension funds, cooperative societies and credit unions, including international business companies (IBC), mutual funds, and insurances services.

Generating more than 264,000 tons of municipal solid waste annually, the management of solid waste disposal varies throughout The Bahamas archipelago. Most Family Islands' solid waste disposal processes are underdeveloped compared to New Providence's solid waste and landfill management system carried out by the New Providence Ecology Park (NPEP). Notwithstanding, in 2011, The Bahamas established its first biodiesel production facility, Bahamas Waste Limited. The facility has the capacity to convert up to one million gallons of waste cooking oil into biodiesel. Currently, the facility is using a 50:50 blend of biodiesel to petroleum diesel in four vehicles in hopes of running its entire fleet on 100% biodiesel as production increases.

The Public Hospitals Authority oversees the quality of the three public hospitals in The Bahama. In contrast, the National Health Insurance (NHI) offers Bahamian residents access to primary health care, free at the point of service. Making a conscious effort to improve its healthcare system, the Government invested around 8% of its GDP into health care in 2018. In addition to improving the health care system and addressing climate change impact, the Government executed the "Developing a Climate Resilient Health System in The Bahamas" and the "EU/CARIFORUM Climate Change and Health Project".

Over the last decade, The Bahamas have experienced a significant impact in the form of frequent natural disasters. For example, in 2015, The Bahamas experienced Hurricane Joaquin, followed by Hurricane Matthew in 2016; the preceding year, the country experienced Hurricane Maria and Irma. In 2019, Hurricane Dorian (a Category 5 Hurricane) caused significant loss of life, evacuation of affected islands, climate migration, and damage to infrastructure and the economy, estimated to have caused over US$ 3 billion in loss and damages. The Internal Displacement Monitoring Centre (2020) estimated that 9,840 people were displaced due to Hurricane Dorian. Most persons displaced were from the islands of Abaco and Grand Bahama.

Initial discussions about institutional arrangements were held during a stakeholder workshop for the Project Identification Plan phase for the development of The Bahamas' First Biennial Update Report (BUR1). Through the development of the BUR1, these discussions have been further refined.

The BUR1 development was led by the Department of Environmental Planning and Protection (DEPP) and the National Climate Change Committee (NCCC). The Project Manager is a staff member of The Climate Change & Environmental Advisory Unit (CCEAU), a technical advisory arm of the Office of the Prime Minister (OPM). Consultants were engaged to complete the various chapters of the BUR1. And all chapter drafts were reviewed by the project team members and the NCCC. The NCCC members have also supported the process by providing information and data from their respective organizations and ensuring the chapters accurately reflect circumstances in The Bahamas and future plans for addressing climate change.

The following technical group was established to address future National Communications (NC) and other reports to the UNFCCC: Greenhouse Gas Inventory, Vulnerability & Adaptation Assessment, Mitigation Analysis, Environmentally Sound Technologies, Research & Systematic Observations, Education-Training & Public Awareness, Information & Networking Capacity-building.

b) Domestic measurement, reporting and verification (MRV) Summary

This chapter highlights how work during The Bahamas' Third National Communications/First Biennial Update Report (TNC/BUR1) cycle, as well as previous and on-going climate projects, that the Government of The Bahamas has positioned itself on a path towards establishing a comprehensive and all-encompassing MRV system through its National Climate Change Committee (NCCC) and intensive capacity building of local experts to meet the demands of the newer reporting requirements.

Through implementation and continued prioritization for future reporting cycles, the country has envisaged that this system will measure, report, and verify the following activities and actions in adherence with the Transparency, Accuracy, Completeness, Comparability, and Consistency (TACCC) principles:

- Activities that cause climate change (Greenhouse Gas Inventory (GHGI));
- Actions taken that prevent climate change (mitigation actions and Nationally Determined Contributions (NDC) implementation progress);
- Climate change impacts and adaptation;
- Actions taken to adapt to climate change (adaptation actions and NDC implementation progress); and
- Financial and other support needed and received for undertaking actions above.

Like many SIDS, The Bahamas faces challenges due to limited human, technical and institutional capacity within the country and has normally engaged regional and international consultants to conduct the relevant planning and preparation activities to meet its reporting obligations, with previous reports conducted using a decentralized, project-based MRV system.

Cognizant of the obstacles faced in previous reporting cycles and an understanding of the necessary improvements to previous institutional arrangements, The Bahamas decided to use the opportunity of the NC3 and BUR1 reporting cycle to move from a decentralized project-based system to a centralised project-based system. Several initiatives were conducted over the course of the reporting cycle to enhance the technical and institutional capacity of the local team, in addition to an MRV system status assessment.

Completed in 2022, the MRV system status described within this assessment report underscores the key premise of implementing it in the first place - that expectations based on existing decisions under the Paris Agreement will lead to increased levels of scrutiny on adherence to the TACCC principles of countries' reporting and MRV system institutional arrangements. The assessment provided an understanding of the current MRV system barriers and established a starting point for future improvement areas to be made (as outlined in Table 15 in Chapter 2).

The Bahamas MRV assessment also informed an initial "roadmap" of prioritised set of recommendations. The roadmap builds out a step-by-step process that, if implemented, will move The Bahamas towards a centralised project-based system, and then to an eventual centralised on-going system. The roadmap sets out prioritized activities across the following MRV system component areas:

- Legal framework(s)
- Institutional formal and informal procedural agreements or arrangements
- Data sources and data collection procedures
- Documentation of resource (financial and human resource) allocation
- Country-specific planning or preparation documents
- Quality assurance and quality control procedures
- Type and number of reporting documents
- Methodologies applied for estimation
- Information management and archiving procedures
- Stakeholder engagement

Furthermore, domestically, it is expected that this future MRV system will allow for the Government of The Bahamas to:

- Demonstrate transparency, accountability, and trust to the taxpayers of The Bahamas
- Determine the impacts and costs of climate change actions
- Determine the investments needed to achieve The Bahamas' adaptation and mitigation priorities
- Track progress of climate policies to improve implementation and ensure climate priorities and outcomes are achieved

In regard to support and climate finance MRV, the country has developed a climate finance MRV methodology and tool for tracking climate support needed and received. The feasibility study conducted to develop this tool provided data for reporting support needed and received. The climate finance MRV tool has yet to be integrated with other finance systems in the Ministry of Finance (but should be prioritized).

This tool would allow for The Government of The Bahamas to:

- Have a clear overview of NDC related financial flows, sources, and purposes
- Indicate the recipients of financial support and identify gaps in sectoral and geographical support
- Demonstrate accountability, transparency, and trust in future United Nations Framework Convention on Climate Change's (UNFCCC) negotiations and to the taxpayers of The Bahamas.
- Through the outputs of the project, the Bahamas intends to determine the following to prioritise its implementation next steps:
- The costs to implement the adaptation and mitigation actions that are outlined in the NDC, using results from a cost analysis
- The investments and finance needed to achieve The Bahamas' adaptation and mitigation priorities as outlined in the NDC

c) National Greenhouse Gas (GHG) Inventories Summary

i) GHG inventory scope and approach

This chapter presents The Bahamas's national GHG inventory for the years 2001-2018, prepared in line with the IPCC 2006 Guidelines for national GHG inventories. The inventory scope covers the geographical borders of The Bahamas. Gases covered are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). While it is assumed that emissions from hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are at least likely to occur, the necessary data to perform estimates for these gases were not available. The Bahamas intends to move towards covering these gases in future GHG inventory submissions.

The Global Warming Potential (GWP) values from the IPCC's 5th Assessment report[1] were used (see Table 1).

Table 1: Global warming potentials used

Gas	GWP
CO_2	1
CH_4 (biogenic origin)	28
CH_4 (fossil origin)	30
N_2O	265

ii) GHG inventory preparation

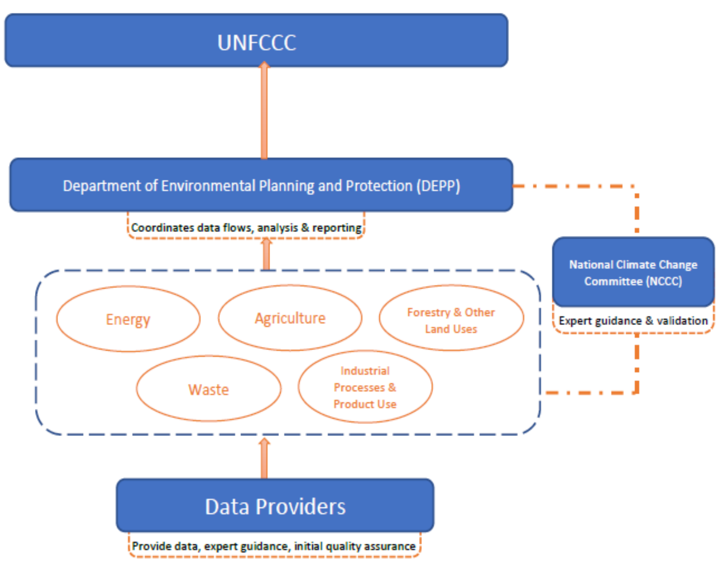
At present, The Bahamas National Climate Change Committee (NCCC) provides strategic level guidance on climate change related activities, policies, and plans, including the preparation of National Communications (NC), Biennial Update Reports (BUR),

[1] See Table 8.A.1, WG III, Chapter 8. Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

National Greenhouse Gas Inventory Reports (NIR), among others. The NCCC is chaired and led by the Department of Environmental Planning and Protection (DEPP) (formerly BEST Commission) and consists of representatives from the government, private sector, non-governmental agencies and academic institutions.

The DEPP, apart from its role as the chair of the NCCC, is also the UNFCCC and Global Environmental Facility (GEF) operational focal point, and coordinates the preparation and presentation of all reporting requirements to the UNFCCC. The technical aspects of the preparation of this NIR were led by regional consultants in a collaborative fashion with national experts with an aim to build national capacity. This included both GHG inventory data collection, estimation, compilation, and quality control and assurance throughout the inventory compilation period. The institutions and roles of these actors involved are described in "Annex II - Institutions and Roles of those involved in the Preparation of The Bahamas' NIR". An illustration of these roles is shown below in Figure 1.

Figure 1: Institutional arrangements for the national GHG inventory preparation



iii) Quality assurance and quality control

The following quality control steps were undertaken initially by the inventory compiler, and secondarily internally reviewed by the Caribbean Cooperative MRV Hub GHG accounting experts not involved in the preparation of the NIR as a quality control check for each sector inventory. These quality control steps include:

- Check that assumptions and criteria for the selection of activity data and emission factors are documented.
- Check for transcription errors in data input and reference.
- Check for correct calculation of emissions and removals that utilize appropriate equations and steps based on the methods used.
- Check that parameters and emission and removal units are correctly recorded and that appropriate conversion factors are used.
- Check that estimates are complete, that all categories and all years from the base year (2001) to the current inventory year (2018).

In terms of quality assurance, national sector experts were involved in data collection and understanding sector specific assumptions for methods. Other line Ministry representatives and experts from non-governmental organizations and academia reviewed emissions estimates and methodological assumptions. Additional quality assurance reviews were performed by regional GHG Inventory experts who were not involved in the compilation of the NIR.

The documentation and archiving of emissions estimates, worksheets, activity data, expert judgement, and assumptions was completed by the inventory compilers, and shared with DEPP through a Dropbox folder, organized and used throughout all stages of the GHG inventory cycle. This was done to ensure transparency, national ownership of data and reports, and promote continuity of inventory preparation for subsequent cycles.

The final stage of the inventory preparation cycle included identification and documentation of further improvements. The identified improvements (cross-cutting as well as sectoral) relate to both the emissions inventory data and also the institutional arrangements and are detailed in Annex II. These will be taken into account as the Government of The Bahamas continues to develop its national inventory team and climate measurement, reporting, and verification (MRV) system.

iv) Key Categories

A key category assessment was carried out for The Bahamas' GHG inventory estimates for the time series 2001-2018.[2] Both the level and trend assessments under approach 1 according to Volume 1, Chapter 4 of the IPCC 2006 Guidelines were conducted.

Table 2 below presents the 13 key categories identified and indicates whether they have been identified by the level assessment (L) and/or the trend assessment (T).

The majority of key categories identified, were identified under both level and trend assessment. They include stationary as well as mobile fuel combustion activities in the energy sector, land-based categories in the AFOLU sector (all for CO_2) as well as solid waste disposal (for CH_4).

Table 2: Key categories identified

IPCC Category Code	IPCC Category Name	Gas	Key category related to Level (L) and/or Trend (T)
1.a.1.a.i	Electricity Generation	CO_2	L, T
1.A.2.m	Non-specified Industry	CO_2	L, T
1.A.3.b.i	Cars	CO_2	L, T
1.A.3.b.ii	Light-duty trucks	CO_2	L
1.A.3.b.iii	Heavy-duty trucks and buses	CO_2	L, T
1.A.4.a	Commercial/Institutional	CO_2	L, T

[2] The previous National GHG Inventory of The Bahamas was published as part of The Bahamas' Second National Communication in 2014. This GHG inventory did not include a key category assessment, it is therefore not possible to assess how key categories have changed over time.

3.B.1.a	Forest land Remaining Forest Land	CO_2	L, T
3.B.1.b	Land Converted to Forest Land	CO_2	L, T
3.B.2.b	Land Converted to Cropland	CO_2	L, T
3.B.3.b	Land Converted to Grassland	CO_2	L, T
3.B.4.b	Land Converted to Wetlands	CO_2	L, T
3.B.5.b	Land Converted to Settlements	CO_2	L, T
4.A	Solid Waste Disposal	CH_4	L

v) Source and sink category emission estimates and trends

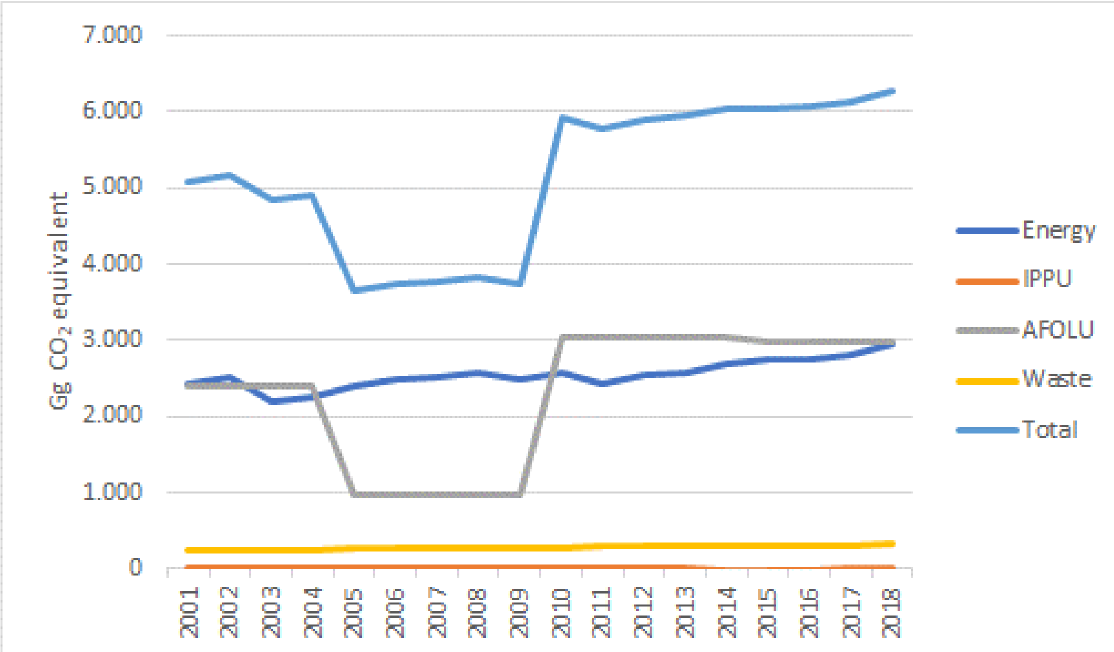
V.I Overview

Total GHG emissions in The Bahamas rose from 5,074.09 Gg CO_2-eq in 2001 to 6,264.39 Gg CO_2-eq in 2018, which equals an increase by 23.5 cent.[3] During the same time period GHG emissions from the waste sector rose by 30.6 per cent, from the AFOLU sector (including both emissions and removals) by 25.1 per cent, and from the energy sector by 21.1 per cent. IPPU sector emissions, to the extent estimated in this GHG inventory publication which covered only lubricant use[4], fell by 71.1 per cent. Total GHG emissions by sector are presented in Figure 2 (below). GHG estimates for 2001-2018 are presented in Table 2 (above). Developments of and drivers for sectoral and category-level trends are presented in the forthcoming sectoral chapters (3.7 - 3.10)

[3] The previous GHG inventory of the BAHAMAs published as part of The Bahamas Second National Communication in 2014 presented GHG emissions for the year 2000, amounting to 702.82 Gg CO_2-eq. when considering the gases CO_2, CH_4 and N_2O. These had been estimated using the IPCC Revised 1996 Guidelines for national GHG inventories and the GWPs from the IPCC's 2nd Assessment Report.

[4] Due to lack of data, GHG emissions from the use of HFCs and PFCs and of other potentially relevant sources could not be estimated. More information is provided in section 2 of this report.

Figure 2: Total GHG emissions by sector 2001-2018



The AFOLU and energy sectors dominate total national GHG emissions in The Bahamas, contributing 47.8 per cent and 47.1 per cent, respectively, to total emissions in 2018. The waste sector contributes 5.1 per cent and the IPPU sector was less than 0.1 per cent during the same year (see Figure 3 below).

Total CO_2 emissions amounted to 5909.18 Gg in 2018, representing 94.3 per cent of total GHG emissions. CH_4 amounted to 11.68 Gg in 2018, representing 5.2 per cent of the total and N2O to 0.12 Gg in 2018, representing 0.5 per cent of the total (see Figure 4 below).

Likely drivers to The Bahamas' GHG inventory emissions are the population and economic development. The increase in tourism has likely lead to an increase in demand on fuel and transportation, thus affecting energy sector emissions. GDP has increased by 56 per cent since 2001, the population by 27 per cent (see Figure 5 below).

Figure 3: Percent contribution of IPCC sectors to total GHG emissions in 2018

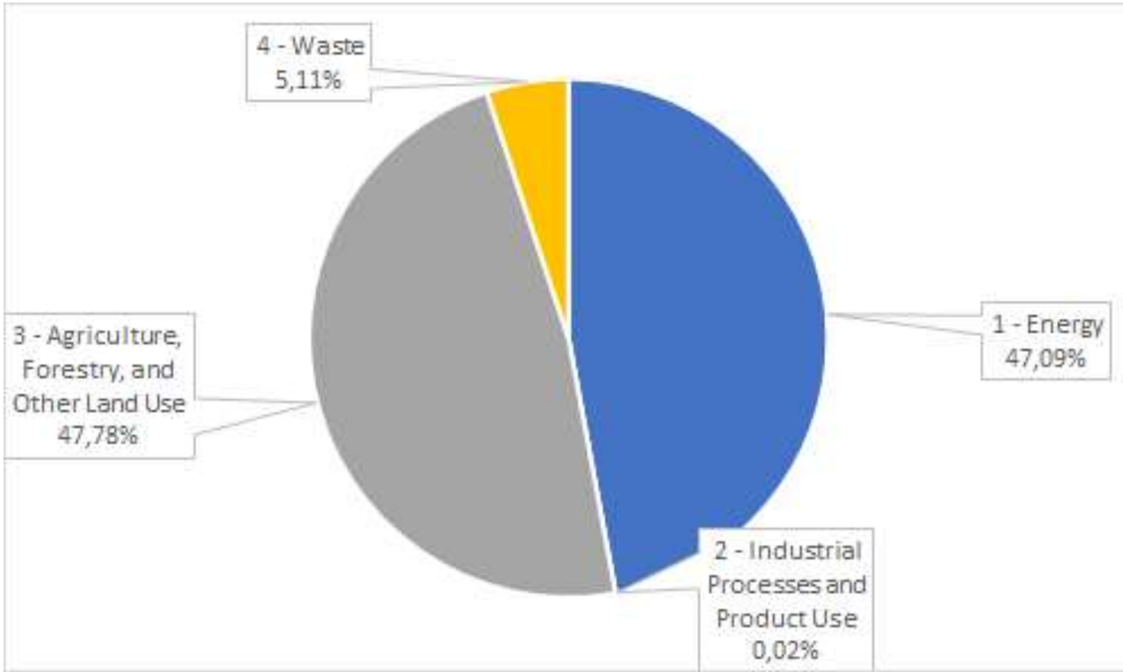


Figure 4: Contribution of gases to total GHG emissions in 2018

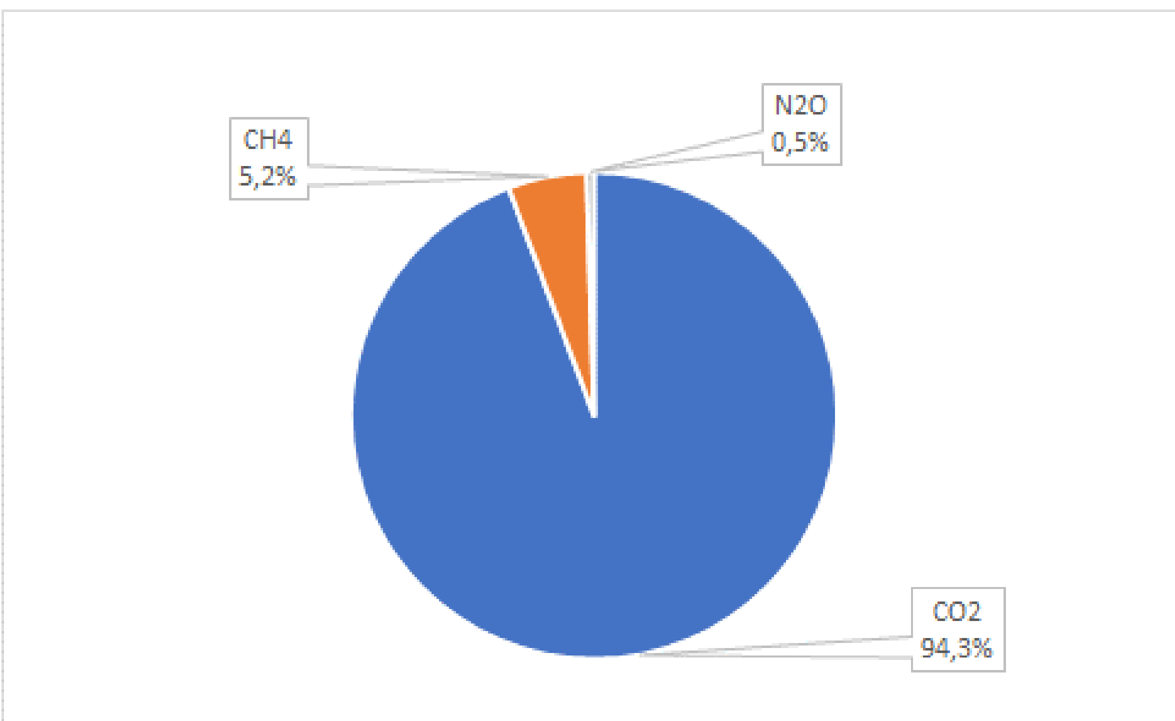
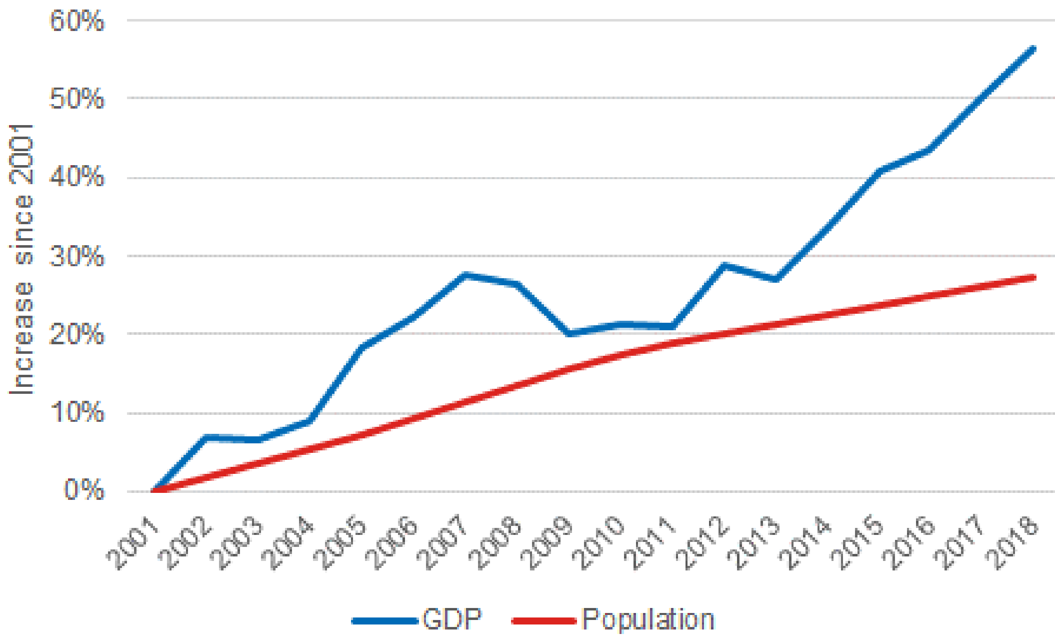


Figure 5: Increase in GDP and population in the Bahamas between 2001-2018



The GHG emissions per capita in The Bahamas was 16.24 tCO_2eq in 2018, which represents a decrease of 3.2 per cent compared to 2001.

V.II Energy sector

An overview of GHG emissions in the Energy sector by category and by gas is presented below. Total GHG emissions in the energy sector amounted to 2435.21 Gg CO_2-eq in 2001 and 2949.58 Gg CO_2-eq in 2018, see Figure 6. This represents an increase by 21.1 per cent. In the same time frame, GDP has increased by over 60 per cent and population by nearly 30 per cent.

Main power and heat generation is the largest GHG emission source in the energy sector with 48.5 per cent of total emissions, followed by transport with 24.7 per cent. Manufacture and construction contributes 11.9 per cent and Other 15.0 per cent. The contribution of Fugitive Emissions category is minute with 0.0006 per cent (Figure 7).

Figure 6: GHG emissions in the energy sector 2001-2018, by categories

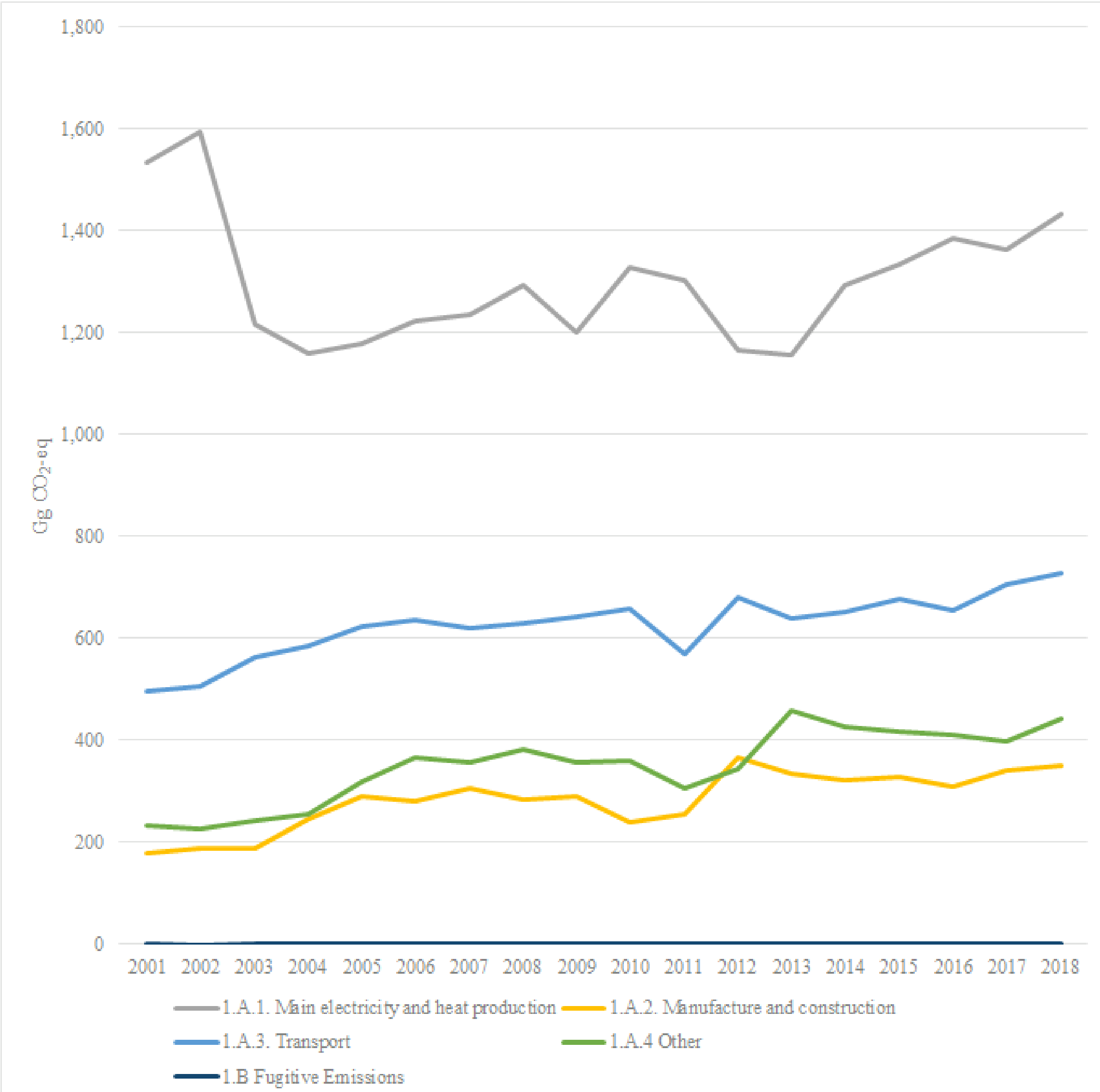
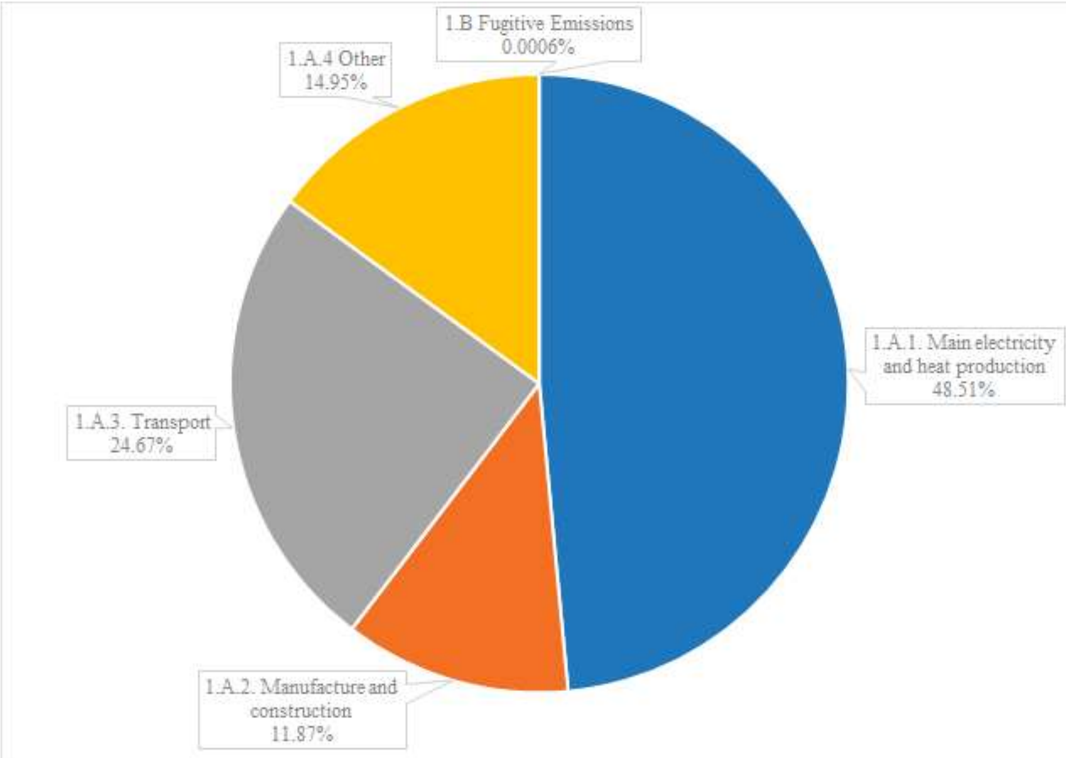
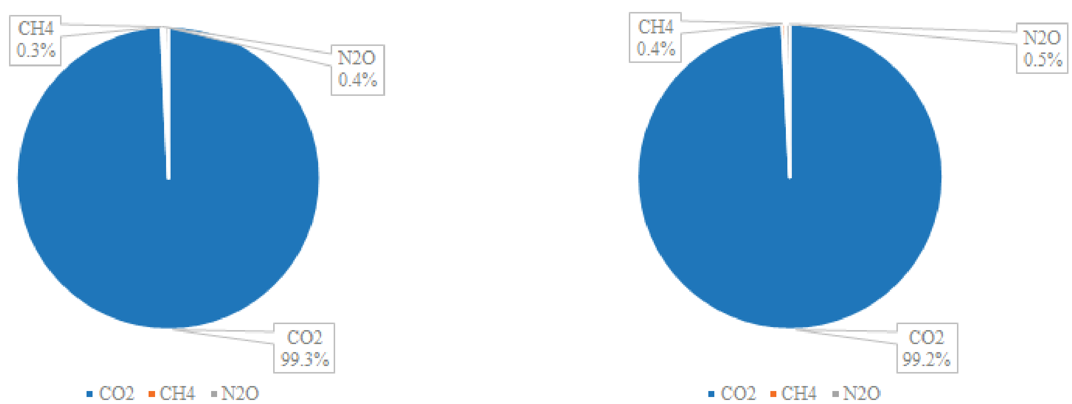


Figure 7: Contribution of categories to total GHG emissions in the energy sector in 2018



Shares of the gases in total emissions have remained similar over time, around 99 per cent for CO_2 and below 1 per cent for CH_4 as well as for N_2O. Figure 8 shows the contribution of the three gases to total GHG emissions in the energy sector in 2001 as well as in 2018.

Figure 8: Contribution of gases to total GHG emissions in the energy sector in 2001 and 2018



GHG emissions for the subcategories 1.A.1 Main Electricity and Heat Production, 1.A.2 Manufacture and Construction, 1.A.3 Transport and 1.A.4 Other sector all show an increasing trend since 2011. Before, they had shown an overall slightly downward trend. For the energy sector as a whole, GHG emissions have increased by 21.1 per cent between 2001 and 2018. This includes a reduction of 6.6 per cent from Main Electricity and Heat Production, and an increase by 97.7 per cent in Manufacture and Industries, 90.8 per cent in Other and 47.2 per cent in Transport. The increase in population as well as in GDP and related to that, tourism activity, can be deemed to have played a key role in the generally upwards moving trend since 2011. Technological change, e.g. the replacement of equipment for power generation, might potentially have played a role in reducing fuel consumption in earlier years of the time series. Data indicates that generation efficiency has considerably increased from 2003 onwards compared to 2001 and 2002. Furthermore, GDP has remained nearly stable between 2002-2004. A general decrease in fuel consumption in the sectors Transport and Other can be seen between 2009-2010. This might be related to the global financial crisis 2008-2010.

V.III Industrial Processes and Product Use

The industrial processes and product use sector covers a wide range of sources of GHG emissions. These include process (i.e., non-energy related) emissions from industrial production as well as emissions related to the use of certain products. GDP in The Bahamas focuses on the financial sector as well as on tourism, with only very limited industrial production taking place.

Data collection and consultation with experts indicates that no relevant industrial production, e.g., of cement clinker, glass, ceramics or steel takes place in The Bahamas at present.

A number of product use categories clearly occur or are likely to occur, while no data is available. These are presented in
Table 3.

Table 3: Categories of the IPPU sector not estimated due to lack of data

Gas and IPCC category	IPCC category code	Likelihood of occurrence
CO_2 emissions from the use of paraffin waxes and solvent use	2.D.2, 2.D3	Likely
HFC emissions from the operation and discharge of refrigeration and air conditioning equipment	2.F.1	Emissions do occur
HFC emissions from the use of building foams, aerosols and solvents	2.F.2, 2.F.3, 2.F.4	Likely
SF_6 emissions from the operation of electrical equipment	2.G.1	Likely
N_2O emissions from the use of N_2O in hospitals	2.G.3	Likely

Due to the lack of data, GHG emissions from these categories could not be estimated. Particularly the HFC emissions from the operation and discharge of refrigeration and air conditioning equipment are likely to make a relevant contribution to The Bahamas total GHG emissions. The collection of relevant data for the compilation of the next GHG inventory should thus be considered a priority. Annex III presents suggestions on how to retrieve relevant data in the course of future GHG inventory compilations.

Emissions of product use which occur and for which data was available, relates to the use of lubricants. This source only leads to emissions of CO_2. These fell from 3.75 Gg CO_2-eq in 2001 to 1.08 Gg CO_2-eq in 2018. This means that emissions have decreased by over 70% over the time series, with a dip of over 50% happening between 2010 and 2011. Reasons for this development are presently unknown and should be researched as part of future GHG inventory compilations. A potential explanation could be structural changes after the economic crisis 2008-2010.

V.IV Agriculture, Forestry and Other Land Use

Agriculture

The agriculture sector covers a wide range of sources of GHG emissions including from livestock, crop production, fertilizer use, and soil management. The agriculture sector in The Bahamas represents about 2.3% of the national GDP. These practices include small-scale farming of food crops, limited livestock production throughout the islands and more significantly, poultry egg and broiler production, and soil enrichment from fertilizers. The addition of lime to agricultural soils was not estimated, as all national soils are considered calcareous[5].Biomass burning was also not estimated, as post-crop burning is not considered a common practice.

Total GHG emissions in the agriculture sector amounted to 16.08 Gg CO_2-eq in 2001 and 14.23 Gg CO_2-eq in 2018, see Figure 9 (below). This represents a decrease by 11.54% per cent.

Per cent contributions of individual gases in total emissions have remained similar over time, with N_2O accounting for 88.3 per cent in 2001 and 83.6 per cent in 2018, less than 1% CO_2 in both 2001 and 2018, and 11.3 per cent and 15.6 per cent for CH_4. Total direct N_2O emissions on managed soils, particularly from fertilizer was the highest contributor to sector emissions (56.1 per cent). This is attributable to the importation of nitrogen-based fertilizers during the time series. This is followed by indirect N_2O emissions to managed soils from leaching and atmospheric volatilization from fertilizers and managed animal waste, accounting for (18.per cent). Emissions from livestock enteric fermentation (11.9 per cent) and manure management (10.2 per cent) followed. Indirect N_2O emissions from manure management and urea application jointly represented about 3 per cent of sector emissions (see Figure 10).

[5] All Bahamian protosols are alkaline, usually in the range 7.5 t0 8.5, with its red soils being less so, or neutral depending on the amount of limestone they include, *Soil and Land Resources of The Bahamas, N. Sealey*

Figure 9: GHG emissions in the agriculture-sector 2001-2018, by categories

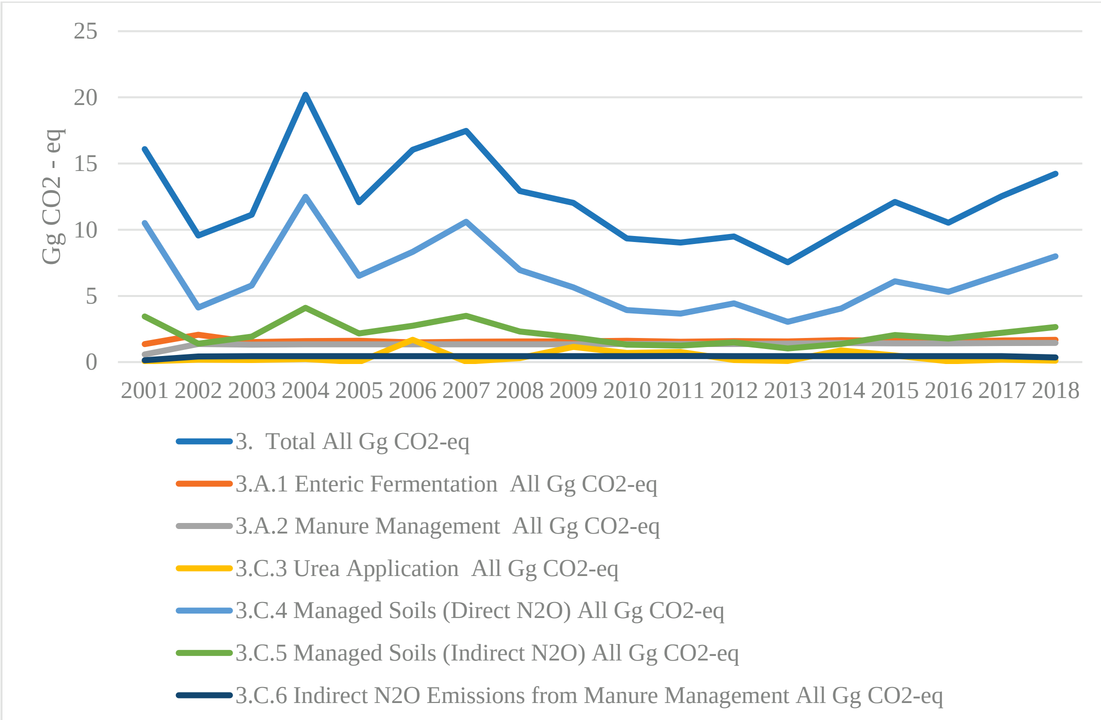
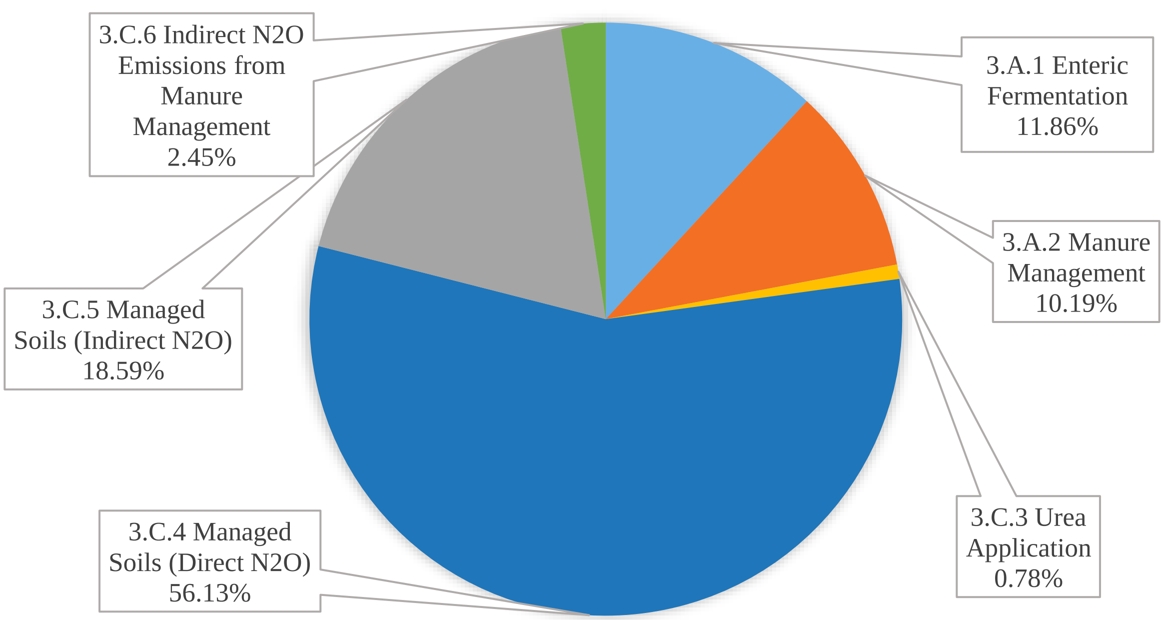


Figure 10: Per cent contribution of agriculture categories to total agriculture sector GHG emissions in 2018



Forestry and Other Land Uses

GHG emissions in the Forestry and Other Land Use (FOLU) sector typically come from a number of sources related to CO_2 emissions and removals from carbon stock changes in above and below-ground biomass pools of forest land. This includes forest land converted to other land uses such as cropland, grasslands, wetlands, and settlements. CH_4 and N_2O, and additional CO_2 emissions arise from fires and drainage of organic soils, however, these emissions were not estimated due to unavailability of data on forest fires and non-occurring drainage of organic soils.

Total GHG emissions in the FOLU sector were dominated by the land converted to grassland category in 2018, with conversion from forest land to grassland (shrublands and grasslands) representing 75 percent of emissions (as opposed to net-emissions) in this sector. All emissions and removals estimated within this sector relate to CO_2.

Across the time series, the trends that influenced annual emissions were those categories that contain the greatest amount of carbon stock (i.e. Forest land, Grassland, and conversion to either). Lowest emissions were noted within the time period of 2005-2009 (955.66 Gg CO_2 eq yearly emissions) attributed to land conversion to forest land (more removals). This effect was noted after the passing of two hurricanes, Hurricane Frances and Hurricane Jeanne, occurring two weeks apart in October of 2004. Both hurricanes severely impacted the north-western Bahamas, including Abaco, Andros, Berry, Bimini, Eleuthera, Exuma, Grand Bahama, and New Providence islands which are mainly forested islands. The pine forests of Grand Bahama were especially impacted with regeneration not comparable to its previous state. The effects of secondary foliage regrowth (and subsequently greater removals) enhanced sinks and reduced emissions in the 2005-2010. This regrowth is discernible by satellite imagery and can be viewed for the year 2010 on Grand Bahama and Abaco Islands.

In the subsequent years, from 2010 to 2014, a 30 per cent increase in emissions occurred

Figure 11: FOLU Sector Emissions by Category

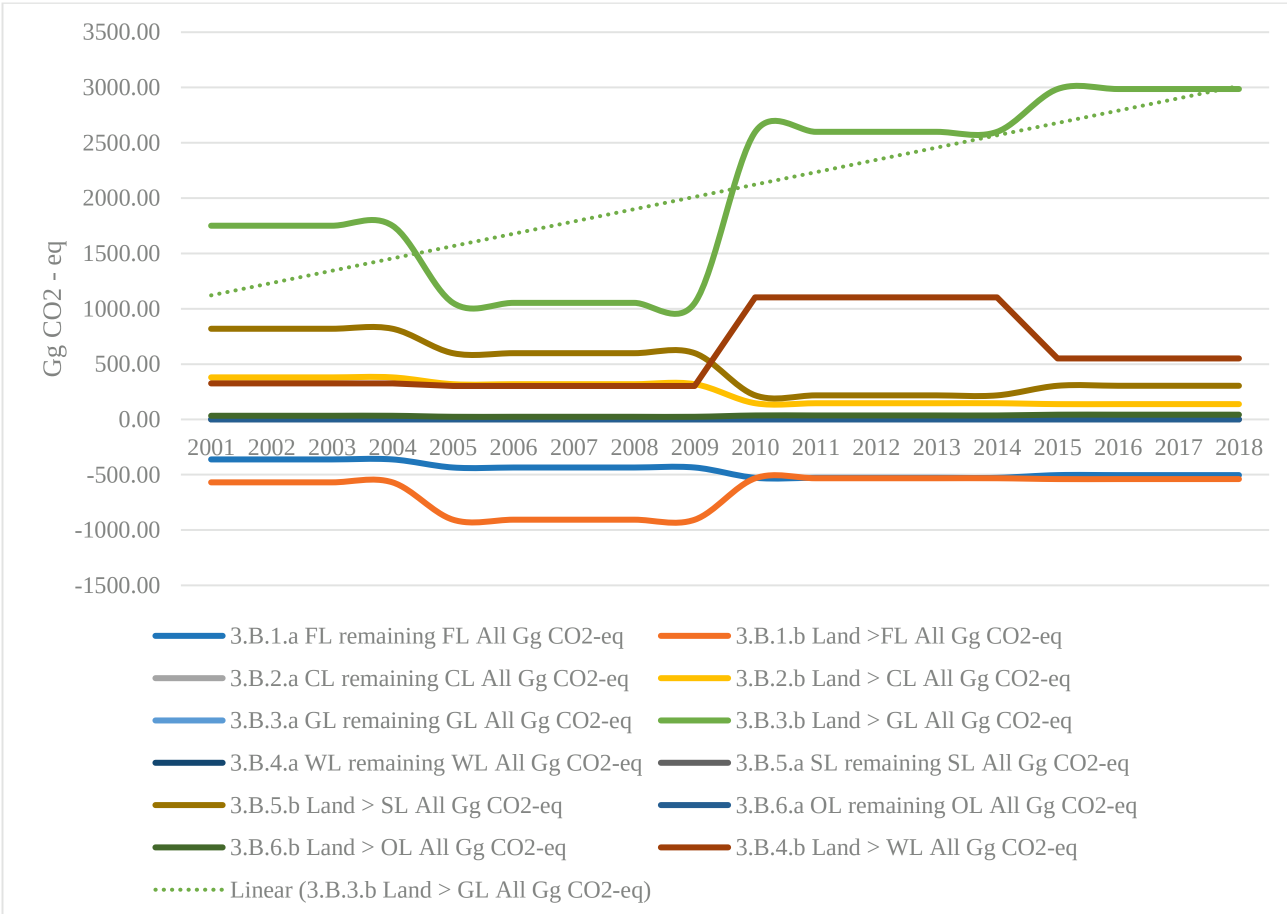
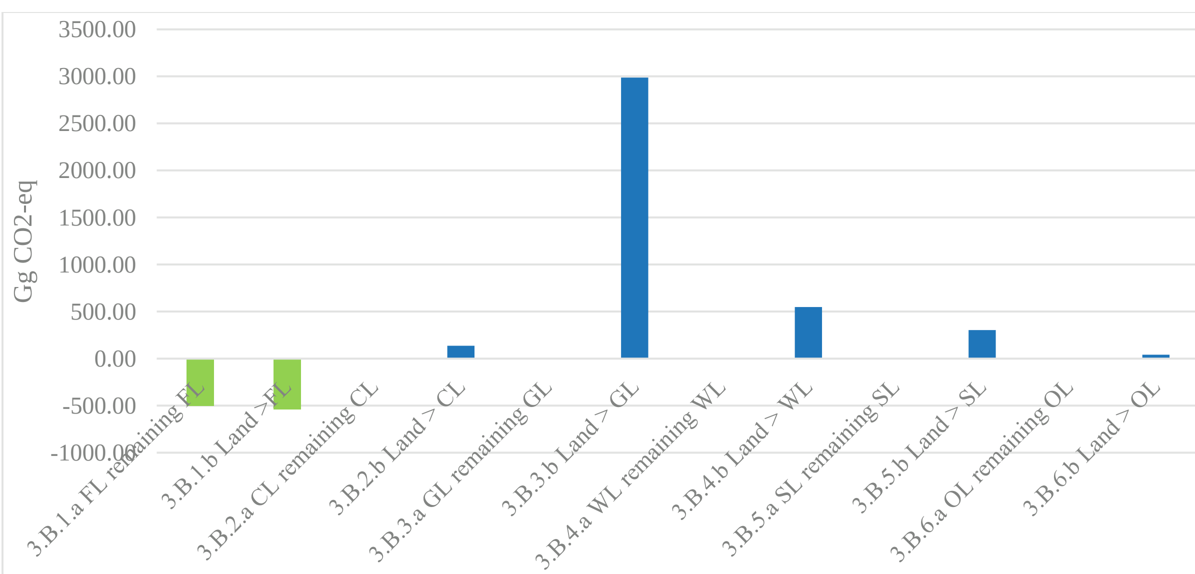


Figure 12: Contribution of categories to total FOLU GHG emissions in 2018



due to conversion from forestland to grassland and secondarily from a large conversion of forest land to wetlands (reduction in carbon stocks). Furthermore, in more recent natural disasters, Hurricane Dorian in 2019 has demonstrated partial to severe destruction to mangroves, coral reefs, and forests of Abaco and Grand Bahama, particularly the eastern sides of Grand Bahama, however the overall emissions from land use change between 2010 and 2020 were relatively constant.

V.V Waste

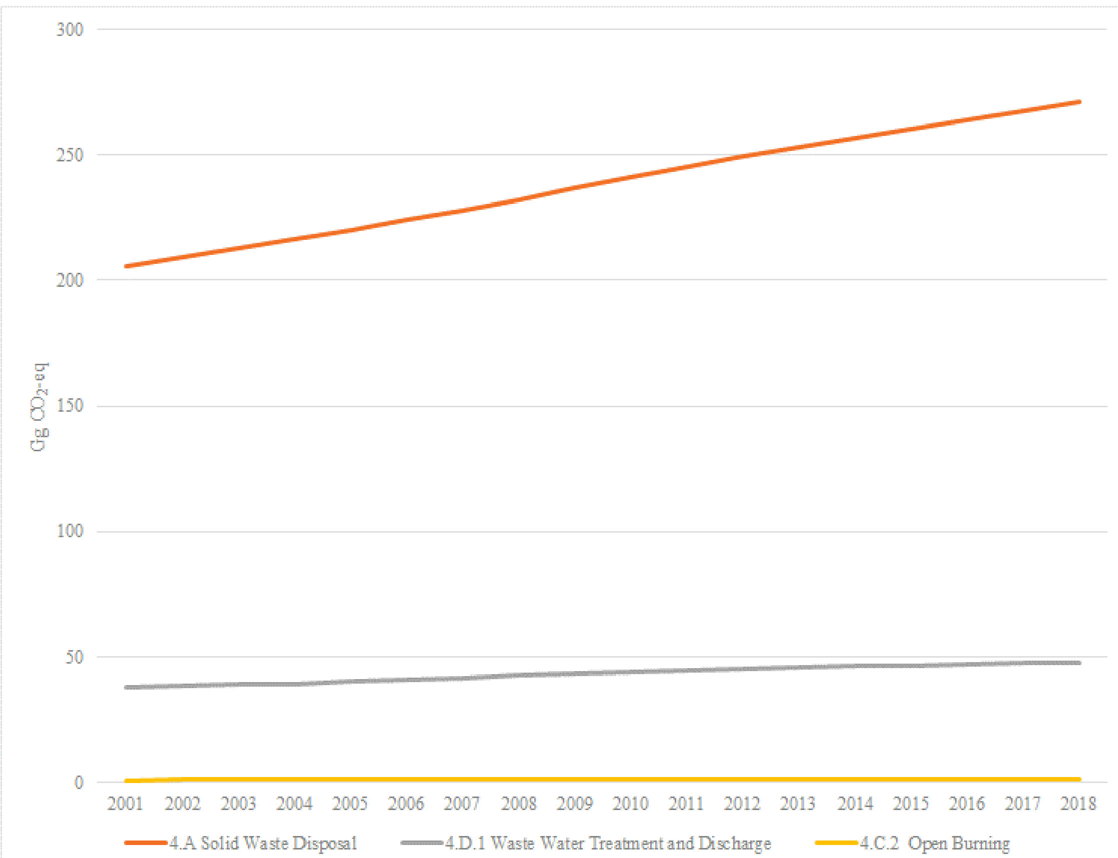
GHG emissions in the waste sector typically come from a number of sources related to the treatment of solid waste as well as the management of wastewater. With regards to solid waste, solid waste disposal (i.e., landfilling of solid waste) and, to a small extent, open burning of waste, take place in The Bahamas. One landfill is currently being converted to a managed form, while the remaining landfills are unmanaged. Biological treatment of solid waste does not take place. Large scale waste incineration does not take place in The Bahamas according to available information and expert judgement. The incineration of hazardous waste at smaller facilities, e.g. in hospitals, might take place according to expert judgement. Information on amounts of hazardous waste and treatment approaches could not be obtained, this is clearly an area for improvement.
On this basis, GHG emission estimates for the gases CO_2, CH_4, N_2O were compiled for the waste sector categories presented in Table 4 below.

Table 4: IPCC 2006 GL categories for which Waste GHG emissions were estimated

IPCC Category	Category Name
4.A	Solid Waste Disposal
4.C.2	Open burning of waste
4.D.1	Domestic Wastewater Treatment and Discharge

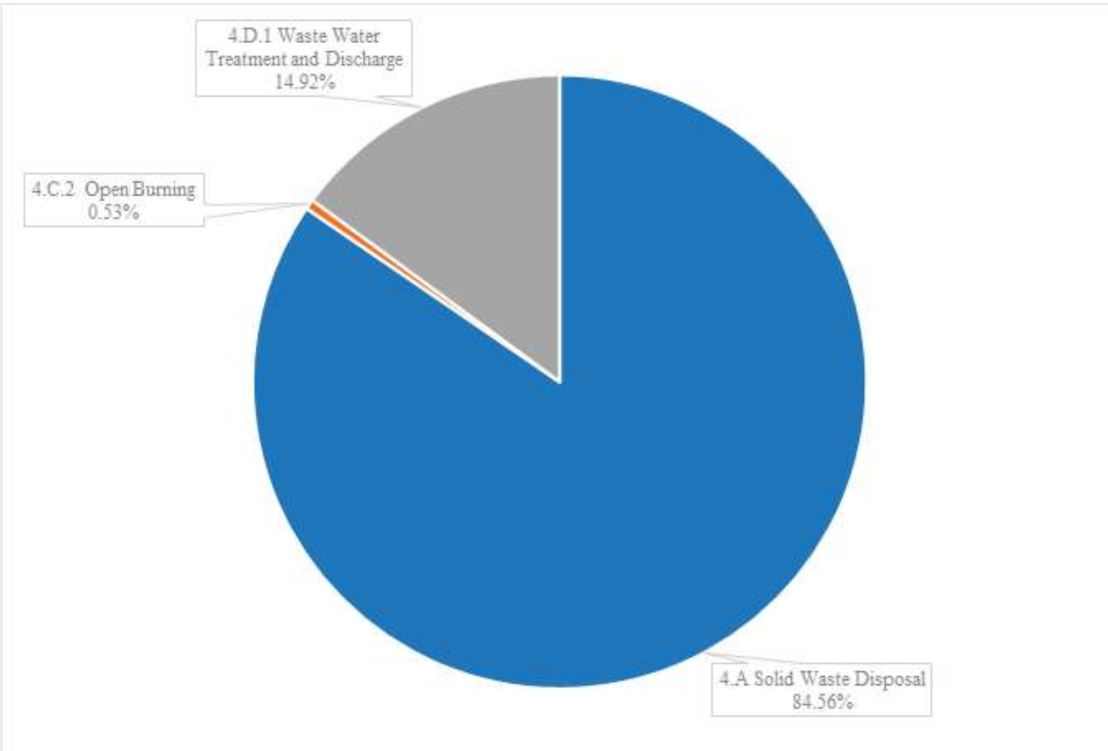
Total GHG emissions in the waste sector amounted to 245.20 Gg CO_2-eq in 2001 and 320.31 Gg CO_2-eq in 2018, see Figure 13. This represents an increase by 30.6 per cent. It is important to note that the calculation has heavily relied on IPCC default values and assumptions (e.g., waste generation rate, waste composition), so that the current estimations mainly reflect The Bahamas' population increase over the time series. Information indicating technological change and change in treatment approaches (e.g., moving from shallow to deep landfills over time) was not available. Generally, the increase in GDP and also tourism activity are likely to influence GHG emission developments in the waste sector, but are currently not reflected in the calculation. Annex II suggests improvements which would allow considering these drivers in the future.

Figure 13: Total GHG emissions in the waste sector 2001-2018, by categories



Total GHG emissions in the waste sector are dominated by the category solid waste disposal contributing 84.6 per cent in 2018. Wastewater treatment and discharge contribute 14.9 per cent and 0.5 per cent, see Figure 14. Between 2001 and 2018, the three subcategories show similar growth rates. GHG emissions from solid waste disposal grew by 31.6 per cent, from wastewater treatment and discharge by 27.4 cent and from open burning by 25.4 per cent.

Figure 14: Contribution of categories to total GHG emissions in 2018 in the waste sector



Planned improvements

During the compilation of The Bahamas' national GHG inventory, future improvement potential was identified and documented. The full list of improvements are presented in Annex III. The improvement options presented in the Annex differ in both their urgency and timeframes for which they could be implemented in. This chapter presents the improvements deemed most relevant, as they pertain to the set-up of a sustainable national GHG inventory system, the existing key categories, and the categories for which no or only limited activity data were available.

Table 5: Most relevant areas for improvement

Area	Most relevant areas for improvement
Cross-cutting	● Set up appropriate institutional, procedural, legal arrangements, and documentation for recurring preparation of the national GHG inventory ● Appoint a national GHG inventory compilation team ● Fully establish and implement QA/QC procedures for the national GHG inventory
Energy	● Ensure data on fuel imports compiled by the Central Bank of the Bahamas are complete and accurate ● Obtain disaggregated data of fuel imports (potentially with the help of fuel distributors) by relevant subcategories, e.g. manufacture and industries (1.A.2), commercial/institutional (1.A.4.a), and residential (1.A.4.b). ● Develop a national energy balance in the longer term ● Collect power generation and fuel consumption from local power producers (Bahamas Power and Light, Company Ltd. Grand Bahama Power Company) ● Develop country-specific emission factors ● Better understand which relevant manufacture and production activities take place and collect activity data ● Obtain complete activity data on vehicle population across the entire time series
IPPU	● Collect HFC and PFC import data (as substance and in products) ● Assess which IPPU categories occur (e.g. electrical equipment, category 2.G.1)
AFOLU	● Develop country-specific emission factors for categories 3.B.1.a-b, 3.B.2.b, 3.b.3.b, 3.B.4.b and 3.b.5.b

	• Establish and validate (i.e. ground-truth) a sample of permanent plots of each land use type (at minimum the main IPCC classes, especially pine and mangrove for forest land which are prominent in the Bahamas) to improve land classification maps and remote sensing model • Determine the occurrence of harvested wood products, biomass burning and mineral soils in the country • Determine the end use of fertilizers and other agricultural additives reported in the annually produced Customs Imports report with Agriculture experts • Conduct a survey of livestock in country, including livestock manure management practices on an annual basis, and align with National Agricultural Census cycle
Waste	• Collect information on the depth of landfills (one-time survey) • Assess solid waste generation and composition • Collect data from national food and beverage manufacturing companies on industrial wastewater flows

d) Mitigation actions and their effects, including associated methodologies and assumptions (BUR)

The purpose of this chapter is to discuss existing and proposed mitigation actions for five IPCC sectors (Energy, Industrial Processes and Product Use, Agriculture, Land Use, Land Use Change and Forestry, and Waste) in The Bahamas. Based on the latest inventory estimates, the majority of GHG emissions are contributed by two sectors; the Land Use, Land Use Change and Forestry and Energy sectors, which each account for over 45 % of the total emissions.

To address The Bahamas' GHG emissions, mitigation actions presented in this chapter were prepared based on desk reviews and consultations with key stakeholders in both the private and public sector. Many mitigation actions discussed in this chapter result in direct emissions reductions. Other actions, known as enabling measures, create opportunities for direct emissions reductions. These measures are policies or incentives whose implementation will indirectly lead to emission reductions.

In addition to GHG emissions reduction, the mitigation actions have many sustainable development benefits associated with the seventeen sustainable development goals (SDGs).

This chapter outlines a total of 35 mitigation actions and 6 enabling measures, with several being enhanced from the Second National Communication (SNC) or are newly proposed actions.

The actions are heavily focused on the energy sector, with over eighty per cent (80%) of the actions focussed on the subsectors of Energy Demand, Electricity Generation and Transport.

Examples of country-wide mitigation actions include increasing the use of solar water heaters by 40%, increasing sales of electric vehicles by 35%, lighting retrofits for all government occupied buildings in The Bahamas, and the phasing out of hydrofluorocarbons. While, examples of island specific mitigation actions include implementing sustainable agroforestry practices in Acklins, Andros, Crooked Island, Grand Bahama Plana and Samana Cays or the installation of a 3-megawatt solar farm in Grand Bahama.

Examples of enabling measures include upgrading incentives for renewable energy systems, implementing standards for vehicle fuel efficiency and the implementation of charging stations for electric vehicles. All of proposals in this chapter, whether a mitigation action or an enabling measure, are intended to achieve the goals of the Paris Agreement, to limit global temperature rise to 1.5℃, and enable The Bahamas to meet its 2030 NDC Targets.

This chapter provides two scenarios for mitigation actions and enabling measures. They are the mitigation and ambitious mitigation scenarios. Compared to a business as usual (BAU) scenario for 2030, the mitigation scenario reduces emissions by 16% and the ambitious mitigation scenario by 33%. Compared to the BAU for 2050, the mitigation and ambitious mitigation scenario reduce emissions by 18% and 63% respectively.

Where possible, this chapter models mitigation actions and estimates emission reductions in gigagrams of carbon dioxide equivalent. The total estimated reductions from modeled mitigation actions is approximately 4,170 Gg CO_2-eq

As a non-Annex 1 Party, The Bahamas was eligible to participate in the Clean Development Mechanism (CDM) under the Kyoto Protocol. There are currently no projects registered with the CDM or other international markets. Under Article 6, The Bahamas is interested in pursuing suitable, beneficial projects, in the International Markets and is also exploring opportunities in the Voluntary Carbon Market space.

e) Constraints, gaps and related financial, technical and capacity needs, including information on support received for preparation and submission on BUR

This chapter outlines constraints and gaps that has hindered complete and accurate UNFCCC reporting for The Bahamas. In preparation of this BUR, The Government of The Bahamas has focused on a review of the following:

- Constraints and gaps in GHG inventory, mitigation, adaptation, and climate finance reporting
- Prioritised needs and improvements to facilitate improved reporting for future cycles in adherence with the TACCC principles

The Bahamas, like most SIDS and other developing countries, faces challenges due to limited human, technical and institutional capacity while attempting to meet its reporting requirements to the UNFCCC and to implement planned and ongoing climate action activities. The Bahamas has shown its commitment to improvements, as outlined in the previous 4 chapters and in noting its challenges, will require both internal and external support to close these gaps.

Regarding GHG inventory, lack of adequate data, limited coordination for the GHG inventory cycle, capacity constrains in applying GHG inventory methodologies, limited understanding of all GHG emitting activities in country, and a lack of archiving previous reporting cycles were constraints and gaps observed in this reporting cycle.

Regarding Mitigation, lack of adequate data, willingness to supply data, intra-ministerial coordination and communication, high capital costs, and technology suitability/availability, and data transparency issues were constraints and gaps observed in this reporting cycle.

Regarding Adaptation, stakeholders with technical capacity constraints, intra/inter-organization coordination and communication, lack of adequate data, key equipment and regulatory frameworks, in addition to high capital costs were constraints and gaps observed in this reporting cycle.

While regarding MRV Assessment, intra-organizational coordination and communication, need for greater public awareness, limited staff and funding, stakeholder hesitation, and difficulty in collecting data were constraints and gaps observed in this reporting cycle.

Prioritized needs to address the above related constraints and gaps include, setting up appropriate intuitional, procedural, legal arrangements and documentation for the recurring preparation of reports for the UNFCCC, appointing a national GHG inventory compilation team, fully establishing and implementing the QA/QC procedures for the national GHG inventory (particular from the QA exercise conducted by the UNFCCC in January 2022), fully establishing data collection and archiving procedures for climate data, improving training and capacity, continuation of modelling done in country (i.e. LEAP), and ensuring all relevant agencies and industries are involved in continuous and open communication to enhance data collection/exchange and improve the timely production of climate reports.

The country has made good progress from its last reporting cycle to the UNFCCC, as outlined in Table 143 of Chapter 5 and identifying Environmentally Sound Technologies (ESTs) for the country to implement via a Technology Needs Assessment (TNA) project, to be concluded in the 2023. The TNA project has prioritized the following sectors: Waste, Forestry, Meteorology and Education.

While The Bahamas has not been able to conduct an assessment and quantification of supported needed during this reporting cycle, given the special circumstance of The Bahamas as a small island developing state across all areas of climate MRV in The Bahamas, technology transfer, capacity-building, and financial - support is needed as soon as possible.

Regarding support received, as highlighted in the climate finance section of the domestic MRV chapter (Chapter 2), The Bahamas through the GCF Readiness and Preparatory Support Programme, engaged in a project to develop a national database system for the

MRV of financial investments with specific emphasis on identified actions in The Bahamas' NDC.

After extensive analysis of readily available documentation and a data collection mission in-country (inclusive of stakeholder interviews), The Bahamas was able to provide an initial mapping of climate finance recipients, mobilising entities and support received values (USD) for the time period 2010-2020. It should be noted that due to data gaps from stakeholders, as well as the need to improve on the outputs of the project, will be improved upon in future reporting cycles.

A summary of The Bahamas climate finance inflows for the period 2010-2020 can be described as follows:

a) Overall climate finance inflows amount to approximately $155M USD
b) When the above figure is disaggregated into Mitigation focused activities, this amounts to over $140M USD, while Adaptation focused activities were funded approximately $15M USD.

This shows a clear imbalance in Adaptation vs Mitigation funding that has been called for by SIDS like The Bahamas, where the former is vital to improving the country's resilience to climate change.

Taking into account finance flows disaggregated by mobilizing entity during the 2010-2020 time series:

a) The Ministry of Environment has mobilized the largest amount of funds – as an in-country/national entity (approx. $56.5M USD). This is not surprising given that the Ministry contains the Department for which Multilateral Environmental Agreements are executed (the DEPP).
b) The largest out of country entity, mobilizing funds for The Bahamas is the UN Environment Programme (UNEP), with approximately $89.2M USD.

Regarding preparation of the BUR, The Bahamas received multilateral financial support from the GEF in 2019 in the amount of 852,0000 (USD) to develop its first BUR (in addition to its Third National Communication). The funding was administered through the Global Environment Facility (GEF) with UNEP having the responsibility as the implementing agency, and the DEPP serving on behalf of the Government of The Bahamas, as the executing agency. The funding was used to contract members of the PMU, consultants and auditors to ensure the production of a high-quality document and proper fiscal management of donor funds.

Chapter 1 – National Circumstances

Introduction

The Commonwealth of The Bahamas is recognized as one of the most vulnerable countries in the world to climate change. The country was ranked third of most affected countries in 2019 with a Climate Risk Index of 6.5 and losses per unit GDP of 31.59% (Eckstein et al, 2021).

The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) provides evidence that the global climate is changing (Nurse et al 2014), and that Small Island Developing States (SIDS), like The Bahamas, are on the frontline of these changes; the economic cost of adapting to the impacts of climate change is high. Global Circulation Model (GCM) projections from a 15-model ensemble indicate that The Bahamas may experience the following impacts:

- *"Temperature rise*: The Bahamas may experience warming of mean annual temperature of between 0.8°C to 1.9°C by the 2050s and 1.0°C to 3.2°C by the 2080s, relative to the 1970-1999 mean. The ranges reflect minimum and maximum projections under three emissions scenarios (A2, high emissions; A1B, medium high emissions; and B1, low emissions) from the Special Report on Emissions Scenarios (SRES). The rate of warming is expected to be pronounced year-round, but particularly significant in the summer months (June-August).

- *Changing precipitation patterns*: GCM projections of future precipitation for The Bahamas span both overall increases and decreases, but tend towards decreases in most models. Projected change in mean annual precipitation range from -20 mm per month to 15 mm per month across the SRES A2, A1B and B1 emissions scenarios. The more recent Representative Concentration Pathways (RCPs) scenarios were used in the IPCC's Working Group I AR5 report, which project that warm/wet season (summer) precipitation will likely decrease in the Caribbean region over the coming century (Nurse et al, 2014). This is consistent with other recent assessments that predict declining annual average precipitation across the Caribbean, with the most pronounced drying during the wet season from May to October. In addition to the overall drying trends, recent models also predict that The Bahamas and other Caribbean countries will have to grapple with increasingly intense precipitation events (Taylor et al, 2018).

- *Increasing intensity of tropical storms*: Climate modelling of projected changes in tropical storms is associated with high uncertainty; however, both the IPCC AR4 and AR5 reports conclude that projections suggest little change in tropical storm frequency, but a likely increase in intensity of tropical storms making landfall in the Caribbean. Some recent models suggest that over the coming decades, rainfall associated with tropical cyclones could increase by 20-30% (near centre of the storm) and 10% at radii of 200km or greater, and that maximum winds speeds could increase by 2-11% (Taylor et al., 2018)".

1.1 Geography

The geography of The Bahamas contributes to its vulnerability. Geographic characteristics of the country include low relief with generally flat terrain and elevations of less than 32 feet (10 metres). 80% of the land lies less than 1.5 metres above sea level and as such, is vulnerable to floods cause by sea level rise and storm surges due to hurricanes (World Bank Group, 2021). A higher coast ridge occurs on most islands, usually located on the exposed side. Islands of the southeast and central Bahamas are generally of higher elevation than islands in the northern Bahamas. The highest elevation in the country is Mount Alvernia on Cat Island which is approximately 211 feet (64 metres).

1.2 Geology

The Bahamas archipelago is situated in the western North Atlantic and is comprised of extensive carbonate islands and shallow banks. There are 29 large islands, over 600 small cays, and more than 2,000 rocks, all low-lying. The surface deposits of archipelago are of Late Quaternary limestones from a glacioeustatic sea-level highstand position; a depositional record of platform flooding and carbonate sediment production. Simply put, alternating glacial expansions and retreats created vast changes in sea levels across geologic time, allowing for the formation of the islands. The islands are tectonically stable, consisting of carbonate sediments with interspersed paleosols (Mylroie, 2016).

With geologic origins that are biogenic and completely carbonate, The Bahamas differs from other islands in the region. The islands rest on shallow water banks which are primarily composed of calcium carbonate sediments. These limestone sediments were created from rapidly growing marine life which extracted calcium carbonate from seawater creating voluminous depositions of sand and mud. The Bahamas consists of eight carbonate banks with the north and central islands resting on two of these banks. New Providence, centrally located, is part of the largest formation – the Great Bahama Bank. The banks are separated by a series of deep-water channels upon which the islands occur unevenly usually on the margins of the larger and in the center of the shallower banks.

Oolitic sands have also contributed to the geologic development of the islands, specifically during the last ice age when sea levels were significantly lower. It was during that time period that oolitic sand dunes hardened and when sea levels rose, the rock ridges formed by these dunes became islands along the edges of the shallow banks.

Another source of islands in the archipelago are limestone rocklands, which were formed from the seabed when sea levels were at their highest. As sea level declined, the exposed seabed underwent erosion and weathering. The resulting formation was rocklands. Rocklands make up the broader islands in the archipelago (such as Andros and Grand Bahama) and oolitic sand dunes are represented in thin long islands (for example, Long Island and Cat Island).

Soil composition in the archipelago consists of organic and inorganic materials and the young age of the soil is reflective of the geologically young age of the limestone. Soils layers are typically thin and usually arranged in one or two layers above bedrock. Three soil types are recognized throughout the islands: organic, red clay, and sedimentary soils. New Providence is primarily made up of organic soils, which is the most common soil type in the archipelago (Currie, 2019).

The dry nature of the soils in The Bahamas means that they are particularly vulnerable to temperature increases and decreasing rainfall.

1.2.1. Hydrogeology

In The Bahamas, the physical geology, hydrogeology, water resources, and coastal zone are diametrically linked, as there are no true rivers in The Bahamas. The sole natural means of recharge for the underlying 'freshwater resources' is via rainfall.

The groundwater resources of The Bahamas are comprised of the fresh, brackish, saline and hyper-saline waters found in the subsurface and in the lakes and ponds that intercept the land surface. There is a direct connection between the landform and the marine and coastal environment, which are separated by a typical mangrove vegetation buffer on the protected coastal flats.

The freshwater resources occur as three-dimensional lens-shaped bodies, which overlie brackish and saline water. All freshwater in The Bahamas is as a result of rainwater that penetrates the ground surface.

Generally, there is no place on the islands that groundwater cannot be met in holes that penetrate 10 ft (3 m) below sea level. Water is typically encountered in the range 0 to 3 ft (0 to 0.9 m) above sea level. Tidal action induces an up and down movement to the entire groundwater table ranging from negligible amounts to about 3 ft (0.9 m). The effect of tides usually decreases inland, but may be substantial if an established cavern or other large opening directly connects an inland area to the sea. In many places inland, rise and fall of the water table is less than 1 ft (0.3 m).

The typical normal water table elevations are estimated at 3 to 5 ft (0.9 to 1.5 m) below ground level. Seasonal high-water table elevations can range from 1 to 3 ft (0.3 to 0.9 m) below ground level. During certain storm periods, the water table elevation can be above ground for a period (“perennial wetland areas”), but dissipates following the storm period. The main freshwater aquifer in The Bahamas occurs in the ‘Pleistocene Age’ formations named the Lucayan Limestone, from approximately 3 to 130 ft (1 to 40 m) below ground level (BGL). Younger Holocene deposits can contain freshwater, but freshwater is not present in older deposits beyond 150 ft (45 m) BGL (Cant & Weech, 1986).

Groundwater saturates the rock and all its pores, fissures and interconnected cavities. The size, shape and orientation of the island, the subsurface geology and the amount of rainfall control the shape size and thickness of the freshwater bodies. In excess of 90% of the freshwater lenses are within five feet of the surface.

Due to climate change, The Bahamas will face several challenges with respect to its water security. These include (MOEH & CDB, 2017):

- *Declining freshwater availability:* With declining average precipitation in the wet (summer) season, increasing temperatures throughout the year (thus increasing evaporation and evapotranspiration) and a potentially longer and drier dry (winter) season, the frequency of droughts is expected to increase and the availability of freshwater is likely to decline. These challenges will be particularly pronounced for the southernmost islands, which already have more limited freshwater supplies due to the tendency for precipitation to decline from north to south in the archipelago. At the same time, the prospects for expanding water supply through seawater reverse osmosis (SWRO) is somewhat constrained. SWRO provides more than 50% of The Bahamas potable water supply, but comes from groundwater sources due to limitations set on marine environment abstractions. Although SWRO will continue to form an important part of the country’s system and efforts to safeguard water security, these regulations limit the extent to which the country can depend on SWRO – a reality that reinforces the need to pursue other solutions in parallel.

- *Increasing contamination of freshwater:* Compounding the challenge of declining freshwater availability is the fact that climate change will increase contamination of freshwater in The Bahamas. Increasingly intense precipitation events and tropical storms, coupled with sea level rise, are expected to increase the frequency and intensity of floods in The Bahamas. This is expected to increase turbidity and the rate at which pollutants contaminate the islands' groundwater lenses which (due to their shallow nature) are highly vulnerable to anthropogenic pollution. Further exacerbating this dynamic is the fact that increasingly intense extreme weather events may damage wastewater treatment and collection systems, flood septic tanks and thereby also increase the risk of contaminated groundwater. Previous flooding in The Bahamas resulted in contamination of the soil and groundwater with seawater, sewage, petroleum and agricultural pesticides – occurrences that could become more pronounced as climate change progresses. Furthermore, The Bahamas is already grappling with sea level rise that is causing saline intrusion of aquifers. These challenges could become increasingly difficult to manage as sea levels continue to rise over the coming decades.

- *Negative impacts on critical water infrastructure:* More intense hurricanes and other extreme weather, as well as heavier precipitation events, are expected to inflict significant damage on water storage, treatment and distribution infrastructure in The Bahamas. This may disrupt efforts to reliably distribute water to end-users throughout the country. This may also increase leakage rates precisely as the country is grappling with declining freshwater availability. The Government is currently working to reduce non-revenue water (NRW) rates in recognition of the fact that this constitutes an effective way to address looming water supply shortages.

Table 6 details freshwater availability per island in The Bahamas.

Table 6: Freshwater resources in The Bahamas

Island	Size (Acres)	Freshwater Lens (Acres)	LensArea/Size	Max. Daily Abstraction (MIG)	Water Available (IG/D) Person 1990 Census	Total Population 1990 Census
Abaco	415,360	116,280	0.28	79.10	7.906	10,003
Acklins	96,000	15,783	0.16	4.36	10,765	405
Andros	1,472,000	338,585	0.23	209.92	25,672	8,177
Bimini	7,040	395	0.06	0.17	104	1,639
Cat Island	96,000	14,774	0.15	6.80	4,005	1,698
Crooked Is.	58,900	5,923	0.10	1.74	4,223	412
Eleuthera	128,000	16,599	0.13	8.13	768	10,584
Exumas	71,680	6,586	0.09	2.90	816	3,556
Grand Bahama	339,200	147,884	0.44	93.17	2,278	40,898
Gt, Inagua	383,360	3,571	0.01	0.86	873	985
Long Island	147,200	9,301	0.06	2.88	977	2,949
Mayaguana	70,400		0.03	0.65	2,083	312
New Providence	51,200	2,340	0.34	9.63	60	172,196
TOTAL	**3,336,340**	**695,524**	**0.208**	**420.31**	**60,530**	**253,814**

Source: Water & Sewerage Corporation, 2007

1.3 Climate

The climate of The Bahamas is tropical marine, wet and dry with winter incursions of modified polar air from the North American continent (Bahamas Department of Meteorology, 2021).

The Bahamas Department of Meteorology (2021) characterizes the trade wind flow as “the single most important climatic agent affecting The Bahamas”. The trade wind is generated by the quasi-permanent Bermuda Azores anticyclone, which is a large area of high atmospheric pressure, covering part of the subtropical north Atlantic Ocean. The trade winds blow at an average speed of 8 knots, mainly from the east and southeast during the months of May to September and mainly from northeast and east during the remaining months. The trade winds are “relatively dry and yield fair-weather cumulus clouds with long period of bright sunshine, broken from time to time by weather systems” (Bahamas Department of Meteorology, 2021).

Summer conditions

“During the summer months, temperatures reach 32 degrees Celsius (90 degrees Fahrenheit) by day and afternoon showers or thunderstorms occur for up to an hour; [the latter] may be widespread and more prolonged when developing weather systems are affecting the islands. These systems include migratory areas of persistent rain, tropical waves and tropical cyclones. These latter may be tropical storms with winds up to 63 knots (73 miles per hour), or hurricanes with stronger winds.” (Bahamas Department of Meteorology, 2021).

Winter conditions

“From about late October through April into early May, the trade winds flow from the east and northeast is interrupted by cold fronts which move south and southeast over North America into The Bahamas, followed by cold polar air and strong northwesterly breezes. In winter months, periods of a day or two of north and northeast winds of about 25 knots may occur. Winds gradually slacken as they shift through northeast, and return to east, their normal direction, over a varying period of up to four days.

Temperatures fall soon after frontal passage, sometimes going as low as the upper forties Fahrenheit, but gradually warm up as the wind returns to its normal easterly direction. These cold fronts from the leading edge of bursts of polar air from the continent and are the main winter feature. This cold air is modified as it traverses the warm Gulf Stream and ambient Bahamian waters, which save The Bahamas from the full frigid blast of the North America winter.

Although cold fronts can yield much rain, they pass through these islands once every five days and therefore the rainfall in winter is scant; the dry season is from November to April. January the driest month for New Providence has an average of 1.86 inches (47.24mm) of rain.” (Bahamas Department of Meteorology, 2021).

1.3.1. Weather conditions

Temperature

"In centrally situated New Providence, winter temperatures seldom fall much below 60°F and usually reach about 75°F in the afternoon (the lowest recorded temperature was 41.4°F on 20 January 1981). In summer, temperatures usually fall to 78°F or less at night, and seldom rise above 90°F during the day. Winter temperatures are lower in more northerly islands than in New Providence, and about five degrees higher than in the south. In summer, temperatures tend to be similar all over The Bahamas. Winds are predominantly easterly throughout the year, but there has been a tendency to become northeasterly from October to April and southeasterly from May to September" (Bahamas Department of Meteorology, 2021).

The CMIP5 models included in the IPCC's Fifth Assessment Report (AR5) projected the mean annual temperature to increase by 0.8 - 2.3°C by the 2060's and 1.2 - 2.5°C by the 2090's (Nurse et al, 2014). Projected rate of warming is most rapid in the summer from June-August and September - November. Substantial increases in the frequency of 'hot' days and nights and decreases in the frequency of cold days and nights are projected to occur, with the most rapid changes occurring in the June - August period.

Rainfall

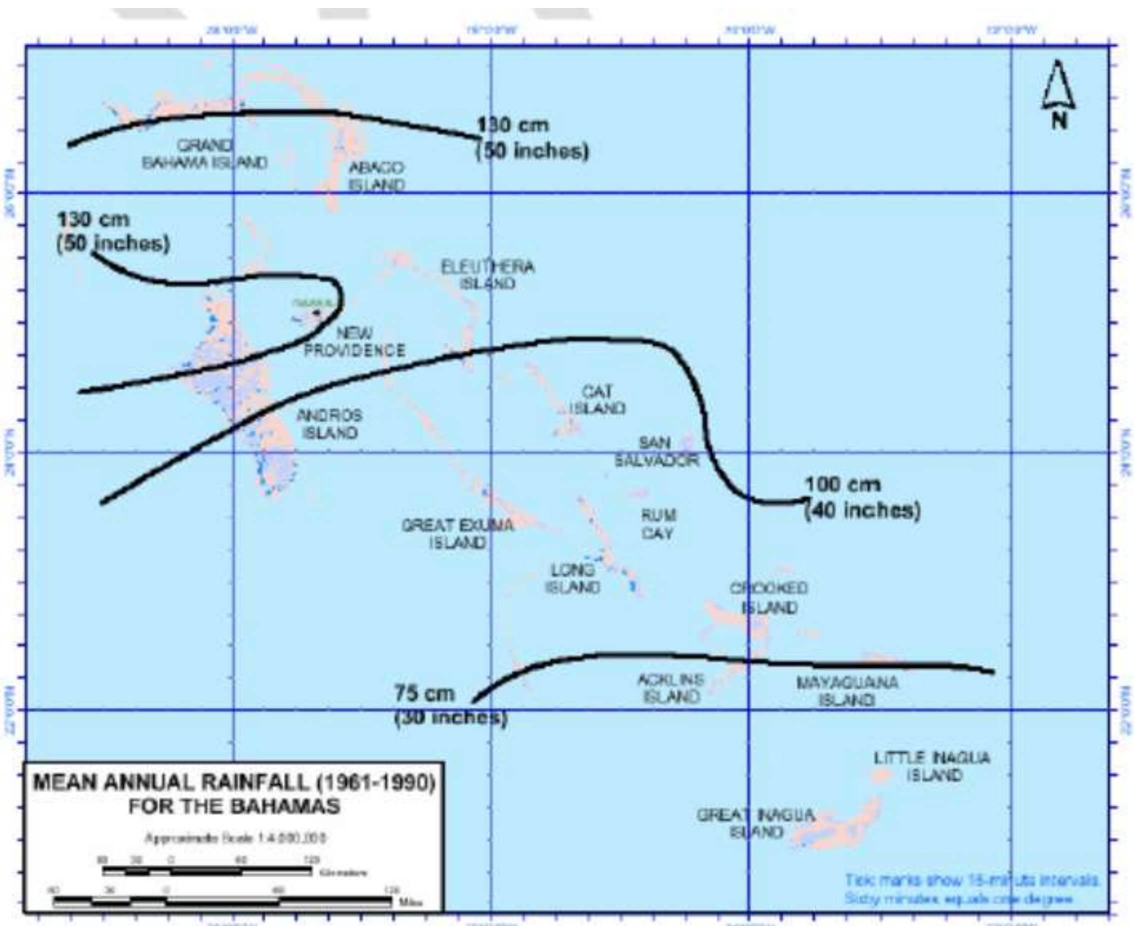
Rainfall is unevenly distributed across The Bahamas.

Figure 15 shows the distribution of rainfall for The Bahamas.

The north and north central Bahamas receive annually some 50 to 60 inches (1270 to 1524 millimeters) of rainfall annually, while in the southeast Bahamas, the rainfall decreases to some 36 inches (914 millimeters) annually. Moving across the archipelago, the average annual rainfall varies from about 60 inches (15.24mm) per year at Abaco in the northwest to less than half this amount at Inagua in the southeast.

There is a distinct dry season (November to April) and a pronounced wet season (May to October). The seasonal effects of tropical cyclones have a pronounced effect on annual rainfalls across The Bahamas. Additionally, winter storms flowing off the North American continent also impact rainfall during the normally dry period. However, this effect rarely extends into the central and southern Bahamas.

Figure 15: Mean annual rainfall for The Bahamas



Rainfall projections indicate decreases in rainfall for The Bahamas, mainly due to decreases in rainfall during the March-May and June-August periods. The decreases in the months from March to August however are partly offset by overall increases in rainfall in the September-November period.

The risk of drought increases along a southeastern gradient since the more southern islands already experience only half of the rainfall that falls in the more northern islands.

Additionally, since the weather of The Bahamas is influenced by ENSO events, the likelihood of drought is increased if El Nino episodes become more frequent and/or intense.

1.3.2. Hurricanes and other extreme events

Natural hazards to the country are tropical storms (including hurricanes), lightning, tornado and droughts. These are the extreme events that would cause major losses in the future in The Bahamas. There are other natural phenomena that have lower probability of affecting the country, such as floods and storm surge, but these can also result in significant local damage.

The Bahamas has a history of suffering major impacts from destructive storms and hurricanes. From 1871 to 2000, 186 hurricanes and 86 tropical storms passed within 160 km of The Bahamas (BEST Commission, 2014).

Hurricanes Maria and Irma in 2017 and Dorian in 2019 (a Category 5 Hurricane) have caused significant loss of life, evacuation of affected islands and damage to infrastructure and the economy in billions of dollars. Hurricane Dorian alone is estimated to have caused over US$ 3 billion in damages. These hurricanes happened shortly after Hurricanes Joaquin (2015) and Matthew (2016) which also inflicted significant damage on The Bahamas. Hurricanes have had dramatic negative impacts on economic development across The Bahamas (as outlined in Table 7)

During Hurricane Dorian, the wind speeds were up to 220 mph with gusts of 310 mph, Dorian decimated the islands of Abaco and Grand Bahama. In January 2020, the Government of The Bahamas reported the official deaths from Dorian as 71 persons and 282 persons missing. According to the official Census 2010, the islands of Abaco and Grand Bahama are home to approximately 17,000 and 51,000 residents respectively.

According to Shelter Cluster Bahamas, it is estimated that 9,000 homes were affected. Damage to the housing sector is estimated at US$1.48 billion, 88.9% of which took place in Abaco. The Ministry of Housing and Environment issued a Prohibition to Build Order for the Mudd, Pigeon Pea, Sand Bank and Farm Road shanty towns located on the island of Abaco, where a large number of vulnerable, irregular migrants used to live.

Table 7: Hurricanes impacting The Bahamas 2015 – 2019

Name of Hurricane	Active dates	Category	Estimates of loss and damage (US$)
Joaquin	28 Sep – 15 Oct 2015	4	120+ Million
Matthew	28 Sep – 10 Oct 2016	4	600 Million
Irma	30 Aug – 13 Sep 2017	5	135 Million
Dorian	24 Aug – 8 Sep 2019	5	3.4 Billion

Sources: NOAA, 2021; Bahamas Department of Meteorology, 2016; IADB, 2019; MOEH, 2018

1.3.3. Sea level rise

Sea level rise (SLR) and other oceanic climate change will result in salinization, flooding, and erosion. SLR will also affect human and ecological systems, including health, heritage, freshwater, biodiversity, agriculture, fisheries and other services. Increased heat in the upper layer of the ocean is also driving more intensive storms and greater rates of inundation, which, together with SLR, are already driving significant impacts to sensitive coastal and low-lying areas.

By the end of the 21st century, it is very likely that sea level will rise in more than about 95% of the ocean area and about 70% of the coastlines worldwide are projected to experience a sea level change within ±20% of the global mean (IPCC Global Warming of 1.5 °C Report, 2018).

1.4 Governance in The Bahamas

A sovereign nation since 1973, The Bahamas has a democratic, Parliamentary system of governance. The Head of State (King of England) is represented by the Governor-

General and the Government comprises the Executive Branch with the Prime Minister, the Attorney-General and at least seven other members. The other Cabinet Ministers and Ministers of State are responsible for running their Government ministries.

1.4.1. National government

Parliament constitutes the Legislative Branch and is a two-chamber system based on the Westminster model, with a House of Assembly and a Senate. There are currently 39 seats in the House of Assembly and 16 members of the Senate.

The Judiciary comprises the Court of Appeal and the Supreme Court. They function as independent institutions under the Constitution and are not Government departments.

1.4.2. Local government

Each island, with the exception of New Providence, is divided into Local Government districts under the Local Government Act 1996. There are 32 Local Government districts. Local elections are held every three years.

Local Government districts do not have revenue-raising powers; they receive transfers from Central Government. Their responsibilities include supply of potable water by standpipes, upkeep of public schools and other public buildings as well as general health and sanitation.

1.5 Population

The most recent published population census was in 2010. Approximately 30 of the over 700 islands are inhabited. The population of The Bahamas was estimated to be approximately 295,000 in 2000, growing at a rate of just over 1%. By 2010, The Department of Statistics recorded that the population growth increased to approximately 351,471 persons in The Bahamas. The key demographic indicators for 2020 and 2025 are outlined in Table 8 (Bahamas Census, 2010).

Table 8: Key Demographic indicators for The Bahamas 2020 and 2025

Demographic Indicator	2020 Projection	2025 Projection
Total population	389,410	408,930
Average annual growth rate	1.02	0.92
Number of births	6,040	6,260
Number of deaths	2,470	2,800
Natural increase	3,570	3,460
Total immigrants	400	300

Most of the population lives in urban areas, with two-thirds living on New Providence Island where the capital city of Nassau is located.

1.5.1. Living conditions

According the 2013 Bahamas Household Expenditure Survey, 58.5% of the dwellings in The Bahamas are separate, detached houses (houses that did not share walls, roofs, or floors with other houses). The second most significant type of dwelling is single, attached houses (24.8%), while apartments or flats account for 15.1% of total dwelling units. In New Providence, there is a higher proportion of separate, detached houses (27.3%) and of apartments or flats (16.5%), while in Grand Bahama and Family Islands is significantly higher the proportion of separate, detached houses (66.8% and 70.2%, respectively).
There seems to be a positive relation among the percentage of households living in separate detached houses and the level of per capita consumption of the quintile: the proportion of households living in separate detached houses tends to increase when consumption level grows.

The average number of rooms of a Bahamian dwelling is 4.2, with 2.6 bedrooms. Dwellings in Grand Bahama have, on average, more rooms (4.5), while the opposite is true for dwellings in Family Islands (3.9). The numbers of rooms in the dwelling increases as the level of per capita consumption expenditure of the household increases. Over fifty-night percent (59.2%) of the households in The Bahamas have access to public water piped into the dwellings, and 33.1% have a private source of water piped into the dwelling.

At the regional level there are some differences: in Grand Bahama the percentage of households with public water piped into the dwellings is 94%, but in New Providence and Family Islands this percentage decreases to 52% and 59%, respectively.

Regarding the access to lighting, the information presented shows that electricity is the main lighting source (98%). The rate of coverage is almost the same as the national level in New Providence and Grand Bahama, but in the Family Islands, the rate of coverage is lower (96%). Electricity is the main source of lighting for households across all consumption quintiles. However, a significant proportion (almost 8%) of households in the poorest quintiles tends to use kerosene, oil or gas lamp as source of lighting.

At the national level, 74% of the households have toilets attached to a cesspit or septic tank and for 14% of the households the toilet is linked to public sewer. Only 0.6% of households report having no toilet.

The three most important expenditure items for total population, in terms of its budget share, are the following:

- housing, water, electricity, gas and other fuels (46.7%);
- transportation (13.8%); and
- food and non-alcoholic beverages (11.9%).

For the poorest 10% of the population, the budget share of food and non-alcoholic beverages climbs to 24.7%, while the budget share of transportation decreases to 7.4%. The overall poverty rate in The Bahamas is 12.5 %. New Providence and Grand Bahama present similar or lower poverty rates (respectively 12.4% and 9.4%) whereas Family Islands have a higher rate (17.2%). Hence, poverty rates are higher in rural communities. However, the majority of the poor (71.5%) are located in New Providence (Bahamas Household Expenditure Survey, 2013).

1.5.2. Migration trends due to hurricanes and other extreme events

All the major hurricanes in the past 7 years have resulted in displacement of people. As of January 2020, the International Organization for Migration (IOM) estimated that 2,000 internally displaced people were still residing in collective centres, rental apartments and with host families in New Providence following Hurricane Dorian.

The Internal Displacement Monitoring Centre (2020) estimated that 9,840 people were displaced due to Hurricane Dorian. The majority of persons displaced were from the islands of Abaco and Grand Bahama, which were hardest hit by the storm. Most of them were evacuated to New Providence, while approximately 500 went to Eleuthera; some migrated to the United States and Canada with the help of extended family members. According to the Miami-based Consul General of The Bahamas, an estimated 650 people now reside in Florida.

Two months following Dorian, 3,142 displaced people returned to Abaco. The majority were men who returned to their home communities where they lived in tents and began clean-up and reconstruction efforts (IDMC, 2020).

1.6 Economy

The economy of The Bahamas is primarily dependent on tourism and financial services. Tourism accounts for approximately 50% of GDP; financial services account for about 15% of GDP (Government of The Bahamas, n.d.). Manufacturing and agriculture contribute approximately 7% of GDP. Public debt increased in 2017 largely due to hurricane reconstruction and relief financing.

Due its heavy reliance on tourism, the country is vulnerable to changes in the global economy. The 2017 assessment by the Central Bank of The Bahamas showed very mild growth of the economy. The country's GDP was US$12.16 billion in 2017 with tourism accounting for more than 50%, financial services about 20% and the balance spread among retail and wholesale trade, fishing, light manufacturing and agriculture. The Bahamian tourism infrastructure supports approximately 1.5 million stopover visitors and 3.5 million cruise visitors annually. Just under 50% of the labour force is directly employed in tourism. When one adds persons indirectly employed, this increases to 70%.

Most of the infrastructure and settlements of the islands are located along or near to the coast where they are particularly vulnerable to flooding and sea level rise which will have serious economic and social implications for residents and for sectors of the economy, particularly the tourism sector.

Table 9 provides information on GDP per capita since 2000 along with unemployment rates. Table 10 provides nominal GDP by island with percentage change from 2015 – 2019. Of the 2019 GDP of $13,578 billion in nominal (current) dollars, New Providence represented $10.114 billion (74%), Grand Bahama $1.876 billion (14%) and other Family Islands grouping, the remaining $1.588 billion (12%). The high percentage for New Providence was primarily due to high levels of construction and tourism activity as well as gains in economic activity, stemming from the relocation of persons from hurricane-affected islands to the capital. Grand Bahama's overall increase in 2019 was supported by increases in contribution from construction, accommodation, and food services sectors.

Table 9: The Bahamas unemployment rate and GDP per capita

Year	**Unemployment rate**	**% change**	**GDP per capita, current prices**	**% change**
2000	7	-10.21%	25823.64	4.79%
2001	6.9	-1.43%	26682.62	3.33%
2002	9.102	31.91%	27436.9	2.83%
2003	10.835	19.04%	27206.74	-0.84%

2004	10.202	-5.84%	27802.01	2.19%
2005	10.17	-0.31%	29249.63	5.21%
2006	7.628	-25%	30518.48	4.34%
2007	7.853	2.95%	31412.35	2.93%
2008	8.703	10.82%	30914.64	-1.58%
2009	14.246	63.69%	29510.23	-4.54%
2010	15.082	5.87%	29978.72	1.59%
2011	15.889	5.35%	30452.46	1.58%
2012	14.367	-9.58%	31641.21	3.9%
2013	15.782	9.85%	31710.07	0.22%
2014	14.636	-7.26%	31905.94	0.62%
2015	13.379	-8.59%	32224.26	1.0%
2016	12.15	-9.19%	31672.41	-1.71%
2017	10.1	-16.87%	32376.79	2.22%
2018	9.2	-8.91%	33494.19	3.45%
2019	9.046	-1.67%	34421.23	2.77%

Source: International Monetary Fund, 2019

Table 10: Nominal GDP by Island 2015 – 2019 (in B$ Million)

ISLANDS/YEARS	2015	2016	2017	2018	2019
New Providence	8,258	8,524	8,950	9,513	10,114
NP % change		3.2%	5.0%	6.3%	6.3%
% of Total GDP	71%	71%	72%	73%	74%
Grand Bahama	1,980	2,025	2,008	1,833	1,876
GB % change		2.3%	-0.8%	-8.7%	2.3%
% of Total GDP	17%	17%	16%	14%	14%
Family Islands	1,473	1,380	1,533	1,676	1,588
FI % change		-6.3%	11.1%	9.3%	-5.2%
% of Total GDP	13%	12%	12%	13%	12%
All Bahamas	11,711	11,929	12,491	13,022	13,579
All Bah % change		1.9%	4.7%	4.3%	4.3%

Source: Bahamas Department of Statistics, 2019

1.6.1. Energy

The electricity and transport sectors are the main users of fossil fuels in the country. The two major utility companies in the country, Bahamas Power and Light Company Limited (BPL) and Grand Bahama Power Company respectively generate 438 MW and 98.5 MW of power (Bahamas National Energy Policy, 2013).

The high dependency on imported oil, almost 100%, has made energy production in The Bahamas vulnerable to global oil price fluctuations, making budgeting and reinvestment into equipment difficult for state-owned electricity company, Bahamas Power and Light Company Limited (Holdom, 2019), as well as other energy providers. This has resulted in significant debt to BPL and the reliance on price increases to maintain its service.

For renewable energies to supply more than 20% of The Bahamas' power needs, different islands must be interconnected to enable electricity to flow between them. This was the recommendation from the National Energy Policy Committee's second report presented to the Government in April 2011 that also urged the Government to focus on deploying water heaters, bio-energy and nearshore wind power as renewable energies in the short-term.

The Bahamas National Energy Policy 2013 – 2033 was designed to ensure that by 2033 The Bahamas has "a modern, diversified and efficient energy sector, providing Bahamians with affordable energy supplies and long-term energy security towards enhancing international competitiveness and sustainable prosperity".

In an effort to achieve the targets set by the Policy, the Government has developed and implemented a number of projects including:

- **Ragged Island Microgrid** – A hybrid solar-battery microgrid coupled with an existing diesel plant is being developed on Ragged Island for power generation. Previous power generation was approximately 100% diesel. Once completed, the capacity of the microgrid will be 402 kW.

- **Solar car park** – A 925 kW-solar array has been installed at the Thomas A. Robinson Sports Centre car park. The installation is estimated to displace 310,000 litres of diesel and offset 856 tonnes of carbon dioxide annually. The system has been designed to withstand extreme weather conditions with winds of up to 160 mph. The power generated at the facility feeds into the national grid and also provides power to charging stations for electric cars free of charge to the public (The Tribune, 2019).

Other mitigation measures are further outlined in the Chapter 4 of this BUR1.

1.6.2. Transport

The Bahamas has 13 international airports and numerous smaller Government-owned and private airports with regularly scheduled flights across the island chain and to various parts of the world. 23 seaports span the archipelago, facilitating regular shipping connections to Europe and the Americas. The ports in Nassau and Freeport are major international transshipment centres, servicing both tourism and commerce.

Electric vehicles (EVs) sales have continued to increase annually in The Bahamas. From 2019 to 2020, there was a 133% increase in sales and sales for 2021 are on track to be higher (Tribune, 2021). Tax incentives for purchasing electric vehicles include lower import duty of 10% (for EVs under $70,000) and 25% (for EVs over $70,000) compared to vehicles powered by fossil fuels. Government agencies, including BPL, have also begun transition to include electric vehicles as a part of their vehicle fleet.

1.6.3. Water

In general, water resources vary between islands and the supply-demand balance is highly dependent on population density. New Providence, which is the main population centre, has far less water available in freshwater lenses than is needed, and therefore relies heavily on reverse osmosis plants. Although there is not yet a net shortage of water on many islands, the population centres on each island have a major deficiency.

The Water and Sewerage Corporation (WSC) is the country's main water supplier; the Corporation is owned by the Government and falls under the portfolio of the Ministry of

Works and Utilities. The Water and Sewerage Corporation Act of 1976 established WSC and defines the responsibilities of the Corporation. WSC has a Water Resource Management Unit (WMRU) to manage water resources and water quality.

The water sector is identified as a national priority for climate change adaptation in the first Nationally Determined Contribution (NDC) for The Bahamas, and previously in the National Climate Change Adaptation Policy.

Agricultural practises have negatively impacted the water quality of The Bahamas. Studies on water quality have found traces of pesticides within the available freshwater. Floods are a particular problem in agricultural landscapes due to the erosion of the topsoil and the flushing of pesticides, fertilisers, animal waste and sewage into water sources. There is also increasing evidence of contaminants such as hormones, endocrine disruptors and drugs in the water supply. To safeguard water security in a changing climate, it is essential that The Bahamas minimize the extent to which climate change exacerbates these trends and risks.

Internally, WSC is making strides to assess, retrofit and fortify existing infrastructure to become more climate-resilient as well as implementing climate resilience for new construction. A project funded by the Caribbean Development Bank and the Bahamas Government is focused on increasing climate resilience for water infrastructure on five Family Islands.

1.6.4. Tourism

Tourism sector is the major driver of the Bahamian economy. In 2019, there were more than 7.2 Million visitors to The Bahamas even with destinations in Abaco and Grand Bahama being severely impacted by Hurricane Dorian. A significant decline in visitor numbers is expected for 2020 and 2021 due to COVID-19. Initial estimates indicate that stopover visitors for the country for 2020 was 452,640 versus over 1.8 Million in 2019, representing a decrease of 75% (Ministry of Tourism, 2021).

Accommodation is the most vital component of the tourism product and the tourist destination. There are approximately 65 hotels in Nassau, with 8,688 rooms. In The Bahamas there are 270 hotels with 14,797 rooms (Ministry of Tourism, 2021). Other components of the sector include food and beverage, recreation, transportation, attractions and conferences.

A 2011 ECLAC report on the economic impact of climate change on the Bahamian tourism sector noted the following:

The Bahamas is at great risk and vulnerability given its geographical features as a low-lying, sea encircled country. If projected sea level rise is reached by 2050, between 10-12% of territory will be lost, especially in coastal zones where the main tourism assets are located…The second and no less important threat is tropical cyclones, which may be associated with raising sea level. Estimations posited the amount of losses in excess of 2,400 million US$ for the four decades under examination…In the same period, total estimated impacts of progressive climate change are between 17 and 19 billions of B$ with estimated discount rates applied.

1.6.5. Agriculture – crops and livestock

Different types of land use in The Bahamas include (2016 estimates):

- Agricultural land – 1.4% which includes:
  - Arable land – 0.8%
  - Permanent crops – 0.4%
  - Permanent pasture – 0.2%
- Forest – 51.4%
- Other – 47.2%

Land classified as other includes developed areas, roads, other transportation features, barren land and waste land.

Approximately 90% of the available agricultural land is owned by the government and leased to farmers. Of the 95,000 ha of arable land in the country, only 7,650 ha is under cultivation, with two very distinct systems of agricultural production: mechanized methods in the northern islands that receive more rainfall and have large underground freshwater reserves; and shifting cultivation in the central and southern islands that are characterized by subsistence farming. More than 5,000 acres of agricultural land in The Bahamas are used for citrus production. Major crops for export are grapefruit, limes, avocados, papaya, okras and pineapples. The soils in the country are generally poor in terms of nutrient availability and water holding capacity, so farmers rely on heavy inputs of chemical fertilizer.

A 2014 IICA-IFAD report on climate-smart agricultural production in The Bahamas noted the following concerns about the impacts of climate change which were raised by smallholder rural producers and other stakeholders in the agricultural sectors:

- Crop loss and infrastructure damage (e.g. access roads washed out) due to hurricanes;
- Variability of access to freshwater due to unpredictable rainfall. There seems to be variation from drought to flood in any given year. This also impacts recharge of groundwater lenses which some farmers use for irrigation;
- Lack of information available to them about climate change and its potential impacts on their farms. Farmers want there to be more training opportunities and more communication from the Ministry of Agriculture, Marine Resources and Local Government and the Department of Agriculture; and
- Insurance for farmers so that they can receive at least 15% of the value of their farms in the event of a hurricane or storm surge. After Hurricane Sandy, farmers in Cat Island were given $75 - $100 by the Ministry as damage assistance.

Some of the recommendations for the same report to facilitate climate-smart agriculture in the country include:

- Replacement of traditional slash-and-burn systems with agroforestry systems, greenhouse production and/or hydroponics. These methods are already being used by some farmers.
- Increase soil carbon stocks through restoration of degraded lands and conservation agriculture.

- Using drought-resistant and salt-tolerant varieties of crop species.
- Identification of lands that are best suited for agriculture over the long-term, considering sea level rise and SLOSH (sea, lake and overland surges from hurricanes) modeling, and designation of these areas as agricultural lands.
- Development of policies to build economic resilience at the farm level (e.g. provision of insurance, securing land tenure).
- Training for farmers in sustainable soil and water management practices. This could involve local preparation of bio-fertilizers and bio-pesticides to reduce dependency on expensive, imported fertilizers and to replace hazardous agro-chemicals being used in local agriculture (Sanchez Hermosillo, 2011). Inter-cropping or alley cropping were also recommended; inter-cropping was observed on small farms in Cat Island.

1.6.6. Fisheries

The fisheries sector plays an important role in the Bahamian economy in terms of foreign currency earnings, food supply and employment. The commercial fisheries sector supplies 31 kg/capita/year of fish and fishery products to the population, generates some US$80 million annually in export earnings and provides full-time employment to 9,300 commercial fishers and thousands of jobs more in recreational fisheries, vessel maintenance, fish processing, retail and trade. The fishing fleet is characterized as small-scale and counts approximately 4,000 fishing vessels ranging in length from 3 meters to 30 meters, but generally less than 7 meter in length.

The total commercial fisheries production in 2015 was estimated at nearly 12,000 tonnes. The total production has fluctuated in recent years. Fluctuations are largely caused by the variations in landings of spiny lobster, which were nearly 10,000 tonnes in 2010 and 2012 and around 6,500 tonnes in 2015 (FAO, 2021).

Spiny lobster stocks in The Bahamas are being fully exploited, while conch, snappers and groupers are, like in the rest of the Caribbean, under heavy fishing pressure and some stocks are probably overexploited. The major threats to the marine fisheries resources are coastal zone development, boat and diver damage to the reef, over-harvesting of commercial species and disturbance to sensitive sites.

The recreational and sport fisheries subsector of the fisheries sector is also very important to the country contributes an estimated US$500+ million annually to the national economy through related expenditures by tourists and provides employment for some 18,000 Bahamians. The recreational and sport fisheries target game fish, such as marlins and sailfishes, as well as bone fish.

1.6.7. Industry

Industry includes activities such as light manufacturing and resource mining, particularly for aragonite. There has been recent consideration by the Government of oil exploration. Oil refining is presently occurring on Grand Bahama. Grand Bahama is the most industrialized of the Bahamian islands with an industrial sector which includes a container port, shipyard, oil refining, storage and transshipment, cement manufacturing, and pharmaceutical manufacturing.

1.6.8. Construction

The entire Bahamas due to its size and topography is vulnerable to the impacts of climate change. Increased development along coastlines tends to increase coastal erosion and therefore vulnerability of populations. Yet coastal development is one of the primary income generators of the country, and therefore this dichotomy has engendered conflicting approaches to management of coastal resources. Most of the critical infrastructure in the country (e.g. ports, roads, power stations) is found in vulnerable coastal areas.

1.6.9. Finance

The sector consists of commercial banks, savings banks, trust companies, offshore banks, insurance companies, a development bank, a publicly controlled pension fund, a housing corporation, a public savings bank, private pension funds, cooperative societies and credit unions. Capital and money market activities received a significant boost in

2000, with the introduction of The Bahamas International Securities Exchange (BISX), which operates alongside the informal over-the-counter exchange of public sector bonds and bills, which is administered through the Central Bank.

The array of financial services in The Bahamas also includes international business companies (IBC), mutual funds, and insurances services. The IBC is a flexible form of corporate vehicle governed by the International Business Companies Act, 2000. IBCs can only be incorporated by a bank or trust company - which is regulated by the Central Bank - or a person licensed under the Financial and Corporate Services Providers Act, 2000. Mutual funds operating in The Bahamas take the form of either managed investment companies with shares, or trusts with units representing ownership.

A significant number of insurance companies are also registered to operate in or from within The Bahamas. While many of these insurance companies service the domestic risk needs of The Bahamas, a number were also established to insure risks situated elsewhere in the world.

1.6.10. Waste management

Bahamians and visitors together generate more than 264,000 tons of municipal solid waste annually (World Bank, 2016) with New Providence contributing about 77% (GIS, 2016) and Grand Bahamas 17% of this total, leaving only about 6% or 15,800 tons annually generated on the Family Islands.

The typical mode of solid waste disposal on the Family Islands is to dump at formal sites near main settlements, burn and sporadically push aside the burned material to make room for more refuse. Almost all sites are unregulated, have debris spread over wide areas and are contaminating water supply areas. Indiscriminate dumping along roadsides is common on all islands, including New Providence. Some islands do have sanitary landfills that are maintained and some resorts operate a system of daily waste management geared toward maintaining compost bins, segregating, preparing and transporting bottles and cans for shipment to recycling facilities overseas.

New Providence Ecology Park (NPEP) is a private entity that has been engaged by the Government to manage the landfill on New Providence. NPEP has undertaken several activities to improve waste management at the landfill including:

- Consolidating and capping over 80 acres of waste;
- Implementing rigorous solid waste handling practices; and
- Commencing recycling and recovery activities for construction demolition debris and vegetative waste.

Future plans include landfill gas collection and recycling infrastructure as well as a public green space on reclaimed landfill property.

The Bahamas first large-scale biodiesel production facility was opened in February 2011 by Bahamas Waste Limited. It will allow for up to one million gallons of waste cooking oil collected from restaurants in Nassau, such as McDonald's, Burger King, KFC and Wendy's, as well as cruise ships to be processed and converted into biodiesel each year. Currently, four Bahamas Waste trucks are using a 50:50 blend of biodiesel to petroleum diesel. The company hopes to eventually run its entire fleet of 50 vehicles off of 100% biodiesel as production increases.

1.6.11. Health

The Bahamian government is making a conscious effort to improve its health care system, investing around 8% of its GDP into health care in 2018, and building new hospitals and facilities. Public health services are delivered through a network of 57 community clinics and 54 satellite clinics in New Providence and the Family Islands (PAHO, 2021). For those living on smaller islands without medical facilities, travel by boat or plane is required. The Public Hospitals Authority in the Bahamas oversees the quality of the three public hospitals in The Bahamas. These three hospitals are the Princess Margaret Hospital, the Sandilands Rehabilitation Centre, both on New Providence, and the Rand Memorial Hospital on Grand Bahama. There are also two main private hospitals in The Bahamas, both on New Providence - Doctors Hospital and Lyford Cay Medical Facility.

The National Health Insurance (NHI) programme was launched in 2016 and offers Bahamian residents access to primary health care, which is free at the point of service. While the government is initially paying for the care offered, this is expected to change in the future with NHI members and their employers being required to pay up to 1.5% of their income towards the programme.

Despite initiatives like NHI, many Bahamians still struggle to access the health care they need. The majority of Bahamians do not have health insurance and are unable to afford the high costs of secondary (specialists such as cardiologists) and tertiary medical care (such as surgeries).

There are a number of projects underway to mainstream climate change into the health sector. These include:

- **Developing a climate resilient health system in The Bahamas** – Through funding from the Green Climate Fund, the project will result in the development of climate change-specific chapters as a part of The Bahamas National Health System Strategic Plan (NHSSP). These chapters will address resource mobilization, SMART health facilities and policies, and health workforce to address climate change and health mainstreaming. The project will also enhance national public health surveillance systems of hospitals and primary care clinics and strengthen communication across agencies to respond to climate change impacts.
- **EU/CARIFORUM climate change and health project** – The objective of this project is to improve the capacity of Caribbean countries (including The Bahamas) to reduce the negative impacts of climate change on health. Benefits of the project to The Bahamas will include development of a health adaptation plan to advance national climate change and health prioritization and financing; strengthening of water, sanitation and food safety systems to be more resilient to climate change; and a national climate informed disease surveillance and modelling system.

1.6.12. Education

Education is available to all segments of the Bahamian population and is compulsory to children aged 5 to 16. There are 170 public schools in the country; total enrollment for K-12 is more than 50,000.

The Bahamian education system is structured in a 6-3-3 format. The first cycle is primary education, which lasts for six years and is designed to cater to students aged five to eleven. Secondary education is divided into two equal parts of three years' duration; junior high is designed to accommodate students from age 11 to 14 while it is expected that students aged 14 to 17 attend senior high. Although not yet mandatory, education at the preschool and post-secondary levels is rapidly expanding (MOEST, 2020). Climate change is incorporated into the national curriculum beginning in primary school at fourth grade level.

An example of climate change activities at school was a climate change workshop held at Columbus Primary School for fourth and fifth grade students; the students learned about global warming, climate change, and its impact on the environment. The workshop was a collaborative effort between the Science Specialist at the Sadie Curtis and Columbus Primary Schools and Innovative Science, a private sector organization that provides interactive science experiments for primary school children.

The Bahamas has further strengthened its commitment to climate education, with the appointment of an Action for Climate Empowerment (ACE) Focal Point in the Ministry of Education.

Tertiary education is provided at the University of The Bahamas (UB), which offers both associate's and bachelor's degrees in the arts and sciences. The Climate Change Adaptation and Resilience Research Centre (CCARRC) is a part of UB. Established in 2019, the Centre serves as a resource for SIDS and coastal communities throughout the world to effectively address the human dimensions of climate change. The Centre focuses on the impacts of climate change on societies in at-risk regions and how members of these communities can best prepare for and respond to the many risks posed by climate change.

There are also a number of privately-run institutions that also offer associate degrees and are affiliated with tertiary educational institutions in the United States. Technical and vocational training is available at the Bahamas Technical and Vocational Institute (BTVI) (PAHO, 2021).

Considerable efforts have been made within the past ten years to incorporate technology in the both public and private schools in The Bahamas. To date, Almost 5 million dollars was spent in the last 2 years to install computer labs, and E-literacy capabilities in every junior and senior high school in The Bahamas.

The Ministry of Education has implemented training programmes for teachers to ensure that they are able to teach technology to students and improve achievement levels using this vital teaching tool.

The Ministry of Education also works with non-Governmental agencies on climate change education including:

Bahamas Reef Environment Educational Foundation (BREEF) – BREEF provides teacher training programmes every summer. It also produces teacher resource materials including a guide for educators on consumers, corals and climate change.

1.6.13. Social Services

The Department of Social Services provides food, financial services, counselling, advocacy, education, health and wellness, shelter and housing, and protection services. There are 13 divisions within the Department including a Disaster Management Unit.
The Disaster Management Unit (DMU) is primarily responsible for hurricane shelter management. The Unit is also tasked with assisting in national disaster preparedness and mitigation efforts relative to all natural and man-made events and disasters

throughout The Bahamas. DMU works in partnership with the National Emergency Management Agency (NEMA) and in compliance with the National Disaster Plan.
Benefits offered by the Department of Social Services following Hurricane Dorian included food assistance, home repair, assistance to purchase beds and appliances (up to $2,000), rent assistance for displaced hurricane victims (up to $700 per month), and burial assistance for persons who died during the hurricane (up to $5,000) (Freeport News, 2020).

1.7 National Priorities

National priorities specifically related to climate change are included in the 2001 First National Communication, 2014 Second National Communication, 2004 National Policy for Adaptation to Climate Change and the 2015 Intended Nationally Determined Contributions (INDC), and 2022 Updated Nationally Determined Contributions (NDC)

Other national policies and plans that identify priorities with respect to climate change include:

- 1968 Coastal Protection Act
- 1997 Conservation and Protection of the Physical Landscape of The Bahamas Act and Regulations
- 1999 National Biodiversity Strategy and Action Plan
- 2003 The Bahamas Building Code – 3rd edition – Ministry of Works and Utilities
- 2004 National Wetlands Policy
- 2004 The Environmental Health Services Act
- 2005 National Environmental Management and Action Plan
- 2006 The Planning and Subdivision Act
- 2009 The Utilities Regulation and Competition Authority (URCA) Act
- 2010 Disaster Preparedness and Response Act
- 2013 The Bahamas National Energy Policy 2013 -2033
- 2013 The Montreal Protocol (Controlled Substances) Act (Cap. 216A) and Customs Management (Amendment) Act of 2013

- 2013 National Invasive Species Strategy
- 2014 Forestry Act (Amended 2014) and Forestry Regulations
- 2015 National Maritime Policy
- 2015 SIDS DOCK
- 2015 Electricity Act (Renewable Energy) (Amended)
- 2015 Water and Sewerage Corporation Act (Amended)
- 2017 National Tourism Development Strategy 2017-2022
- 2019 Environmental Planning and Protection Act
- 2019 Environmental Protection (Control of Plastic Pollution) Act, 2019
- 2020 Bahamas Power and Light (BPL) requirements for grid interconnection of small-scale renewable energy generation systems
- 2021 National Biodiversity Strategy and Action Plan
- 2021 Civil Aviation Authority Bahamas (CAAB) Environmental Regulation
- 2022 Climate Change and Carbon Market Initiatives Act Bill
- 2022 Carbon Credit Trading Act Bill
- 2022 Grand Bahama Power Company (GBPC) rules and regulations for Renewable Generation Systems (RGS)
- 2022 Disaster Risk Management Act

A National Development Plan (NDP) was drafted in 2017, but has not been approved by Cabinet to be considered an official national document. The drafting of plan involved consultations across the country. Goals in the draft plan relevant to climate change include development of modern infrastructure in the country built to withstand the effects of climate change and rising sea levels and positioning The Bahamas as a leader in researching and implementing climate change adaptation and mitigation measures and as an incubator of green technologies.

The SDG informed policy recommendations report by the National SDGs Technical Committee and SDG Unit of the Office of the Prime Minister made the following climate change recommendations (OPM, 2020):

- Ensuring that support is not given to industries or practices that are not climate resilient including stockpiling oil, encouraging oil drilling or development that increases vulnerability to the impacts of climate change;
- Strengthen national social protection systems and the coherence of disaster management and climate change adaptation policies;
- Build national climate change expertise through capacity development to prepare and respond to all climate risks;
- Increase the number of communities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, and resilience to disasters; and
- Promote mechanisms for raising capacity for effective climate change-related planning and management, focusing on women, youth and local and marginalized communities.

Moreover, in January 2022, the Climate Change & Environmental Advisory Unit (CCEAU) was established, as the technical advisory arm of the Office of the Prime Minister (The Bahamas) to provide support on matters of the blue and green economy, renewable energy, reduction in the use of fossil fuels, carbon credits, large scale climate change mitigation and adaptation projects, climate risk insurance and the other progressive climate policy agenda items.

1.8 The Environment

The environment of The Bahamas is characterised by coastal and marine habitats and ecosystems that are areas with high productivity, biological diversity and natural beauty (Newbold, 2016). These attributes have been the foundation of the country's tourism-based economy for decades and provide opportunities for sustainable livelihoods, including ecotourism and sustainable harvesting. Sustainable forestry is an area that the Government is exploring through the GEF Pine Islands project. Sustainable fisheries is being promoted through the Marine Stewardship Council certification program for spiny lobster in The Bahamas.

Exploring opportunities for economic growth linked to sustainability and the environment are vital for The Bahamas. The country must find ways to adapt to the shocks of increasingly frequent hurricanes associated with climate change. If immediate and significant mitigation action is not taken globally, even diversifying its economy to these sectors may not make The Bahamas sufficiently resilient to the severe impacts of climate change.

1.8.1. Land use, land use changes and forestry

The thin, dry, calcareous soils of The Bahamas are generally low in fertility and soon become exhausted when used for farming. Historically, subsistence farming was a common activity. The slash and burn farming method would see large plots cleared and the foliage burnt so that the ashes would quickly return a small amount of nutrients to the soil. The land would typically become exhausted after a few seasons of farming and when yield dropped significantly, a new area was cleared. Due to the rapid spread of this type of agriculture, most islands now have very little old growth or pristine forests.

Large scale agricultural operations including cotton, citrus, pineapple, sisal, tomatoes and watermelon have seen limited or short-lived success in the thin Bahamian soil.

The tourism industry has boomed in recent decades and luxury resorts are being built throughout The Bahamas. Coastlines of New Providence, in particular, have been extensively cleared for hotels, luxury housing complexes and private homes. The interior of the island is also subject to unprecedented urban sprawl. Large tracts of land are being cleared for housing and business developments as well as road construction. Other islands in the archipelago have also been affected by rapid urbanization and development.

The lumber industry in the 20th century devastated the pine forests of The Bahamas. A sawmill operated in Abaco until 1943, and then Grand Bahama until 1970, leaving the pine forests virtually denuded. Similar operations in New Providence and Andros were much smaller though they amounted to similar effects on the environment. Abaco currently has the largest area of pine forest habitat in The Bahamas, but very few of the original trees remain standing there. After its eclipse, the logging industry left numerous logging and access roads throughout the aforementioned islands, which are now used by hunters in those islands and, to a limited extent, bird watchers and persons participating in ecotourism.

The Abaco species of the Bahama Parrot is currently known to be the only Amazon parrot to nest in ground cavities. It has been suggested that this may be in response to the removal of the vast majority of trees large enough to hold nesting cavities as is normal for the parrots in Inagua. Stahala (2004) and Gnam (1990 & 1991) discuss the ecology and conservation of the ground nesting Bahama parrot. The pine forests are recognized as an important and exploitable resource. The restoration of the forests is important to the viability of future sustainable use activities as well as to the many under-storey broadleaf plants, orchids, bromeliads, ferns and vines. Crabs in the forests of Andros are an intimate part of that island's heritage and culture.

1.8.2. Marine and coastal habitats

Marine and coastal habitats of The Bahamas include coral reefs, seagrass beds, mangroves, sandy beaches, and rocky shorelines. The health of these habitats are important to ensuring resilience of the islands of The Bahamas. With unplanned and unregulated development, these are often some of the most impacted habitats, particularly for tourism-based development.

The Bahamas Coral Reef Report Card, Volume 2011 – 2013 classifies Bahamian reefs as impaired overall (Dahlgren et al, 2016). Other key findings of the report include (Dahlgren et al, 2016):

1) Lower live coral cover on Bahamian reefs than on other Caribbean reefs;
2) Low coral recruitment (though similar to the rest of the Caribbean);
3) Reef structure, parrotfish populations were scored as fair in most areas surveyed; and

4) Large groupers were fairly common on Bahamian reefs but practically absent from the rest of the Caribbean. Grouper populations were healthiest in the Exuma Cays. It is important to note that the Exuma Cays Land and Sea Park is a marine protected area in the Exuma chain.

Key threats to coral reefs include climate change. Climate-related changes in habitat include coral bleaching as a result of increasing sea surface temperatures, rising sea levels, and coastal erosion. Impacts on the marine environment specifically, will be felt across ecosystems like coral reefs, and mangroves due to changes in sea level. With changes to these ecosystems, we may also see changes in populations of marine and terrestrial organisms that are dependent on these ecosystems for the various ecosystem services they provide (NBSAP, 2021).

1.8.3. Biodiversity

The distinct environment of The Bahamas gives rise to numerous irreplaceable habitats and species, including vast expanses of Caribbean pine forest, tidal flats with thriving bonefish populations, extensive barrier reefs, the highest concentration of blue holes in the Western Hemisphere, and critical fish nursery habitat believed to contribute significantly to fisheries stocks throughout the Caribbean region. The insularity and extensive carbonate shelf with productive coral reefs and other habitats, plus a large area of coastal wetlands, especially mangrove forests, contribute to the abundance and diversity of fish. Rare, critically endangered, and endemic species can also be found in The Bahamas including the Bahama parrot, several species of Rock iguana, Kirtland's warbler, West Indian flamingo, Hutia, Smalltooth sawfish, Queen conch, and Loggerhead, Hawksbill, and Green turtles.

Important, and easily-recognized, Bahamian ecosystems include — but are not limited to — the following:

- Pine woodland (forest) – northern islands
- Coppice – central and southern islands

- Wetlands – may be allocated amongst five categories: mangrove swamps and marshes, beach vegetation, swashes, pine forests/barrens, broad-leaf coppice. Mangroves are dominated by one or more species of mangrove (*Avicennia, Laguncularia* and *Rhizophora,)*.
- Seagrass beds – dominated by turtle grass (*Thalassia testudinum*)
- Coral Reefs – of great significance in terms of Bahamian biodiversity
- Other shallow water marine habitats – rock and unvegetated sediments
- Caves, sinkholes and blue holes

In partnership with BirdLife International, the Bahamas National Trust (BNT) is in the process of developing a climate change adaptation strategy for the national parks and Key Biodiversity Areas (KBAs) on the islands of Grand Bahama, Abaco, New Providence, Andros, Eleuthera, Exuma, San Salvador and Inagua.

1.9 Institutional arrangement for preparation of NCs and BURs

The UNFCCC has prepared a toolkit to provide recommendations to non-Annex I Parties on establishing and maintaining institutional arrangement for preparing national communications (NCs) and biennial update reports (BURs). These recommendations include the following (UNFCCC, 2013):

- A single body be designated to be responsible for the overall coordination and management of the process and preparation of NCs and BURs.
- Due to volume and diversity of information required to prepare these reports, providers of key information should be identified and their roles and responsibilities within the process clearly defined.
- It is strongly recommended that the process, roles and responsibilities, including procedures for the flow of information, be formalized through an MOU or other formal agreement between the coordinating body and key stakeholders.

The initial discussion of institutional arrangements was held during stakeholder workshop for the Project Identification Plan phase of this project. Through the development of the BUR, these discussions have been further refined.

1.9.1. Current institutional arrangements

The Bahamas has never submitted a Biennial Update Report. However, past reports to the UNFCCC including its FNC and SNC were prepared through a collaborative effort of the National Climate Change Committee (NCCC) under the Bahamas Environment, Science and Technology (BEST) Commission (now the Department of Environmental Protection and Planning, DEPP). Experts from various Government and non-Governmental organizations were members of the Committee and responsible for either drafting sections of each Communication or reviewing sections. Some sections were developed by consultants, such as greenhouse gas inventory and vulnerability and adaptation assessments. A project manager was tasked with ensuring all the information provided by both Committee members and consultants was compiled into the final reports.

Figure 16: Institutional framework for 2001 First National Communication (FNC)

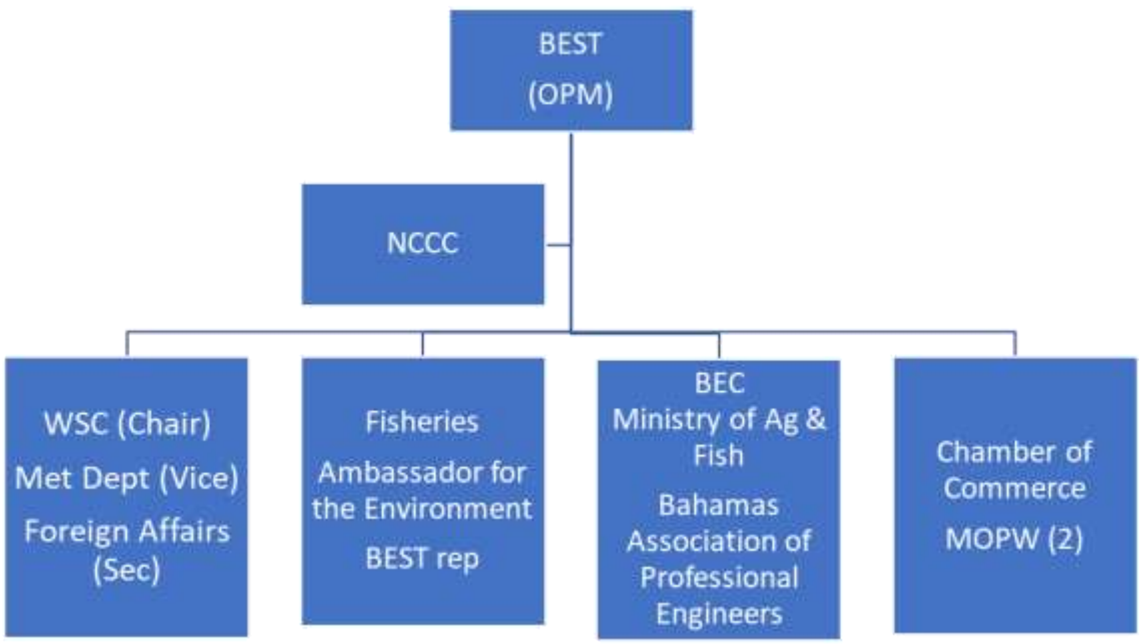
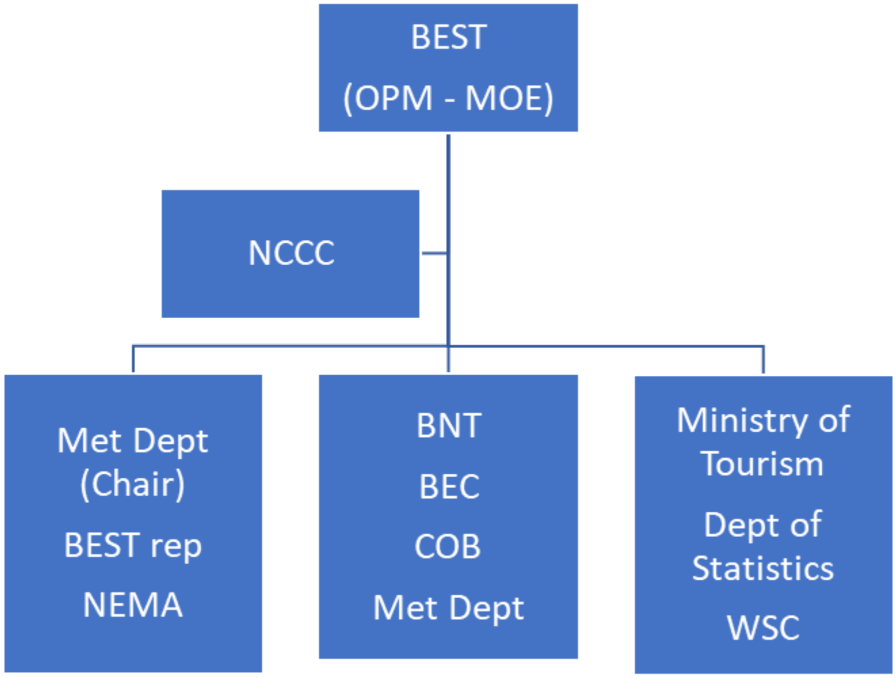


Figure 17: Institutional framework for the 2014 Second National Communication (SNC)



The TNC and BUR1 process is currently being led by DEPP and the NCCC. Again, consultants have been engaged to complete the various chapters of both documents. The project manager is a staff member of The Climate Change & Environmental Advisory Unit (CCEAU), a technical advisory arm of the Office of the Prime Minister (OPM), and all chapter drafts are reviewed by the project team members and the NCCC. NCCC members have also supported the process through provision of information and data from their respective organizations as well as ensuring the chapters accurately reflect circumstances in The Bahamas and future plans for addressing climate change.

The following agencies are currently represented on the NCCC:

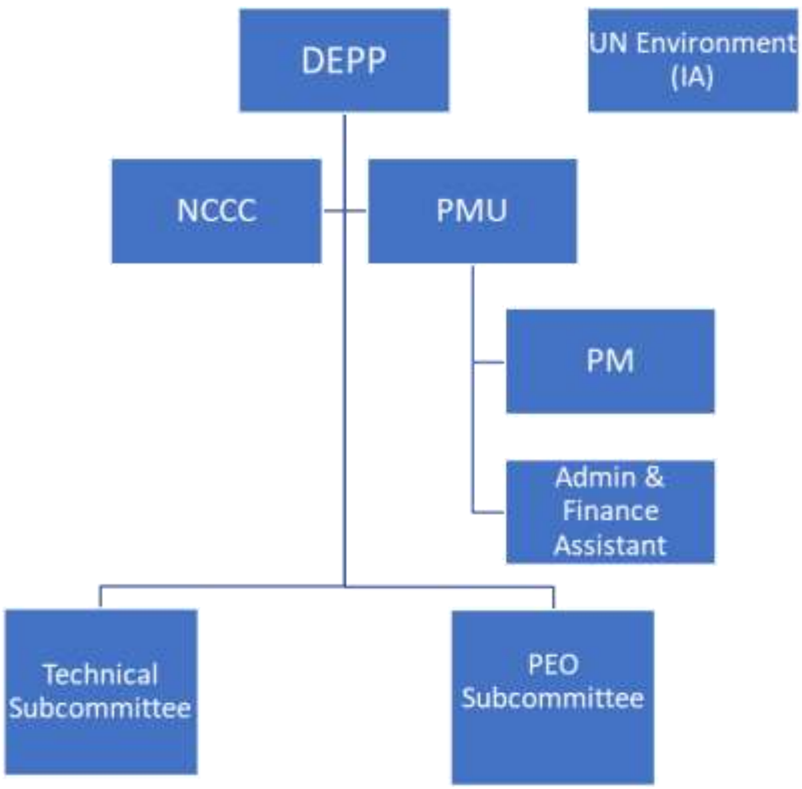
1. DEPP – Department of Environmental Protection and Planning
2. BDM – Bahamas Department of Meteorology
3. DMR – Department of Marine Resources
4. DMU - Disaster Management Unit (Department of Social Services)
5. DOA – Department of Agriculture
6. Department of Gender & Family Affairs

7. Department of Statistics (Bahamas National Statistical Institute)
8. Forestry Unit
9. MOHW – Ministry of Health and Wellness
10. MOWI – Ministry of Public Works
11. MOT – Ministry of Tourism
12. Ministry of Transport & Local Government
13. NEMA – National Emergency Management Agency
14. OPM – Office of the Prime Minister of The Bahamas
15. Port Department
16. UB – University of The Bahamas
17. BAHFSA - Bahamas Agricultural Health and Food Safety Authority
18. BMA – Bahamas Maritime Authority
19. BPL – Bahamas Power & Light Company Limited
20. WSC – Water & Sewerage Corporation
21. BNT – Bahamas National Trust
22. BPAF – Bahamas Protected Area Fund
23. BREEF – Bahamas Reef Environment Educational Foundation
24. TNC – The Nature Conservancy
25. BCCEC – Bahamas Chamber of Commerce & Employers' Confederation

1.9.2. New institutional arrangements

It is recommended that the institutional arrangement outlined in Figure 18 be established for the TNC-BUR1 process and be utilized moving forward to facilitate the preparation of NCs and BURs

Figure 18: Recommended institutional arrangement for NC-BUR preparation



As the UNFCCC Focal Point, DEPP will serve as the Coordinating Body for the NC-BUR process. Its responsibilities will include:

1. Identify all institutions and teams that will be involved in the preparation of the NC and BUR, including establishing any formal working arrangements.
2. Ensure that the Project Management Unit (PMU) is adequately staffed throughout the NC and BUR preparation process.
3. Allocate responsibilities for all components of the NC and BUR ensuring that there is a clear lead for each section, and establish a formal approval process.

4. Develop and maintain an archiving system to ensure institutional memory.
5. Keep stakeholders informed of any emerging issues related to climate change and the UNFCCC.

Specific responsibilities of the PMU will include:

1. Plan and conduct all coordination and consultation activities with stakeholders.
2. Develop and monitor a timeframe and schedule for the preparation of the NC and BUR, including specific milestones and dates for deliverables.
3. Keep stakeholders informed of progress and any emerging issues related to NC and BUR.
4. Develop and oversee the implementation of a quality assurance strategy for the reports.
5. Manager the overall budget for the preparation of reports.
6. Document systematically all the assumptions, data and methods used to prepare the reports.
7. Integrate and compile all sections of the NC and BUR into a cohesive document.
8. Conduct an evaluation exercise to identify key lessons learned and areas for improvement.

For any GEF-funded projects, DEPP will liaise with UN Environment as the Implementing Agency (IA).

A Project Management Unit (PMU) will be created within DEPP, consisting of a project manager and assistant for administrative and finance issues related to NC-BUR preparation. The NCCC will continue to fulfil its role with respect to the UNFCCC. Over time, the capacity of the Committee will be built to develop all chapters within the reports without the need for external consultants.

The NCCC will create two subcommittees:

- **Technical Subcommittee** – This Subcommittee will provide technical expertise for the five Technical Expert Group (TEG) areas – GHG Inventory, V&A Assessment, Mitigation Analysis, Environmentally Sound Technologies (EST) and

Research & Systematic Observations (RSO). Recommended agencies to be represented include: Bahamas National Statistical Institute (formerly known as the Department of Statistics), BDM, DMR, DOA, MOWU (MOPW), Road Traffic Department, BPL and WSC.

- **Public Education & Outreach (PEO) Subcommittee** – This Subcommittee will be responsible for the sixth TEG area. Recommended agencies to be represented include Bahamas Information Services (BIS), Department of Gender & Family Affairs, Ministry of Education, UB, BREEF, BCCEC and Bahamas Press Club.

Table 11: Recommended duties for Technical Expert Groups (TEG)

	TEG	Recommended Duties
Technical Subcommittee (TEGs 1 through 5)	Greenhouse Gas Inventory	1. Advise on selection and application of appropriate inventory methodologies. 2. Assist in data quality assistance and key source analysis. 3. Recommend the ways of improvement of the national emission actors. 4. Contribute substantially to development of the *National Inventory Report* and identify the follow-up activities. 5. Assist the PMU in arrangement of the national review and training workshops on improving quality of the national GHG inventory. 6. Make suggestions on technical capacity building and participate in the subregional, regional and

		international training on GHG inventory.
	Vulnerability & Adaptation Assessment	1. Advise on selection of appropriate methodologies to assess vulnerability and adaptation. 2. Oversee the development of climatic scenarios and selection of relevant methodologies. 3. Supervise/conduct an assessment of vulnerability and climate change impact. 4. Contribute substantially to development of the National Strategy on Adaptation to Climate Change and identify the follow-up activities. 5. Help the PMU to organize the national review and training workshops on vulnerability and adaptation measures. 6. Make suggestions on capacity building and participate in the subregional, regional and international trainings on integrated assessment modeling.
	Mitigation Analysis	1. Assist the PMU in search and choice of appropriate training courses on applying macro-economic models. 2. Advise on selection of macro-economic models for evaluating mitigation options and measures for GHG emission reduction.

		3. Overview and select measures to mitigate climate change and identify the follow-up activities. 4. Assist the PMU in arranging the national review and training workshops on climate change mitigation measures. 5. Suggest on technical capacity building and participate in the subregional, regional and international trainings on mitigation measures analysis.
	Environmentally Sound Technologies	1. Advise on selection of priority technological needs. 2. Analyze the cost-effectiveness of the technologies and the opportunities for their application. 3. Assess the existing endogenous technologies for further promotion within the context of national circumstances. 4. Contribute substantially to the establishment of a database for ESTs, including both mitigation and adaptation technologies. 5. Identify the follow-up activities 6. Assist in arranging the national review and awareness raising workshops on ESTs and participate in the subregional, regional and international trainings on ESTs.

	Research & Systematic Observations	1. Assess the existing system for early warning on extreme weather events and methods of seasonal forecasting. 2. Analyze the existing barriers for development of observation systems and research, and identify the follow-up activities *3.* Contribute substantially to development of the *National Information Report on Research and Systematic Observation.* 4. Assist the PMU in arranging the national review and awareness raising workshops on research and systematic observation, and participate in the sub regional, regional and international trainings on the matter.
PEO Subcommittee (TEG 6)	Education, Training & Public Awareness, Information & Networking, Capacity-building	1. Compile and analyse information on activities/tasks relating to the implementation of the New Delhi work program on Article 6 of the Convention. 2. Compile and analyse information on activities/tasks relating to the implementation of the capacity-building framework of the UNFCCC. 3. Identify the needs and priorities for climate change education, training and public awareness and capacity-

		building as they relate to the other 5 TEGs. 4. Liaise and consult with the various TEGs. 5. Assist in implementation of the National Plan for Article 6 of the Convention and the UNFCCC capacity-building framework. 6. Identify technology needs for information and networking. 7. Assist the PMU in organizing workshops on ways to promote climate change education, training and public awareness. 8. Substantially contribute to chapters in the NC on (i) Education, Training and Public Awareness, (ii) Information and Networking, and (iii) Capacity-building.

Chapter 2 – Domestic measurement, reporting and verification (MRV)

2.1 Introduction to Measurement, Reporting and Verification (MRV) Systems

A national climate MRV system can be defined by the characteristics of what is measured, reported, and verified when it comes to a country's climate action under its main functional components such as mitigation and greenhouse gas emissions, adaption, and support. The interaction between system inputs and its defined outputs are critical to build understanding of emissions trends and feasible strategies and policy actions for addressing climate change. Historically since 2002, when the basis for non-Annex I reporting to the United Nations Framework Convention on Climate Change (UNFCCC) was established, developing country parties have strived to implement these systems cognisant of their nation priorities and circumstances. Today, through the Paris Agreement, defined more recently in the Glasgow Pact, Parties are required to implement the Enhanced Transparency Framework (ETF) with common reporting tables and formats (with flexibility provisions) to build mutual trust and confidence and promote the effective implementation of actions. Through this work during The Bahamas' Third National Communications/First Biennial Update Report (TNC/BUR1) cycle as well as previous and on-going climate projects, the Government of The Bahamas has positioned itself on a path towards establishing a comprehensive and all-encompassing MRV system through its National Climate Change Committee (NCCC) and intensive capacity building of local experts to meet the demands of the newer reporting requirements. Through its implementation and continued prioritization for future reporting cycles, it is envisaged that this system will measure, report, and verify the following activities and actions in adherence with the Transparency, Accuracy, Completeness, Comparability, and Consistency (TACCC) principles:

- Activities that cause climate change (Greenhouse Gas Inventory (GHGI));

- Actions taken that prevent climate change (mitigation actions and Nationally Determined Contributions (NDC) implementation progress);
- Climate change impacts and adaptation;
- Actions taken to adapt to climate change (adaptation actions and NDC implementation progress); and
- Financial and other support needed and received for undertaking actions above.

2.2 Institutional arrangements related to MRV

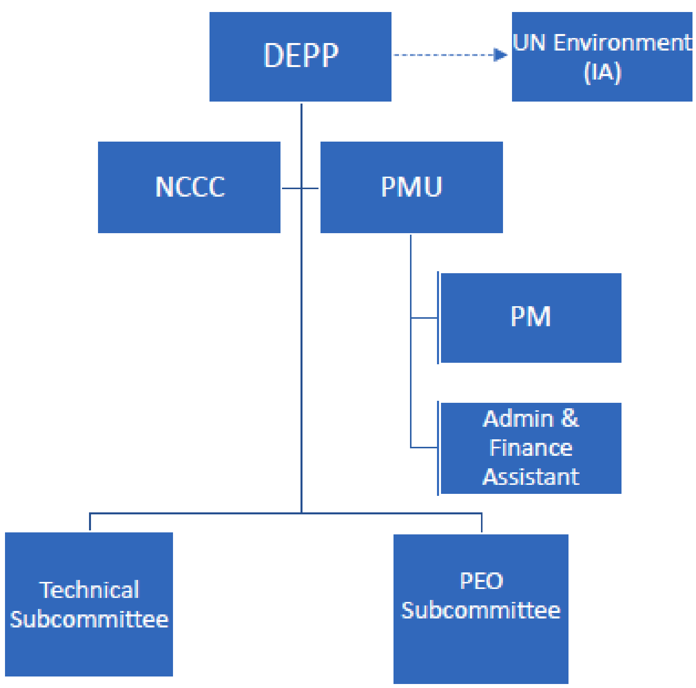
Small Island Developing States (SIDS) member countries are widely considered to be some of the first countries to experience the adverse effects of climate change though they are amongst the least responsible in terms of global GHG emissions. Recent evidence indicates that these adverse effects are already occurring in the Latin America and Caribbean (LAC) region. The Bahamas is a SIDS member country and although its overall GHG emissions profile is small, it has prioritised the need to provide the domestic and international community with the required reports highlighted in the Paris Agreement that adhere to the TACCC principles in an effort to demonstrate leadership and commitment to action to combat this global issue.

Like many other developing countries, The Bahamas faces challenges in this process due to limited human, technical and institutional capacity within their local teams. To overcome these obstacles for previous reporting (namely, the NC1 and NC2), The Bahamas engaged regional and international consultants to conduct the relevant planning and preparation activities to meet its reporting obligations.

Analysis of historical information revealed a lack of documented and archived datasets (inclusive of methodologies and expert judgement) from previous reporting events, that hindered the opportunity to improve reporting through the latest NC3/BUR1 reporting cycle. Previous reports were conducted using a decentralized, project-based MRV system.

Cognizant of the obstacles faced in previous reporting cycles and an understanding of the necessary improvements to previous institutional arrangements, The Bahamas decided to use the opportunity of the NC3 and BUR1 reporting cycle to move from a decentralized project-based system to a centralised project-based system. To achieve this goal, the Party prioritised the enhancement of technical and institutional capacity of the local team; through capacity building activities conducted by the different consultant teams during their identified tasks for the relevant reporting requirements. An example of this approach can be seen through the Greenhouse Gas Inventory (GHGI) compilation process where technical aspects led by regional consultants in a collaborative fashion with national experts simultaneously underwent targeted training. These activities included both GHG inventory compilation training and hands-on participation in data collection, and a UNFCCC quality assurance review during inventory compilation.

Figure 19: Institutional arrangements for the development of The Bahamas' Third National Communication and First Biennial Update Reports



2.3 Overall coordination of MRV

The government structures relevant to climate MRV are led by The Department of Environmental Planning and Protection (DEPP). DEPP has the role and responsibility of overseeing and convening The Bahamas National Climate Change Committee (NCCC) and the Project Management Unit (PMU), which lead in the compilation of, required reports. The PMU also oversees the implementation of procurement and deliverables produced from national, regional, and international project-based consultants. DEPP ultimately provides final validation and approval, prior to report submission to the UNFCCC.

The NCCC provides strategic level guidance on climate change related activities, policies, and plans as well as functioning as the National Project Advisory Committee for national reports to the UNFCCC or other climate entities and provides strategic direction and oversight to the implementation of the UNFCCC objectives. The NCCC is a multi-disciplinary and multi-sectoral body and as of February 2022 includes representatives from government, private and civil agencies that are guided by an agreed upon Terms of Reference.

It should be noted for historical context that the NCCC was established in 1996 by The Bahamas Environment Science and Technology (BEST) Commission while under the Office of the Prime Minister, and now chaired and led by the Department of Environmental Planning and Protection (DEPP) (formerly BEST Commission). The DEPP, apart from its role as the chair of the NCCC, is also the UNFCCC and GEF operational focal point, and coordinates the preparation and presentation of all reporting requirements to the UNFCCC.

Regionally, The Bahamas has worked with other CARICOM countries on climate MRV elements vis a vis an executed Memo of Understanding (MoU) with the Caribbean Cooperative Measurement, Reporting and Verification Hub (MRV Hub) (2019-2023), the Regional Framework for Achieving Development Resilient to Climate Change (2009-2015), and through regional Green Climate Fund (GCF) projects, such as institutionalizing a common framework for climate finance MRV (2021 – under implementation), and building capacity for regional approaches to climate action in the Caribbean (2019 – under implementation). The Bahamas has successfully engaged regional partners, namely the MRV Hub (for mitigation MRV), and the Caribbean Community Climate Change Centre (5Cs) (for finance MRV).

2.3.1 Legal arrangements for domestic MRV

The Bahamas ratified the Paris Agreement under the UNFCCC on 22nd August 2016 and further enshrined it into law in 2022 via The Climate Change and Carbon Markets Initiatives Act. The Bahamas has the responsibility to meet the climate change reporting requirements of the Paris Agreement, including the Enhanced Transparency Framework (ETF). Nationally, The Bahamas currently lacks a detailed, comprehensive, and unambiguous legal framework for national climate MRV. However, there does exist legal context that has relevance to components of climate MRV.

Within the context of climate MRV, The Bahamas has several pieces of legislation that address natural resources management and environmental protection. Table 12 identifies the existing laws and policy frameworks with a brief summary noting their key aspects in the context of climate change MRV.

Table 12*:* Existing legal arrangements that are relevant for climate MRV

Identified Law/Political Framework	Summary of Key aspects in the context of Climate Change
The National Policy for the Adaptation to Climate Change (2006)	Specifies institutional climate MRV roles and responsibilities. Namely, that the NCCC, or its successor body shall monitor implementation of the National Climate Adaptation Policy; and that Government shall review the mandate, terms of reference, and composition of the NCCC with a view to better equipping it to fulfil its monitoring role. The NCCC shall report to the Cabinet

	of Ministers through the Ambassador for the Environment and the Minister responsible on a semi-annual basis, as well as at any other time deemed necessary. The NCCC shall present to Cabinet and the House of Assembly an annual report on measures that have been undertaken to implement this policy. The policy does not specify indicators that should be monitored.
National Energy Policy (2013)	Specifies specific sector indicators that should be monitored and for which targets should be set. While the policy states that a government designated entity should monitor the policy, the designated entity, and its role in monitoring indicators or setting targets is not described within the policy.
Forestry Act (2010), Amended (2014)	Establishes the Forestry Unit and specifies that the Director of Forestry should conduct forest inventories. Forest inventories provide activity data for estimating emissions or reductions within a national GHG inventory or a mitigation assessment
Electricity Act	Establishes the organisation of The Bahamas Electricity Sector. Of relevance to the climate MRV system, it describes the process, authorization, and enforcement mechanisms for public electricity suppliers and renewable energy formulation, procurement, and approval. The Act describes the formulation of renewable electricity plans and specifies that public electricity suppliers shall develop in writing for the Utilities Regulation and Competition Authority's approval of an annual report on the accomplishments made against the approved plans. Inclusions in these plans include renewable energy policy statements, minimum percentages of electricity products from eligible renewable electricity resources, specified dates, reports, and mechanisms for review. The Utilities Regulation and Competition Authority is to approve plans as consistent with the sector policy objectives and the national energy policy.

Environmental Planning and Protection Act (2019)	Created provisions for ensuring the ease of doing responsible business by creating a streamlined process, which requires individuals to obtain environmental clearances before commencing projects. The Ministry of the Environment and Housing has published subsequent supporting regulations. Under Section 12 of the EPPA, the Ministry has issued the *Environmental Impact Assessment Regulations (EIARs) 2020.*
Statistics Act	Specifies the development of a National Statistical Strategy and National Statistical System. This system is to set standards for collecting, compiling, analysing, and publishing official statistics. The body to implement this strategy and system development will be called The Bahamas National Statistical Institute.
Climate Change and Carbon Market Initiatives Act (2022)	Codifies the Paris Agreement into law. Legal mandate outlined related to institutional arrangements between key agencies tasked with supporting climate action (i.e. the Office of the Prime Minister, Ministry of Finance and Ministry of the Environment). Establishes a national emissions registry, and outlines deadlines for reporting related to Article 6 and Article 13 of the Paris Agreement. Outlines responsibility in reporting to The Prime Minister, Ministers, and the House of Assembly. Lays down framework for regulations to further strengthen MRV and national climate change response.

The Bahamas is also party to various international multilateral environmental agreements (MEAs) including the three "Rio Conventions" - the United Nation Convention to Combat Desertification (UNCCD), the United Nation Convention on Biological Diversity (UNCBD), and the United Nation Framework Convention on Climate Change (UNFCCC). The Bahamas ratified the UNFCCC in 1994 and has also ratified the subsequent Kyoto Protocol in 1999, and the Paris Agreement in 2016.

2.3.2 Informal arrangements for domestic MRV

The Bahamas has numerous departmental strategy and planning documents are inclusive of climate MRV components. These strategies and planning documents serve as guiding documents, however, and are not necessarily indicative of formalized MRV roles or responsibilities.

2.3.3 Stakeholders involved in MRV

The Bahamas has a strong set of stakeholders involved in climate MRV. Specific roles and responsibilities for each stakeholder have not yet been established. Many of the stakeholders listed in Table 13 carry out MRV activities across multiple climate pillars and/or multiple MRV components.

Table 13*:* MRV system stakeholder list, roughly allocated across the three climate pillars

Primary climate pillar within MRV system ***Agencies may serve in multiple areas and/or sector expertise.***	**Agency or Institution**	**Sector/Expertise**
Institutional Coordination & Leadership	**Department of Environmental Planning and Protection (DEPP)**	Institutional
	National Climate Change Committee (NCCC)	Institutional
Mitigation & GHG Inventory	**Department of Agriculture, Ministry of Agriculture and Marine Resources**	Agriculture
	Bahamas Agricultural Health and Food Safety Authority (BAHFSA)	Agriculture
	Bahamas Agriculture and Marine Science Institute (BAMSI)	Agriculture

	Forestry Unit	LULUCF
	The Nature Conservancy	LULUCF
	Lands and Surveys	LULUCF
	The Bahamas National Trust (BNT)	LULUCF
	Bahamas Power and Light (BPL)	Energy
	Grand Bahama Power Company (GBPC)	Energy
	Freeport Oil Company (FOCOL)/Sun Oil Limited	Energy
	Rubis Bahamas Limited	Energy
	Sol Petroleum Bahamas Limited (ESSO)	Energy
	St. George's Cay Power Company	Energy
	Morton Salt Company - Power Company Division	Energy
	Bahamas Bureau of Standards and Quality (BBSQ)	Energy
	Utilities Regulation & Competition Authority (URCA)	Energy
	Road Traffic Department	Transport
	Engineers & Consultants Ltd	Transport
	Port Department	Transport
	Ministry of Transport and Housing	Transport
	Bahamas Maritime Authority (BMA)	Transport
	Buckeye Bahamas Hub Limited (BBH)	Transport
	Ministry of Public Works (Deputy Director of Works)	Transport
	Grand Bahama Port Authority (GBPA)	Transport

	New Providence Ecology Park	Waste
	Bahamas Waste	Waste
	Water and Sewerage	Waste
	Department of Environmental Health Services (Waste)	Waste
	Department of Environmental Health Services (National Ozone Unit)	IPPU
Adaptation	**Department of Marine Resources**	Water & Coastal Zone Resources
	University of The Bahamas, Climate Change and Adaptation Centre	Adaptation and Resilience
	Department of Gender & Family Affairs, Ministry of Social Services & Urban Development	Gender & Vulnerable Groups
	Ministry of Health and Wellness	Water & Coastal Zone Resources
	Bahamas Reef Environment Educational Foundation (BREEF)	Water & Coastal Zone Resources
	Islands Laboratory, University College London	Adaptation and Resilience
	National Emergency Management Agency (NEMA)	Adaptation and Resilience
	Disaster Reconstruction Authority (DRA)	Adaptation and Resilience
	Immediate Disaster and Emergency Assistance (IDEA) Relief	Adaptation and Resilience

	Department of Meteorology	Data and Information
	Ministry of Public Works	Urban Development & Infrastructure
Support	**Bahamas Development Bank (Climate Change/Blue Economy/Green Economy)**	Finance & Economic Development
	Central Bank of The Bahamas	Finance & Economic Development
	Ministry of Finance	Finance & Economic Development
	Prime Minister Delivery Unit	Finance & Economic Development
Crosscutting	**Bahamas Technical and Vocational Institute (BTVI)**	Education
	Sustainable Development Unit (OPM)	Finance & Economic Development
	Citizen Security and Justice Programme (CSJP) (Vulnerability/Gender)	Gender & Vulnerable Groups
	Bahamas National Statistical Institute (BNSI)	Data and Information
	Organization for Responsible Governance (ORG)	Governance

	The Bahamas Chamber of Commerce and Employers' Confederation	Finance & Economic Development
	Office of the Attorney General	Legal Affairs
	University of The Bahamas (Government and Public Policy Institute)	Education

2.4 GHG inventory, mitigation, adaptation, and support MRV

The Bahamas is working towards further developing MRV system components that move from a project-based (linear) system to an on-going, recurring system (cyclical). Until further development is completed, typical information management systems and cross-coordination of MRV work within each climate change pillar (mitigation, adaptation, support) will be limited. The system utilized for this report can be described, generally across each of the pillars, as the system utilized is the same. Future needs (described within the next section), will support the further elaboration of explicit roles and responsibilities, information collection and management, quality assurance and quality control (QA/QC) procedures, continuous standard operating procedures, documentation and archiving of data, and preparation and improvement planning documents.

2.4.1 Data collection and management

In general, data collection agreements and enforcement are not standard amongst broader climate MRV stakeholders in The Bahamas. However, there are isolated data collection mandates in the LULUCF, tourism, agriculture, energy, and transportation sectors. In general, data collection and reporting is directly linked to Ministry or project-based reporting cycles.

The primary data used in the most recent climate reporting, namely the GHG inventory, mitigation assessment, and vulnerability assessment, is done through various national statistical reports (e.g. Central Bank Annual and Quarterly Report, Customs Annual Imports Report) and through ad-hoc requests from members of the NCCC who may collect data sets through operation of agency-specific projects, research, or other mandates. These sources, combined, constitute a solid foundation of data suppliers. The Bahamas National Statistical Institute conducts labour and census surveys. These surveys are on a typical schedule but challenges have been noted in recent history. In general, data surveying and collection is further limited due to training of surveyors, human resources, and stakeholder fatigue due to lack of harmonization, synchronization, and alignment with multiple data collection requests and efforts.

Disaggregated datasets by standardized social, environmental, or economic indicators or parameters (e.g. sex-disaggregated climate data) are limited, but have improved in recent years due to stakeholder participation and international conventions (e.g. climate change, biodiversity, women's health, sustainable development goals). However, where efforts and progress have been made to improve surveys and/or data collection, the resulting data is still limited in its use.

2.4.2 Climate action development and implementation

Similar to data collection and management, mitigation and adaptation actions are developed and implemented by a range of stakeholders and government ministries. Measurement of actions from preparation, implementation, to on-going monitoring phases have yet to be formalised in The Bahamas. Currently, project-based measurement, reporting, and verification of actions are implemented at the direction of climate action funding sources. The implementation of measuring loss and damage is of high priority in The Bahamas, however MRV components have not yet been established for doing so.

2.4.3 Climate pillar sub-committees of the NCCC

In 2022, the NCCC will continue to fulfil its role with respect to the UNFCCC. Overtime, the capacity of the committee will be built to develop all chapters within the UNFCCC reports without the need for external consultants. In anticipation of trying to develop governmental structure to achieve this goal, it has created two subcommittees.

The ***first subcommittee*** is a Technical Subcommittee to provide technical expertise for the five Technical Expert Group (TEG) areas, namely the GHG Inventory, Vulnerability and Adaptation (V&A) Assessment, Mitigation Analysis, Environmentally Sound Technologies (EST), and Research & Systematic Observations (RSO). The following agencies are being recommended to be a member of this subcommittee: Bahamas National Statistical Institute, Department of Marine Resources (DMR), Department of Aviation (DOA), Ministry of Works and Utilities (MOWU) (formerly known as the Ministry of Public Works (MOPW)), Road Traffic Department, Bahamas Power and Light (BPL), and Water and Sewerage Corporation (WSC). The ***second subcommittee*** is the Public Education & Outreach (PEO) Subcommittee to be responsible for the sixth TEG area. Recommended agencies of this subcommittee are to include: Bahamas Information Services (BIS), Department of Gender & Family Affairs, Ministry of Education, University of The Bahamas (UB), Bahamas Reef Environmental Educational Foundation (BREEF), Bahamas Chamber of Commerce (BCCEC) and Bahamas Press Club. Recommended duties for each TEG are detailed in

Table 14.

Table 14: NCCC Subcommittees to support reporting across each climate pillar

Subcommittee	Expert Group	Duties
Technical Subcommittee	**Greenhouse Gas Inventory**	1. Advise on selection and application of appropriate inventory methodologies. 2. Assist in data quality assistance and key source analysis. 3. Recommend the ways of improvement of the national emission actors. 4. Contribute substantially to development of the National Inventory Report and identify the follow-up activities. 5. Assist the PMU in arrangement of the national review and training workshops on improving quality of the national GHG inventory.

Subcommittee	Expert Group	Duties
		6. Suggest on technical capacity building and participate in the sub regional, regional and international training on GHG inventory.
	Vulnerability & Adaptation Assessment	1. Advise on selection of appropriate methodologies to assess vulnerability and adaptation. 2. Oversee the development of climatic scenarios and selection of relevant methodologies. 3. Supervise/conduct an assessment of vulnerability and climate change impact. 4. Contribute substantially to development of the National Strategy on Adaptation to Climate Change and identify the follow up activities. 5. Help the PMU to organize the national review and training workshops on vulnerability and adaptation measures. 6. Suggest on capacity building and participate in the sub regional, regional and international trainings on integrated assessment modelling.
	Mitigation Analysis	1. Assist the PMU in search and choice of appropriate training courses on applying macro-economic models. 2. Advise on selection of macro-economic models for evaluating mitigation options and measures for GHG emission reduction. 3. Overview and select measures to mitigate climate change and identify the follow-up activities. 4. Assist the PMU in arranging the national review and training workshops on climate change mitigation measures. 5. Suggest on technical capacity building and participate in the sub regional, regional and international trainings on mitigation measures analysis.

Subcommittee	Expert Group	Duties
	Environmentally Sound Technologies	1. Advise on selection of priority technological needs. 2. Analyse the cost-effectiveness of the technologies and the opportunities for their application. 3. Assess the existing endogenous technologies for further promotion within the context of national circumstances. 4. Contribute substantially to the establishment of a database for ESTs, including both mitigation and adaptation technologies. 5. Identify the follow-up activities 6. Assist in arranging the national review and awareness raising workshops on ESTs and participate in the sub regional, regional and international trainings on ESTs.
	Research & Systematic Observations	1. Assess the existing system for early warning on extreme weather events and methods of seasonal forecasting. 2. Analyse the existing barriers for development of observation systems and research, and identify the follow-up activities 3. Contribute substantially to development of the National Information Report on Research and Systematic Observation. 4. Assist the PMU in arranging the national review and awareness raising workshops on research and systematic observation, and participate in the sub regional, regional and international trainings on the matter.
Public Education and	**Education, Training, & Public Awareness,**	1. Compile and analyse information on activities/tasks relating to the implementation of the New Delhi work program on Article 6 of the Convention.

Subcommittee	Expert Group	Duties
Outreach Subcommittee	**Information & Networking, Capacity Building**	2. Compile and analyse information on activities/tasks relating to the implementation of the capacity-building framework of the UNFCCC. 3. Identify the needs and priorities for climate change education, training and public awareness and capacity-building as they relate to the other 5 TEGs. 4. Liaise and consult with the various TEGs. 5. Assist in implementation of the National Plan for Article 6 of the Convention and the UNFCCC capacity-building framework. 6. Identify technology needs for information and networking. 7. Assist the PMU in organizing workshops on ways to promote climate change education, training and public awareness. 8. Substantially contribute to chapters in the NC on (i) Education, Training and Public Awareness, (ii) Information and Networking, and (iii) Capacity-building.

2.4.4 Support and climate finance MRV

The Bahamas through the GCF Readiness and Preparatory Support Programme has developed a climate finance MRV methodology and tool for tracking climate support needed and received. The feasibility study[6] conducted to develop this tool provided data for reporting support needed and received. The climate finance MRV tool has yet to be integrated with other finance systems in the Ministry of Finance.

This tool would allow for The Government of The Bahamas to:

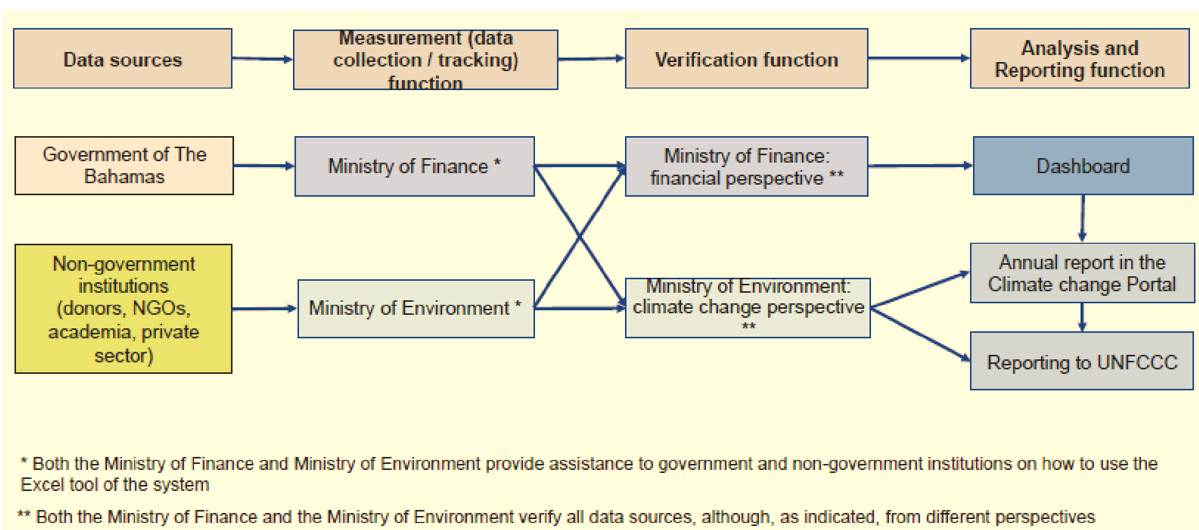
- Have a clear overview of NDC related financial flows, sources, and purposes

[6] Monitoring, Reporting and Verification System Under the GCF Readiness and Preparatory Support in The Bahamas: Feasibility Study Report (2021)

- Indicate the recipients of financial support and identify gaps in sectoral and geographical support
- Demonstrate accountability, transparency, and trust in future United Nations Framework Convention on Climate Change's (UNFCCC) negotiations and to the taxpayers of The Bahamas.
- Through the outputs of the project, the Bahamas intends to determine the following to prioritise its implementation next steps:
- The costs to implement the adaptation and mitigation actions that are outlined in the NDC, using results from a cost analysis
- The investments and finance needed to achieve The Bahamas' adaptation and mitigation priorities as outlined in the NDC

Figure 20 illustrates the proposed institutional arrangements of the climate finance MRV system.

Figure 20*:* Institutional Arrangements for proposed Climate Finance MRV as identified in Climate Finance MRV Manual



It should be noted that the climate finance MRV tool has yet to be integrated with other finance systems in the Ministry of Finance and was considered in the overall MRV assessment conducted during the BUR1 reporting cycle. Proposed institutional arrangements and barriers observed during the aforementioned process formed the baseline for analysis to prioritise recommendations for integration into future MRV system improvements.

2.5 Current progress towards establishment of a domestic MRV system

In an effort to move from a decentralized project-based system and improve transparency, The Bahamas through the TNC/BUR1 project prioritised the need to conduct an MRV system status assessment. Completed in 2022, the status described within this assessment report underscores the key premise of implementing it in the first place - that expectations based on existing decisions under the Paris Agreement will lead to increased levels of scrutiny on adherence to the TACCC principles of countries' reporting and MRV system institutional arrangements. The assessment provided an understanding of the current MRV system barriers and established a starting point for future improvement areas to be made (see Table 15).

Table 15*:* Gaps and needs of improvement identified in The Bahamas MRV system assessment

Identified Gaps	Needs for Improvement
MRV system not yet formally established	Set up MRV system with appropriate administrative capacity with focus on main data source providers involved in multiple reporting sectors.
Data collection, processing and reporting efforts need to yield better data more efficiently.	Establish and implement a sustainable MRV System with appropriate institutional, procedural, and legal arrangements with clear reporting and documentation requirements.
No official legislative or compliance mechanisms	Through the activities identified in the Capacity Building for Increased

	Transparency (CBIT)[7] project, conduct analysis of current legislation and policies and use recommendation for drafting of new policies that mandate the execution and continuity of climate-related institutional arrangements and activities that are internationally binding (example- reporting under the Paris Agreement, etc.)
No established data sharing agreements amongst stakeholders	Implement standardized operating procedures and agreements for data sharing to regularly collect data and reporting across all economic sectors
Need for greater public awareness around climate change initiatives	Conduct education and awareness campaigns from primary education level to broader public awareness campaigns. Public buy-in will foster political buy-in, which will be necessary for government stakeholders to continue their commitment to climate MRV.
Lack of Institutional and Human capacity to operate envisaged MRV System	Increase in number of staff hires, particularly full-time staff, to meet the demands of new national commitments for enhancing national climate MRV systems, and other related permanent functions such as participation in National GHG Inventory preparation,

[7] Building The Bahamas capacity in transparency for climate change mitigation and adaptation

	tracking of NDC goals, gender experts, and climate support tracking.
No established MRV QA/QC procedures	Embed QC procedures throughout the MRV system, and enact a set of QA procedures to assess the accuracy of final reports
No established MRV data archiving procedures	Embed data archiving procedures throughout the MRV system to ensure no loss of instituionalised or historical data for future Party reporting cycles
Lack of formal performance indicators to monitor mitigation and adaptation actions	Develop and track set of national MRV performance indicator to monitor the implementation and progress of mitigation and adaptation actions.
Insufficient domestic allocation for funding MRV system	Increase domestic allocation of funding to implement climate goals and monitor execution in the medium to long term

The Bahamas MRV assessment was conducted over nine months and also informed an initial "roadmap" of prioritised set of recommendations. The roadmap builds out a step-by-step process that, if implemented, will move The Bahamas towards a centralised project-based system, and then to an eventual centralised on-going system. The roadmap sets out prioritized activities across the following MRV system component areas:

- Legal framework(s)
- Institutional formal and informal procedural agreements or arrangements
- Data sources and data collection procedures
- Documentation of resource (financial and human resource) allocation
- Country-specific planning or preparation documents
- Quality assurance and quality control procedures
- Type and number of reporting documents
- Methodologies applied for estimation

- Information management and archiving procedures
- Stakeholder engagement

Furthermore, domestically, it is expected that this future MRV system will allow for the Government of The Bahamas to:

- Demonstrate transparency, accountability, and trust to the taxpayers of The Bahamas
- Determine the impacts and costs of climate change actions
- Determine the investments needed to achieve The Bahamas' adaptation and mitigation priorities
- Track progress of climate policies to improve implementation and ensure climate priorities and outcomes are achieved

Chapter 3 – National Greenhouse Gas (GHG) Inventories

Introduction

This chapter presents The Bahamas's national GHG inventory for the years 2001-2018, prepared in line with the IPCC 2006 Guidelines for national GHG inventories. The inventory scope covers the geographical borders of The Bahamas. Gases covered are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). While it is assumed that emissions from hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are at least likely to occur, the necessary data to perform estimates for these gases were not available. The Bahamas intends to move towards covering these gases in future GHG inventory submissions.

The Global Warming Potential (GWP) values from the IPCC's 5th Assessment report[8] were used (see Table 16).

Table 16: Global warming potentials used

Gas	GWP
CO_2	1
CH_4 (from biogenic sources)	28
CH_4 (from fossil sources)	30
N_2O	265

3.1. Inventory preparation

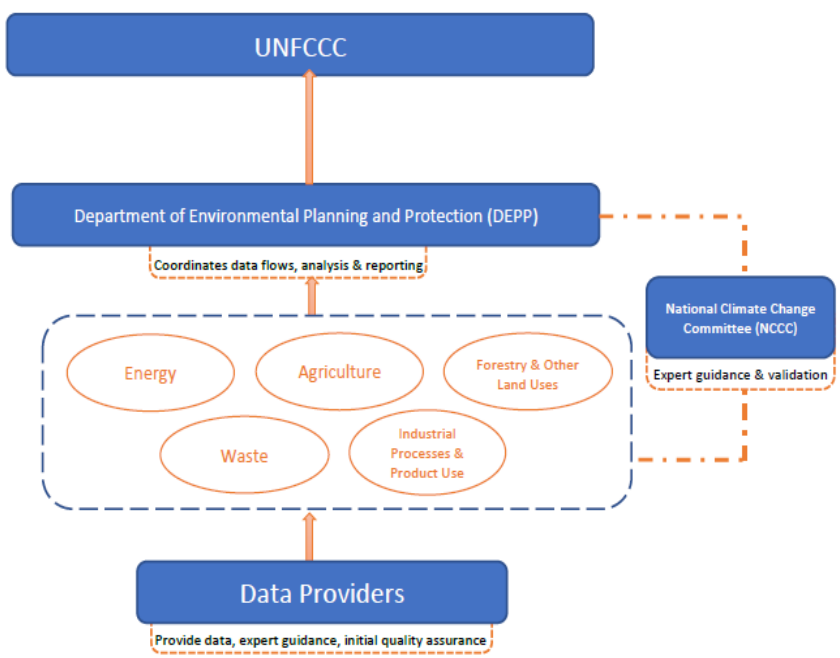
At present, The Bahamas National Climate Change Committee (NCCC) provides strategic level guidance on climate change related activities, policies, and plans, including the preparation of National Communications, Biennial Update Reports, National Inventory Reports, among others. The NCCC was established in 1996 by The Bahamas

[8] See Table 8.A.1, WG III, Chapter 8. Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Environment Science and Technology (BEST) Commission while under the Office of the Prime Minister, and now chaired and led by the Department of Environmental Planning and Protection (DEPP) (formerly BEST Commission). The Bahamas National Climate Change Committee (NCCC) consists of representatives from the government, private sector, non-governmental agencies and academic institutions.

The DEPP, apart from its role as the chair of the NCCC, is also the UNFCCC and GEF operational focal point, and coordinates the preparation and presentation of all reporting requirements to the UNFCCC. At present, the technical aspects of the preparation of the National Greenhouse Gas Inventory Report are led by regional consultants in a collaborative fashion with national experts with an aim to build national capacity. This includes both GHG inventory compilation training and hands-on participation in data collection, and quality assurance activities during inventory compilation. The institutions and roles of these actors involved are described in "Annex II - Institutions and Roles of those involved in the Preparation of The Bahamas' NIR". An illustration of these roles is shown below in Figure 21.

Figure 21: Institutional arrangements for the national GHG inventory preparation



3.2. Quality Assurance and Quality control

At present, The Bahamas is in the process of institutionalising its National Inventory Team and a system for quality control and quality assurance. For this inventory preparation cycle, sector level quality control checks on data being collected and estimations were made by the inventory compilers. Quality control checks were done to ensure that country estimations were developed and reported according to IPCC Good Practice Guidelines and follow the transparency, accuracy, consistency, comparability, completeness (TACCC) principles.

Existing QA/QC practices cover the following areas:

- Selection of methodologies
- Underlying assumptions of method for GHG estimation
- Selection of activity data and emission factors
- Means of data acquisition and management
- Documentation

The following quality control steps were undertaken initially by the inventory compiler, and secondarily internally reviewed by MRV Hub GHG accounting experts as a quality control check for each sector inventory. These quality control steps include:

- Check that assumptions and criteria for the selection of activity data and emission factors are documented
- Check for transcription errors in data input and reference
- Check that emissions/removals are calculated correctly
- Check that parameters and emission/removal units are correctly recorded and that appropriate conversion factors are used
- Check completeness, that estimates are reported for all categories and for all years from the appropriate base year over the period of the current inventory

In terms of quality assurance, national sector experts are increasingly being involved in data collection and understanding sector specific assumptions for methods. Other line Ministry representatives, and experts from non-governmental organizations and academia were also available for providing thorough review and assessment of the outputs from the emissions estimates and methodological assumptions.

The documentation and archiving of emissions estimates, worksheets, activity data, expert judgement and assumptions was done by the inventory compilers, and shared with the Department of Environmental Planning and Protection through a Dropbox folder, organized by all stages of the inventory cycle. This is done to ensure transparency, national ownership of data and reports, and promotes continuity of the inventory preparation for subsequent cycles.

The final stage of the inventory preparation cycle includes identification and documentation of further improvements. The current emissions inventory has already identified a range of cross-cutting improvements relating to both the emissions inventory data and the institutional arrangements, detailed in Annex II. These will be taken into account as the Government of The Bahamas continues to develop its national inventory team and system.

3.3. Description of Key Categories

A key category assessment was carried out for The Bahamas' GHG inventory estimates for the time series 2001-2018.[9] Both the level and trend assessments under approach 1 according to Volume 1, Chapter 4 of the IPCC 2006 Guidelines were conducted. The level of disaggregation chosen for the assessment was chosen according to table 4.1 of Chapter 4, Volume 1 of the IPCC 2006 Guidelines. Table 17 below presents the 13 key categories identified and indicates, whether they have been identified by the level assessment (L) and/or the trend assessment (T).

The majority of key categories identified, were identified under both level and trend assessment. They include stationary as well as mobile fuel combustion activities in the

[9] The previous National GHG Inventory of The Bahamas was published as part of The Bahamas' Second National Communication in 2014. This GHG inventory did not include a key category assessment, it is therefore not possible to assess how key categories have changed over time.

energy sector, land-based categories in the AFOLU sector (all aforementioned for CO_2) as well as solid waste disposal (for CH_4). Table 18 and Table 19 further below present the full results of the level and trend assessment.

A qualitative assessment in line with chapter 4, Volume 1 of the IPCC 2006 Guidelines considering the criteria mitigation techniques and technologies, expected growth and completeness have not led to the identification of additional key categories. At the same time, categories which could not be estimated due to lack of data have in most cases been prioritised in the improvement plan.

Table 17: Key categories identified

IPCC Category Code	IPCC Category Name	Gas	Key category related to Level (L) and/or Trend (T)
1.a.1.a.i	Electricity Generation	CO_2	L, T
1.A.2.m	Non-specified Industry	CO_2	L, T
1.A.3.b.i	Cars	CO_2	L, T
1.A.3.b.ii	Light-duty trucks	CO_2	L
1.A.3.b.iii	Heavy-duty trucks and buses	CO_2	L, T
1.A.4.a	Commercial/Institutional	CO_2	L, T
3.B.1.a	Forest land Remaining Forest Land	CO_2	L, T
3.B.1.b	Land Converted to Forest Land	CO_2	L, T
3.B.2.b	Land Converted to Cropland	CO_2	L, T
3.B.3.b	Land Converted to Grassland	CO_2	L, T

3.B.4.b	Land Converted to Wetlands	CO_2	L, T
3.B.5.b	Land Converted to Settlements	CO_2	L, T
4.A	Solid Waste Disposal	CH_4	L

Table 18: Results of the level assessment

IPCC category code	IPCC Category	Greenhouse gas	Latest year estimate in Gg CO_2-eq	Absolute value of latest year estimate	Level assessment	Cumulative value	Key category?
3.B.3.b	Land Converted to Grassland	CO2	2986.350	2986.350	0.3577	0.3577	Yes
1.a.1.a.i	Electricity Generation	CO2	1426.017	1426.017	0.1708	0.5285	Yes
3.B.4.b	Land Converted to Wetlands	CO2	550.035	550.035	0.0659	0.5943	Yes
3.B.1.b	Land Converted to Forest Land	CO2	-539.285	539.285	0.0646	0.6589	Yes
3.B.1.a	Forest land Remaining Forest Land	CO2	-503.335	503.335	0.0603	0.7192	Yes
1.A.3.b.i	Cars	CO2	380.434	380.434	0.0456	0.7648	Yes
1.A.4.a	Commercial/Institutional	CO2	354.086	354.086	0.0424	0.8072	Yes
3.B.5.b	Land Converted to Settlements	CO2	304.201	304.201	0.0364	0.8436	Yes
1.A.2.m	Non-specified Industry	CO2	282.663	282.663	0.0339	0.8775	Yes
4.A	Solid Waste Disposal	CH4	270.854	270.854	0.0324	0.9099	Yes
3.B.2.b	Land Converted to Cropland	CO2	138.313	138.313	0.0166	0.9265	Yes
1.A.3.b.ii	Light-duty trucks	CO2	131.971	131.971	0.0158	0.9423	Yes

1.A.3.b.iii	Heavy-duty trucks and buses	CO2	119.522	119.522	0.0143	0.9566	Yes
1.A.3.a.ii	Domestic Aviation	CO2	73.724	73.724	0.0088	0.9654	No
1.a.2.k	Construction	CO2	66.353	66.353	0.0079	0.9734	No
1.A.4.b	Residential	CO2	51.729	51.729	0.0062	0.9796	No
3.B.6.b	Land Converted to Other Land	CO2	42.826	42.826	0.0051	0.9847	No
4.D.1	Domestic Wastewaster Treatment and Discharge	CH4	42.565	42.565	0.0051	0.9898	No
1.A.4.c	Agriculture/Forestry/Fishing/ Fish Farms	CO2	32.061	32.061	0.0038	0.9936	No
3.C.4	Direct N2O Emissions from managed soils	N2O	7.988	7.988	0.0010	0.9946	No
1.A.3.d.ii	Water-borne navigation	CO2	5.971	5.971	0.0007	0.9953	No
1.A.3.b.i	Cars	CH4	5.435	5.435	0.0007	0.9959	No
4.D.1	Domestic Wastewaster Treatment and Discharge	N2O	5.210	5.210	0.0006	0.9966	No
1.A.3.b.i	Cars	N2O	4.655	4.655	0.0006	0.9971	No
1.a.1.a.i	Electricity Generation	N2O	3.033	3.033	0.0004	0.9975	No
3.C.5	Indirect N2O Emissions from managed soils	N2O	2.645	2.645	0.0003	0.9978	No
1.A.4.a	Commercial/Institutional	CH4	1.803	1.803	0.0002	0.9980	No
1.a.1.a.i	Electricity Generation	CH4	1.717	1.717	0.0002	0.9982	No

3.A.1	Enteric Fermentation	CH4	1.688	1.688	0.0002	0.9984	No
1.A.3.b.ii	Light-duty trucks	N2O	1.670	1.670	0.0002	0.9986	No
1.A.3.b.iii	Heavy-duty trucks and buses	N2O	1.667	1.667	0.0002	0.9988	No
1.A.3.b.ii	Light-duty trucks	CH4	1.476	1.476	0.0002	0.9990	No
2.D.1	Lubricant Use	CO2	1.085	1.085	0.0001	0.9991	No
3.A.2	Manure Management	N2O	0.918	0.918	0.0001	0.9993	No
4.C.2	Open Burning of Waste	CH4	0.857	0.857	0.0001	0.9994	No
1.A.4.a	Commercial/Institutional	N2O	0.821	0.821	0.0001	0.9995	No
4.C.2	Open Burning of Waste	CO2	0.739	0.739	0.0001	0.9995	No
1.A.2.m	Non-specified Industry	N2O	0.607	0.607	0.0001	0.9996	No
1.A.3.a.ii	Domestic Aviation	N2O	0.547	0.547	0.0001	0.9997	No
3.A.2	Manure Management	CH4	0.532	0.532	0.0001	0.9997	No
3.C.6	Indirect N2O Emissions from manure management	N2O	0.348	0.348	0.0000	0.9998	No
1.A.2.m	Non-specified Industry	CH4	0.346	0.346	0.0000	0.9998	No
1.A.3.b.iv	Motorcycles	CO2	0.310	0.310	0.0000	0.9999	No
1.A.4.b	Residential	CH4	0.195	0.195	0.0000	0.9999	No
1.A.3.b.iii	Heavy-duty trucks and buses	CH4	0.189	0.189	0.0000	0.9999	No
1.a.2.k	Construction	N2O	0.142	0.142	0.0000	0.9999	No
1.A.4.c	Agriculture/Forestry/Fishing/ Fish Farms	CH4	0.134	0.134	0.0000	0.9999	No
3.C.3	Urea application	CO2	0.11	0.111	0.0000	1.0000	No

4.C.2	Open Burning of Waste	N2O	0.088	0.088	0.0000	1.0000	No
1.a.2.k	Construction	CH4	0.081	0.081	0.0000	1.0000	No
1.A.4.c	Agriculture/Forestry/Fishing/ Fish Farms	N2O	0.071	0.071	0.0000	1.0000	No
1.A.4.b	Residential	N2O	0.053	0.053	0.0000	1.0000	No
1.A.3.d.ii	Water-borne navigation	N2O	0.041	0.041	0.0000	1.0000	No
4.C.2	Natural gas liquids transport	CO2	0.017	0.017	0.0000	1.0000	No
1.A.3.d.ii	Water-borne navigation	CH4	0.016	0.016	0.0000	1.0000	No
1.A.3.a.ii	Domestic Aviation	CH4	0.015	0.015	0.0000	1.0000	No
1.A.3.b.iv	Motorcycles	CH4	0.001	0.001	0.0000	1.0000	No
1.A.3.b.iv	Motorcycles	N2O	0.001	0.001	0.0000	1.0000	No
3.A.1	Enteric Fermentation	N2O	0.000	0.000	0.0000	1.0000	No

Table 19: Results of the trend assessment

IPCC category code	IPCC Category	Greenhouse gas	Base year estimate in Gg CO_2-eq	Absolute value of base year estimate in Gg CO_2-eq	Latest year estimate in Gg CO_2-eq	Absolute value of latest year estimate	Trend assessment	% Contribution to Trend	Cumulative value	Key category?
3.B.3.b	Land Converted to Grassland	CO2	1750.812	1750.812	2986.350	2986.350	0.127	0.268	0.268	Yes
3.B.5.b	Land Converted to Settlements	CO2	819.378	819.378	304.201	304.201	0.098	0.207	0.475	Yes
1.a.1.a.i	Electricity Generation	CO2	1527.482	1527.482	1426.017	1426.017	0.059	0.125	0.600	Yes
3.B.2.b	Land Converted to Cropland	CO2	380.163	380.163	138.313	138.313	0.046	0.097	0.698	Yes
3.B.1.a	Forest land Remaining Forest Land	CO2	-361.598	361.598	-503.335	503.335	0.031	0.065	0.763	Yes

3.B.4.b	Land Converted to Wetlands	CO2	324.778	324.778	550.035	550.035	0.023	0.048	0.812	Yes
1.A.4.a	Commercial/ Institutional	CO2	183.347	183.347	354.086	354.086	0.019	0.041	0.852	Yes
1.A.2.m	Non-specified Industry	CO2	143.274	143.274	282.663	282.663	0.016	0.034	0.886	Yes
3.B.1.b	Land Converted to Forest Land	CO2	-568.941	568.941	-539.285	539.285	0.012	0.026	0.912	Yes
1.A.3.b.iii	Heavy-duty trucks and buses	CO2	39.902	39.902	119.522	119.522	0.010	0.022	0.934	Yes
1.A.3.b.i	Cars	CO2	271.101	271.101	380.434	380.434	0.008	0.016	0.950	Yes
1.A.3.b.ii	Light-duty trucks	CO2	81.843	81.843	131.971	131.971	0.005	0.010	0.960	No
1.a.2.k	Construction	CO2	33.304	33.304	66.353	66.353	0.004	0.008	0.968	No
4.A	Solid Waste Disposal	CH4	205.783	205.783	270.854	270.854	0.003	0.007	0.975	No
1.A.3.a.ii	Domestic Aviation	CO2	75.218	75.218	73.724	73.724	0.002	0.005	0.980	No

1.A.4.b	Residential	CO2	30.023	30.023	51.729	51.729	0.002	0.005	0.985	No
1.A.4.c	Agriculture/ Forestry/ Fishing/Fish Farms	CO2	15.973	15.973	32.061	32.061	0.002	0.004	0.989	No
1.A.3.d.ii	Water-borne navigation	CO2	15.574	15.574	5.971	5.971	0.002	0.004	0.993	No
3.C.4	Direct N2O Emissions from managed soils (3)	N2O	10.508	10.508	7.988	7.988	0.001	0.001	0.994	No
2.D.1	Lubricant Use	CO2	3.754	3.754	1.085	1.085	0.000	0.001	0.995	No
3.B.6.b	Land Converted to Other Land	CO2	33.010	33.010	42.826	42.826	0.000	0.001	0.996	No
4.D.1	Domestic Wastewaster Treatment and Discharge	CH4	33.402	33.402	42.565	42.565	0.000	0.001	0.997	No

3.C.5	Indirect N2O Emissions from managed soils	N2O	3.452	3.452	2.645	2.645	0.000	0.000	0.998	No
1.A.3.b.iii	Heavy-duty trucks and buses	N2O	0.557	0.557	1.667	1.667	0.000	0.000	0.998	No
1.a.1.a.i	Electricity Generation	N2O	3.209	3.209	3.033	3.033	0.000	0.000	0.998	No
3.A.2	Manure Management	N2O	0.109	0.109	0.918	0.918	0.000	0.000	0.998	No
1.A.3.b.i	Cars	CH4	3.873	3.873	5.435	5.435	0.000	0.000	0.999	No
1.A.3.b.i	Cars	N2O	3.317	3.317	4.655	4.655	0.000	0.000	0.999	No
1.A.4.a	Commercial/ Institutional	CH4	1.043	1.043	1.803	1.803	0.000	0.000	0.999	No
1.a.1.a.i	Electricity Generation	CH4	1.816	1.816	1.717	1.717	0.000	0.000	0.999	No
1.A.3.b.ii	Light-duty trucks	N2O	1.020	1.020	1.670	1.670	0.000	0.000	0.999	No
4.D.1	Domestic Wastewaster	N2O	4.690	4.690	5.210	5.210	0.000	0.000	0.999	No

	Treatment and Discharge									
1.A.4.a	Commercial/ Institutional	N2O	0.427	0.427	0.821	0.821	0.000	0.000	0.999	No
1.A.2.m	Non-specified Industry	N2O	0.310	0.310	0.607	0.607	0.000	0.000	1.000	No
1.A.3.b.ii	Light-duty trucks	CH4	1.033	1.033	1.476	1.476	0.000	0.000	1.000	No
3.C.6	Indirect N2O Emissions from manure management	N2O	0.138	0.138	0.348	0.348	0.000	0.000	1.000	No
1.A.2.m	Non-specified Industry	CH4	0.177	0.177	0.346	0.346	0.000	0.000	1.000	No
1.A.3.a.ii	Domestic Aviation	N2O	0.559	0.559	0.547	0.547	0.000	0.000	1.000	No
1.A.3.b.iii	Heavy-duty trucks and buses	CH4	0.063	0.063	0.189	0.189	0.000	0.000	1.000	No

1.A.3.d.ii	Water-borne navigation	N2O	0.107	0.107	0.041	0.041	0.000	0.000	1.000	No
1.a.2.k	Construction	N2O	0.072	0.072	0.142	0.142	0.000	0.000	1.000	No
3.A.1	Enteric Fermentation	CH4	1.357	1.357	1.688	1.688	0.000	0.000	1.000	No
1.A.4.c	Agriculture/ Forestry/ Fishing/Fish Farms	CH4	0.067	0.067	0.134	0.134	0.000	0.000	1.000	No
1.A.4.b	Residential	CH4	0.120	0.120	0.195	0.195	0.000	0.000	1.000	No
3.C.3	Urea application	CO2	0.052	0.052	0.111	0.111	0.000	0.000	1.000	No
4.C.2	Open Burning of Waste	CH4	0.673	0.673	0.857	0.857	0.000	0.000	1.000	No
1.A.3.b.iv	Motorcycles	CO2	0.221	0.221	0.310	0.310	0.000	0.000	1.000	No
4.C.2	Open Burning of Waste	CO2	0.580	0.580	0.739	0.739	0.000	0.000	1.000	No
1.A.3.d.ii	Water-borne navigation	CH4	0.042	0.042	0.016	0.016	0.000	0.000	1.000	No
1.a.2.k	Construction	CH4	0.041	0.041	0.081	0.081	0.000	0.000	1.000	No

3.A.2	Manure Management	CH4	0.468	0.468	0.532	0.532	0.000	0.000	1.000	No
1.A.4.c	Agriculture/ Forestry/ Fishing/Fish Farms	N2O	0.036	0.036	0.071	0.071	0.000	0.000	1.000	No
1.A.4.b	Residential	N2O	0.029	0.029	0.053	0.053	0.000	0.000	1.000	No
4.C.2	Open Burning of Waste	N2O	0.069	0.069	0.088	0.088	0.000	0.000	1.000	No
1.A.3.a.ii	Natural gas liquids transport	CO2	0.011	0.011	0.017	0.017	0.000	0.000	1.000	No
1.A.3.a.ii	Domestic Aviation	CH4	0.016	0.016	0.015	0.015	0.000	0.000	1.000	No
1.A.3.b.iv	Motorcycles	CH4	0.001	0.001	0.001	0.001	0.000	0.000	1.000	No
1.A.3.b.iv	Motorcycles	N2O	0.001	0.001	0.001	0.001	0.000	0.000	1.000	No
3.A.1	Enteric Fermentation	N2O	0.000	0.000	0.000	0.000	0.000	0.000	1.000	No

3.4. Uncertainty assessment (qualitative)

This section provides an uncertainty assessment of The Bahamas' national GHG inventory at a qualitative level. The IPCC 2006 Guidelines consider a quantitative assessment good practice. Such a quantitative assessment can however only be meaningful, where estimates for the uncertainty of activity data and emission factors (or other factors/assumptions) are available. Alternatively, the IPCC 2006 Guidelines, in its sectoral chapters provides default values for the uncertainty assessment. The importance of the uncertainty assessment lies less in the overall uncertainty value for the national GHG inventory as a total for a specific year. The assessment becomes valuable once consistently produced uncertainty assessments are available for a number of GHG inventory submissions, thus allowing to understand improvements over time. Considering one specific GHG inventory submission, the assessment helps in identifying and prioritising categories with improvement potential.

Uncertainty data was not available for any activity data in The Bahamas and availability of activity data was limited. The decision was thus taken to focus the available resources on the data collection effort and filling of gaps, instead of conducting an uncertainty assessment based solely on IPCC defaults. Such an assessment would not have yielded any added value with regards to identifying and prioritising improvement potential, as a long list of improvements had already been compiled as part of the data collection process.

The following main sources of uncertainty for The Bahamas' national GHG inventory were identified:

- Related to completeness
    - Lack of information on the existence of emissions from specific IPCC categories (e.g. under category 1.A.2 Manufacture and construction, category 2.G Other product use)
    - Lack of activity data (e.g., 2.G.1 Refrigeration and air conditioning)

- Accuracy
    - Data was often available only for part of the time series making it difficult to understand the trends
    - No country-specific emission factors are available
    - National circumstances might not well or no longer align with the IPCC defaults (e.g. waste generation rates per capita, vehicle categories)
    - Information related to sector-specific assumptions is often not available (e.g. number of trips and average distances for category 1.A.3.b Road transport)

A detailed list of improvements required to reduce uncertainty related to these issues is presented in Annex II.

3.5. Improvement potential

During the compilation of The Bahamas' national GHG inventory, future improvement potential was identified and documented. Table 20 below presents the most relevant areas for improvements, while the full list of improvement options is presented in Annex II. The improvement options presented in the Annex differ in their urgency and timeframes they can be implemented in. This chapter shows the improvements deemed most relevant, as the pertain to key categories.

Table 20: Most relevant areas for improvement

Area	Most relevant areas for improvement
Cross-cutting	• Set up appropriate institutional, procedural, legal arrangements, and documentation for recurring preparation of the national GHG inventory • Appoint a national GHG inventory compilation team • Fully establish and implement QA/QC procedures for the national GHG inventory
Energy	• Ensure data on fuel imports compiled by the Central Bank of the Bahamas are complete and accurate

	● Obtain disaggregated data of fuel imports (potentially with the help of fuel distributors) by relevant subcategories, e.g. manufacture and industries (1.A.2), commercial/institutional (1.A.4.a), and residential (1.A.4.b). ● Develop a national energy balance in the longer term ● Collect power generation and fuel consumption from local power producers (Bahamas Power and Light, Company Ltd. Grand Bahama Power Company) ● Develop country-specific emission factors ● Better understand which relevant manufacture and production activities take place and collect activity data ● Obtain complete activity data on vehicle population across the entire time series
IPPU	● Collect HFC and PFC import data (as substance and in products) ● Assess which IPPU categories occur (e.g. electrical equipment, category 2.G.1)
AFOLU	● Develop country-specific emission factors for categories 3.B.1.a-b, 3.B.2.b, 3.b.3.b, 3.B.4.b and 3.b.5.b ● Establish and validate (i.e. ground-truth) a sample of permanent plots of each land use type (at minimum the main IPCC classes, especially pine and mangrove for forest land which are prominent in the Bahamas) to improve land classification maps and remote sensing model ● Determine the end use of fertilizers and other agricultural additives reported in the annually produced Customs Imports report with Agriculture experts ● Conduct a survey of livestock in country, including livestock manure management practices on an annual basis, and align with National Agricultural Census cycle
Waste	● Collect information on the depth of landfills (one-time survey)

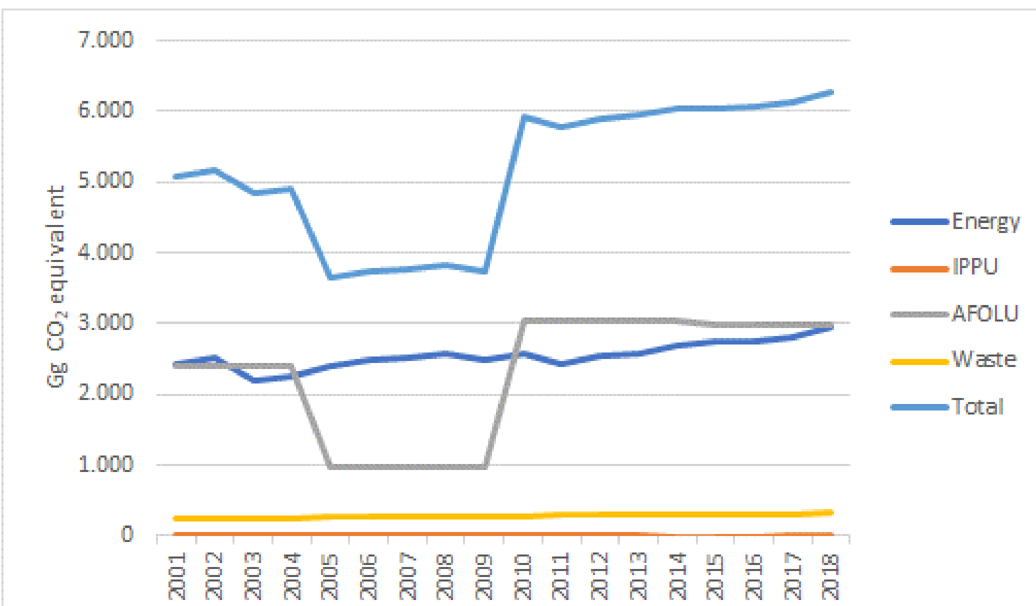
	• Assess solid waste generation and composition • Collect data from national food and beverage manufacturing companies on industrial wastewater flows

GHG emissions and removals 2001-2018

3.6. Overview

Total GHG emissions in The Bahamas rose from 5,074.09 Gg CO_2-eq in 2001 to 6,264.39 Gg CO_2-eq in 2018, which equals an increase by 23.5 cent (see Figure 22).[10] During the same time period GHG emissions from the waste sector rose by 30.6 per cent, from the AFOLU sector (including both emissions and removals) by 25.1 per cent, and from the energy sector by 21.1 per cent. IPPU sector emissions, to the extent estimated in this GHG inventory publication which covered only lubricant use[11], fell by 71.1 per cent. GHG estimates for 2001-2018 are presented in Table 21.

Figure 22: Total GHG emissions by sector 2001-2018



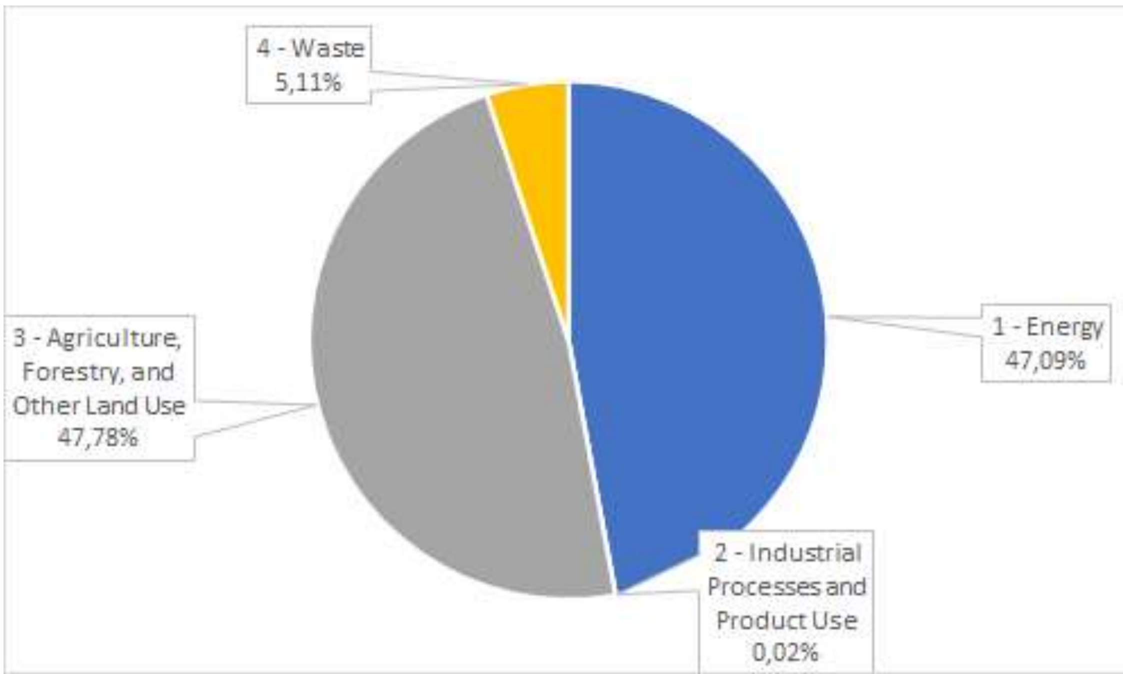
[10] The previous GHG inventory of the BAHAMAs published as part of The Bahamas Second National Communication in 2014 presented GHG emissions for the year 2000, amounting to 702.82 Gg CO_2-eq. when considering the gases CO_2, CH_4 and N_2O. These had been estimated using the IPCC Revised 1996 Guidelines for national GHG inventories and the GWPs from the IPCC's 2nd Assessment Report.

[11] Due to lack of data, GHG emissions from the use of HFCs and PFCs and of other potentially relevant sources could not be estimated. More information is provided in section 2 of this report.

Developments of and drivers for sectoral and category-level trends are presented in the forthcoming sectoral chapters (2.2 - 2.5)

The AFOLU and energy sectors dominate total national GHG emissions in The Bahamas, contributing 47.8 per cent and 47.1 per cent, respectively, to total emissions in 2018. The waste sector contributes 5.1 per cent and the IPPU sector was less than 0.1 per cent during the same year (see Figure 23).

Figure 23: Percent contribution of IPCC sectors to total GHG emissions in 2018



Total CO_2 emissions amounted to 5909.18 Gg in 2018, representing 94.3 per cent of total GHG emissions. CH_4 amounted to 11.68 Gg in 2018, representing 5.2 per cent of the total and N_2O to 0.12 Gg in 2018, representing 0.5 per cent of the total (see Figure 24).

Likely drivers to The Bahamas' GHG inventory emissions are the population and economic development. The increase in tourism has likely lead to an increase in demand on fuel and transportation, thus affecting energy sector emissions. GDP has increased by 56 per cent since 2001, the population by 27 per cent (see Figure 25).

Figure 24: Contribution of gases to total GHG emissions in 2018

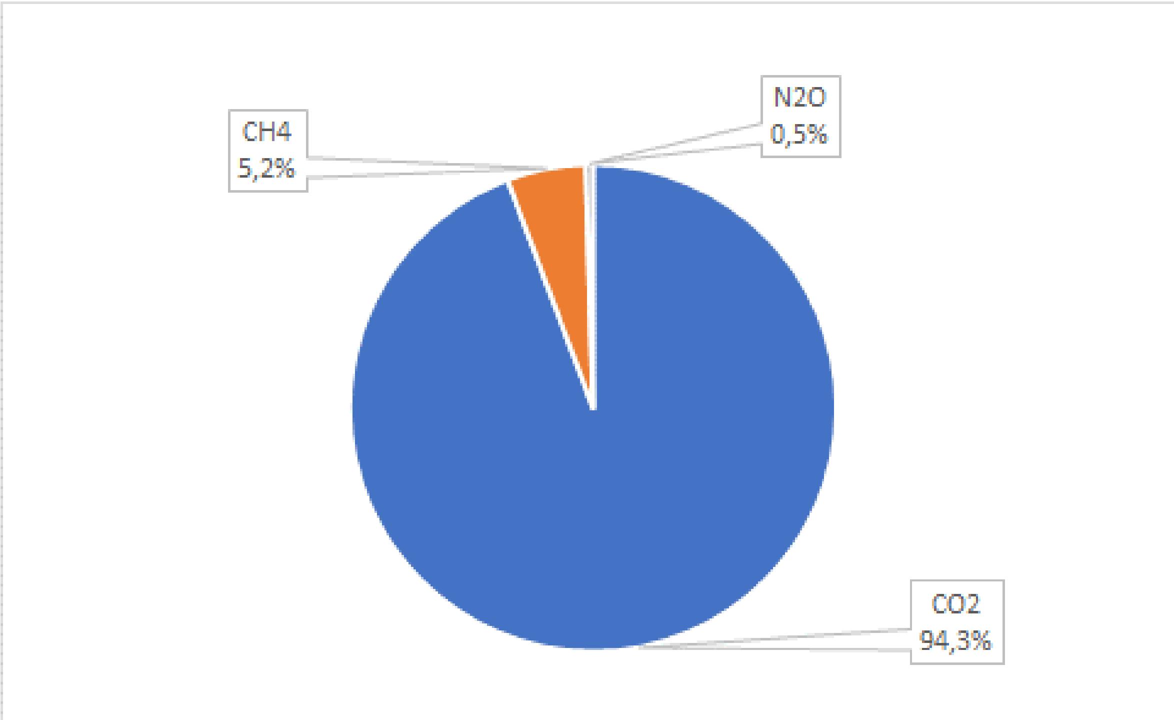
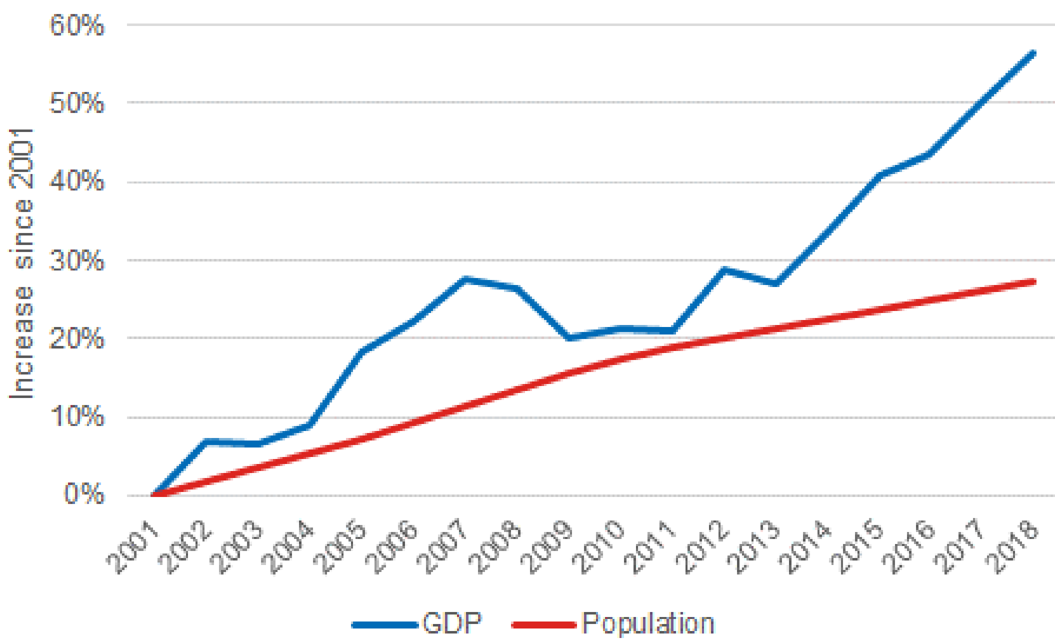


Figure 25: Increase in GDP and population in the Bahamas between 2001-2018



The GHG emissions per capita in The Bahamas was 16.24 tCO_2eq in 2018, which represents a decrease of 3.2 per cent compared to 2001.

Table 21: Total GHG emissions by sector

Categories	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Change between 2001 - 2018
Total	Gg CO_2-eq.	5,077.85	5,157.60	4,852.38	4,901.25	3,640.68	3,744.15	3,765.39	3,832.61	3,738.27	5,926.03	5,771.82	5,902.51	5,941.44	6,045.44	6,053.83	6,063.13	6,115.05	6,264.31	23.4%
1 – Energy	Gg CO_2-eq.	2,435.21	2,512.78	2,207.71	2,243.39	2,407.76	2,501.62	2,517.49	2,583.99	2,485.98	2,583.91	2,427.07	2,553.17	2,588.42	2,686.94	2,752.86	2,759.77	2,805.72	2,949.58	21.1%
2 – Industrial Processes and Product Use	Gg CO_2-eq.	3.75	8.43	2.84	2.84	3.42	4.17	3.25	3.59	3.09	3.17	1.42	1.08	1.75	1.00	1.00	1.00	1.17	1.08	-71.1%

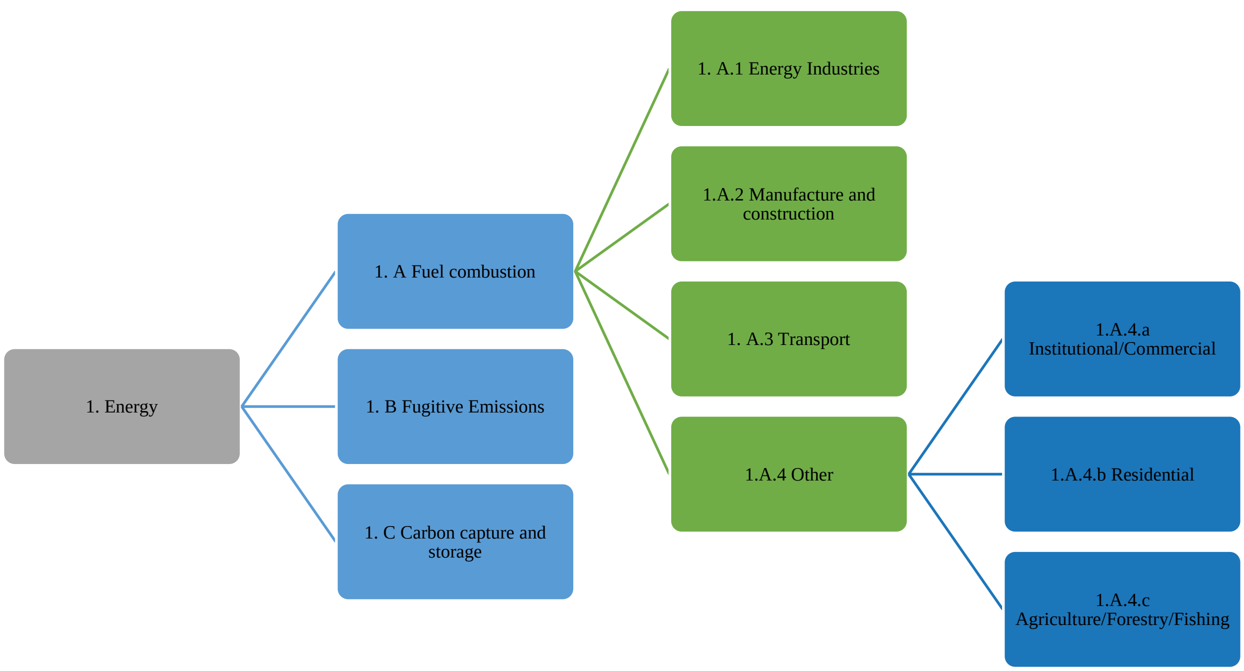
3 – Agriculture, Forestry, and Other Land Use	Gg CO_2-eq.	2,393.69	2,387.17	2,388.73	2,397.80	967.73	971.70	973.12	968.57	967.69	3,052.16	3,051.84	3,052.31	3,050.36	3,052.66	2,991.21	2,989.65	2,991.64	2,993.34	25.1%
4 – Waste	Gg CO_2-eq.	245.20	249.22	253.11	257.22	261.77	266.67	271.52	276.46	281.51	286.79	291.49	295.94	300.90	304.83	308.75	312.71	316.51	320.31	30.6%

3.7. Energy

The scope of the energy sector under the IPCC 2006 Guidelines for national GHG inventories covers a broad array of GHG emission sources. These include stationary fuel combustion (for power and heat generation, in the manufacture and construction sectors, in the residential sector, in the institutional and commercial sector as well as related to agriculture, fisheries, forestry) and fuel combustion in the transport sector. Furthermore, it includes fugitive GHG emissions from fuel production and distribution as well as GHG emissions from carbon capture and storage where such activities take place. Figure 26 provides a simplified overview of GHG emission categories in the energy sector.

In The Bahamas, most energy sector emissions stem from fuel combustion. Power generation is based on fuel oil and diesel. The Bahamas has only limited industrial activities, emissions from fuel consumption in the manufacture and industry sub-sector therefore focus on construction.

Figure 26: Categories in the IPCC sector energy



The transport sector is dominated by road transport, but also domestic aviation and domestic waterborne navigation play a role, with tourism being a strong driver for the subsector.

Emissions in the institutional/commercial subsector are also strongly influenced by tourism activity. Agriculture, fisheries and forestry only take place to a limited extent. Fuel production does not take place, however, fuel distribution does. Carbon capture and storage is not practiced.

On this basis, GHG emission estimates for the gases CO_2, CH_4, N_2O were compiled for the energy sector categories presented in
Table 22 below. These are the categories where relevant activities place in The Bahamas. Information about the activities relevant to each category (e.g., related to manufacture and construction) which are found in The Bahamas is provided from section 3.2.3.1 onwards.

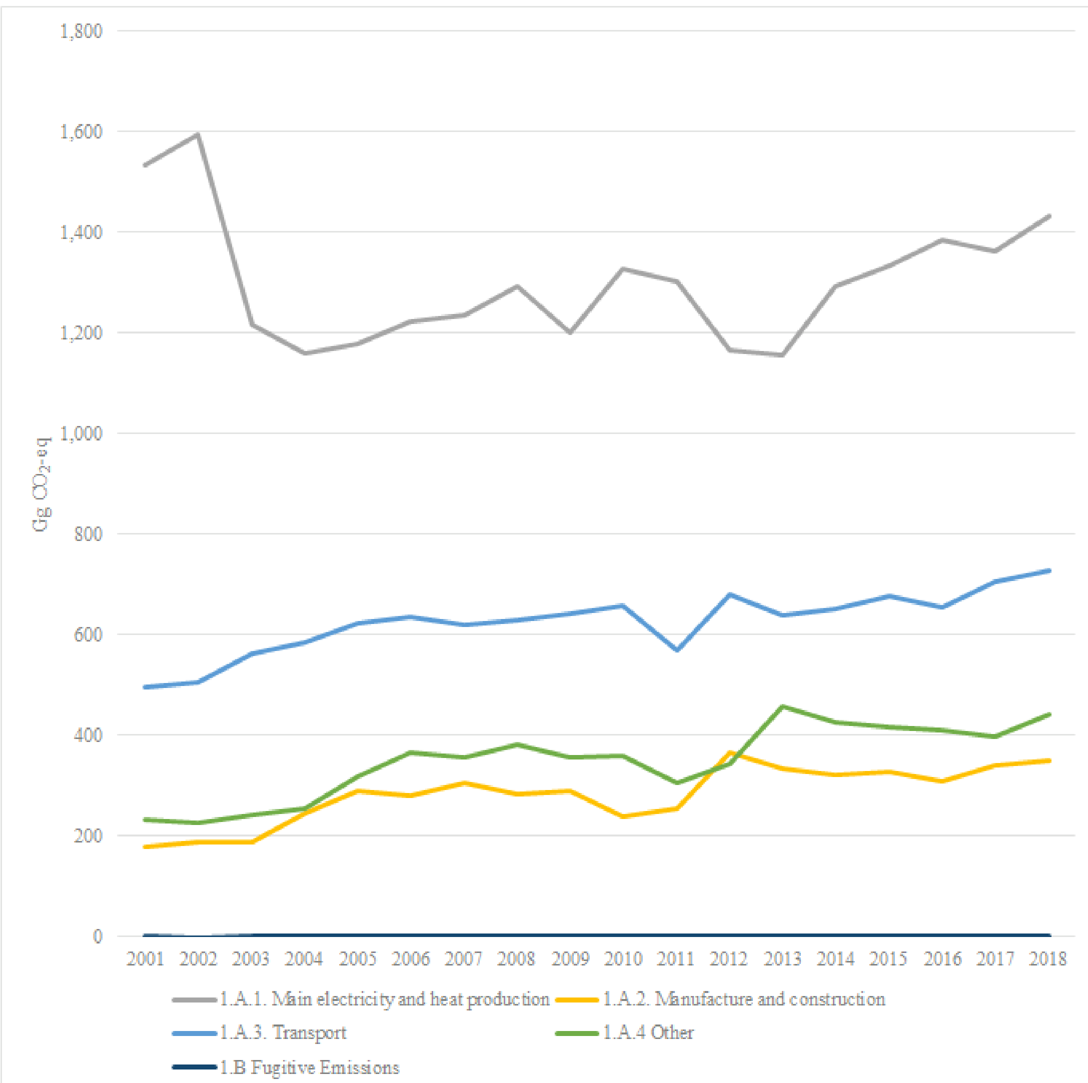
Table 22: GHG emission categories covered for the energy sector

IPCC Category	Category Name
1.A.1.a.1	Main electricity and heat production
1.A.2.	Manufacture and construction
1.A.2.k	Construction
1.A.2.m	Non-specified industry
1.A.3 Transport	
1.A.3.a. Aviation	• 1.A.3.a.i International Aviation • 1.A.3.a.i Domestic Aviation
1.A.3.b Road Transportation	• 1.A.3.b.i Cars • 1.A.3.b.i Light duty trucks • 1.A.3.b.i Heavy duty trucks and buses • 1.A.3.b.i Motorcycles
1.A.3.c. Navigation	• 1.A.3.c.i International Waterborne Navigation • 1.A.3.c.ii Domestic Waterborne Navigation
1.A.4	Other
1.A.4.a	Institutional/commercial

1.A.4.b	Residential
1.A.4.c	Agriculture/fisheries
1.B	Fugitive Emissions
1.B.2.A.iii.3	Natural Gas Liquids transport

An overview of GHG emissions in the Energy sector by category and by gas is presented in Table 23 below. Total GHG emissions in the energy sector amounted to 2435.21 Gg CO_2-eq in 2001 and 2949.58 Gg CO_2-eq in 2018, see Figure 27.

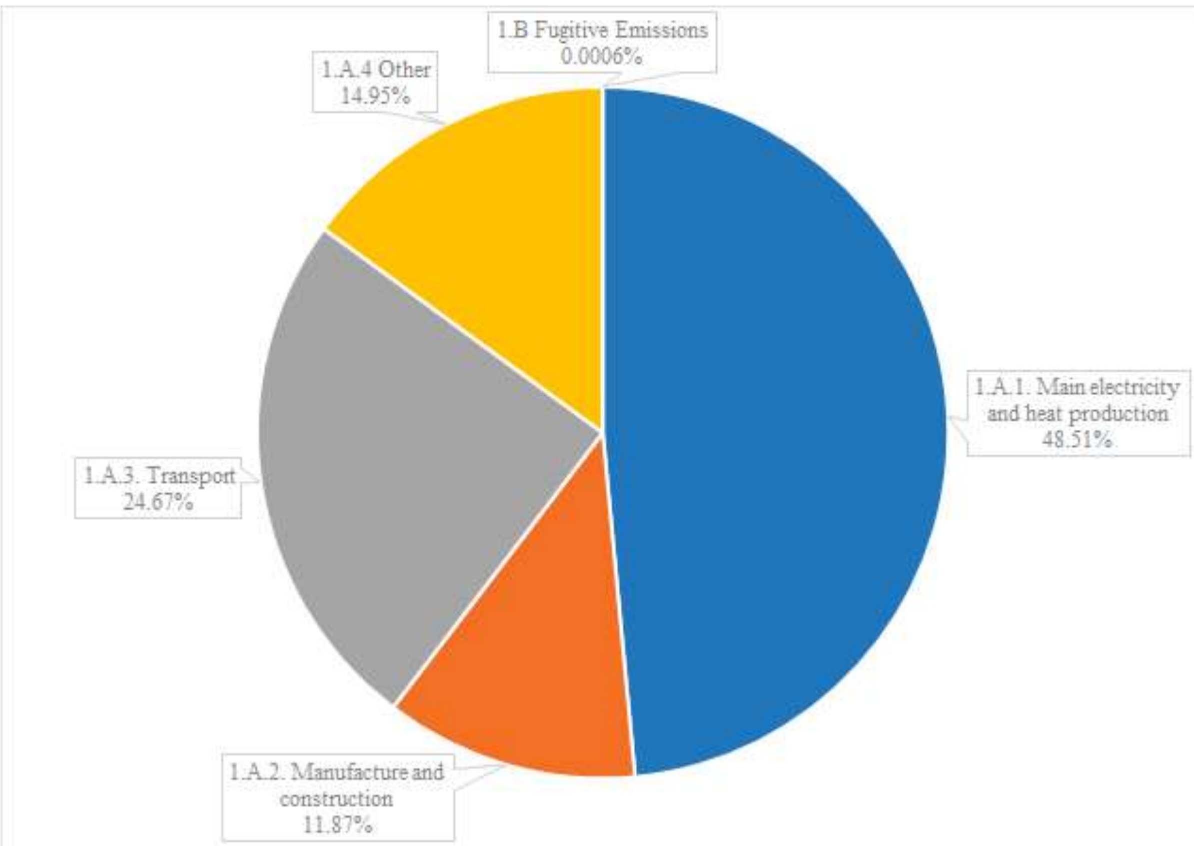
Figure 27: GHG emissions in the energy sector 2001-2018, by categories



The above information represents an increase by 21.1 per cent. In the same time frame, GDP has increased by over 60 per cent and population by nearly 30 per cent.

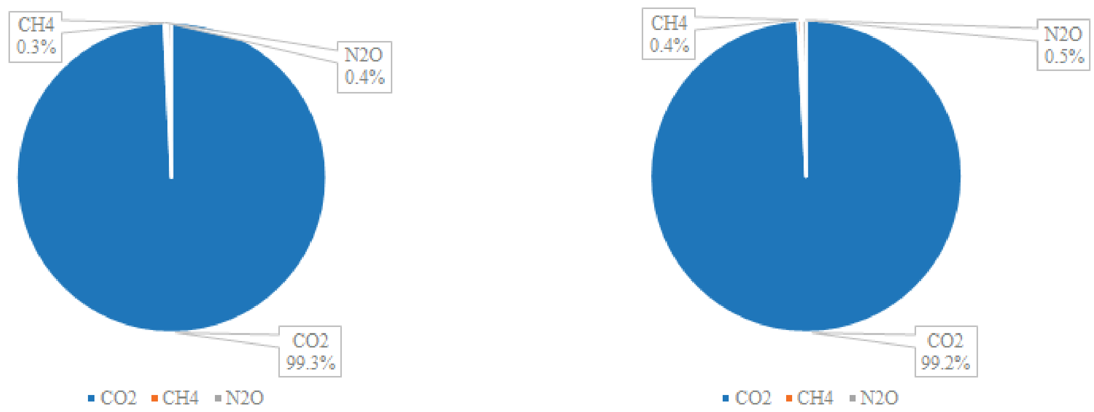
Main power and heat generation is the largest GHG emission source in the energy sector with 48.5 per cent of total emissions, followed by transport with 24.6 per cent. Manufacture and construction contributes 11.9 per cent and Other 15.0 per cent. The contribution of Fugitive Emissions category is minute with 0.0006 per cent.

Figure 28: Contribution of categories to total GHG emissions in the energy sector in 2018



Shares of the gases in total emissions have remained similar over time, around 99 per cent for CO_2 and below 1 per cent for CH_4 as well as for N_2O. Figure 29 shows the contribution of the three gases to total GHG emissions in the energy sector in 2001 as well as in 2018.

Figure 29: Contribution of gases to total GHG emissions in the energy sector in 2001 and 2018



GHG emissions for the subcategories 1.A.1 Main Electricity and Heat Production, 1.A.2 Manufacture and Construction, 1.A.3 Transport and 1.A.4 Other sector all show an increasing trend since 2011. Before, they had shown an overall slightly downward trend. For the energy sector as a whole, GHG emissions have increased by 21.1 per cent between 2001 and 2018. This includes a reduction of 6.6 per cent from Main Electricity and Heat Production, and an increase by 97.7 per cent in Manufacture and Industries, 90.8 per cent in Other and 47.2 per cent in Transport.

The increase in population as well as in GDP and related to that, tourism activity, can be deemed to have played a key role in the generally upwards moving trend since 2011. Technological change, e.g. the replacement of equipment for power generation, might potentially have played a role in reducing fuel consumption in earlier years of the time series. Data indicates that generation efficiency has considerably increased from 2003 onwards compared to 2001 and 2002. Furthermore, GDP has remained nearly stable between 2002-2004. A general decrease in fuel consumption in the sectors Transport and Other can be seen between 2009-2010. This might be related to the global financial crisis 2008-2010.

Table 23: GHG emissions in the Energy sector, by category

Category	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Difference 2018 vs 2001
1.Energy Total	Gg CO_2-eq	**2435.21**	**2512.78**	**2207.71**	**2243.39**	**2407.76**	**2427.07**	**2553.17**	**2588.42**	**2686.94**	**2752.86**	**2759.77**	**2805.72**	**2949.58**	**21.12%**	**2435.21**	**2512.78**	**2207.71**	**2243.39**	**21.1%**
1.A. Fuel combustion	Gg CO_2-eq	2435.20	2512.78	2207.70	2243.38	2407.75	2427.06	2553.16	2588.41	2686.93	2752.85	2759.76	2805.71	2949.56	21.12%	2435.20	2512.78	2207.70	2243.38	21.1%
1.A.1. Main electricity and heat production	Gg CO_2-eq	1532.51	1593.82	1217.35	1159.20	1177.49	1300.38	1165.09	1156.89	1291.53	1334.40	1383.86	1363.47	1430.77	-6.64%	1532.51	1593.82	1217.35	1159.20	-6.6%
1.A.2. Manufacture and construction	Gg CO_2-eq	177.18	188.55	187.28	245.98	290.65	253.17	365.38	335.03	320.99	327.69	309.69	339.29	350.19	97.65%	177.18	188.55	187.28	245.98	97.7%

1.A.3. Transport	Gg CO_2-eq	494.45	504.45	562.57	585.06	621.10	567.16	681.13	639.38	650.10	675.76	654.90	704.57	727.65	47.16%	494.45	504.45	562.57	585.06	47.2%
1.A.4 Other	Gg CO_2-eq	231.07	225.96	240.50	253.15	318.51	306.36	341.57	457.11	424.32	415.00	411.31	398.38	440.95	90.83%	231.07	225.96	240.50	253.15	90.9%
1.B Fugitive Emissions	Gg CO_2-eq	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	64.29%	0.01	0.01	0.01	0.01	64.3%

Table 24: Total GHG emissions in the energy sector, by gas

Gas	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Difference 2018 vs 2001
Total	Gg CO_2-eq	2435.21	2512.78	2207.71	2243.39	2407.76	2427.07	2553.17	2588.42	2686.94	2752.86	2759.77	2805.72	2949.58	2435.21	2512.78	2207.71	2243.39	2407.76	21.1%
CO_2	Gg CO_2-eq	2417.27	2494.28	2188.64	2224.30	2387.62	2407.35	2531.11	2566.67	2664.81	2729.97	2737.12	2781.98	2924.86	21.00%	2417.27	2494.28	2188.64	2224.30	21.0%
CH_4	Gg CO_2-eq	8.29	8.50	9.16	8.73	9.06	9.11	9.75	10.06	10.19	10.53	10.50	10.88	11.41	37.59%	8.29	8.50	9.16	8.73	37.6%

N_2O	Gg CO_2-eq	9.64	10.00	9.91	10.37	11.08	10.62	12.32	11.69	11.95	12.36	12.15	12.85	13.31	38.01 %	9.64	10.00	9.91	10.37	38.01 %

3.8. IPPU

The industrial processes and product use sector covers a wide range of sources of GHG emissions. These include process (i.e., non-energy related) emissions from industrial production as well as emissions related to the use of certain products. GDP in The Bahamas focuses on the financial sector as well as on tourism, with only very limited industrial production taking place.

Data collection and consultation with experts indicates that no relevant industrial production, e.g., of cement clinker, glass, ceramics or steel takes place in The Bahamas at present. Moreover, a number of product use categories clearly occur or are likely to occur, while no data is available. These are presented in Table 25.

Table 25: Categories of the IPPU sector not estimated due to lack of data

Gas and IPCC category	IPCC category code	Likelihood of occurrence
CO_2 emissions from the use of paraffin waxes and solvent use	2.D.2, 2.D3	Likely
HFC emissions from the operation and discharge of refrigeration and air conditioning equipment	2.F.1	Emissions do occur
HFC emissions from the use of building foams, aerosols and solvents	2.F.2, 2.F.3, 2.F.4	Likely
SF_6 emissions from the operation of electrical equipment	2.G.1	Likely
N_2O emissions from the use of N_2O in hospitals	2.G.3	Likely

Due to the lack of data, GHG emissions from these categories could not be estimated. Particularly the HFC emissions from the operation and discharge of refrigeration and air conditioning equipment are likely to make a relevant contribution to The Bahamas total

GHG emissions. The collection of relevant data for the compilation of the next GHG inventory should thus be considered a priority. Annex II presents suggestions on how to retrieve relevant in the course of future GHG inventory compilations.

Emissions of product use which occur and for which data was available, relates to the use of lubricants. These emissions are presented in Table 26. This source only leads to emissions of CO_2. Emissions have decreased by over 70% over the time series, with a dip of over 50% happening between 2010 and 2011. Reasons for this development are presently unknown and should be researched as part of future GHG inventory compilations. A potential explanation could be structural changes after the economic crisis 2008-2010.

Table 26: Total GHG emissions in category 2.D.1 Lubricant use

Category	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% Change 2018 vs 2001
2.D.1	Gg CO_2-eq	3.75	8.43	2.84	2.84	3.42	4.17	3.25	3.59	3.09	3.17	1.42	1.08	1.75	1.00	1.00	1.00	1.17	1.08	-71.11%

3.9. AFOLU

3.9.1. Agriculture

The agriculture sector covers a wide range of sources of GHG emissions including from livestock, crop production, fertilizer use, and soil management. The agriculture sector in The Bahamas remains a small percentage of the national GDP. These practices include small scale farming of food crops, limited livestock production throughout the islands, and more significantly, poultry egg and broiler production and soil enrichment from fertilizers. The addition of lime to agricultural soils was not estimated, as national soils are considered calcareous, and biomass burning was not estimated, as post-crop burning is not considered a common practice.

On this basis, GHG emission estimates for the gases CO_2, CH_4, N_2O were compiled for the agriculture sector categories presented in Table 27 below.

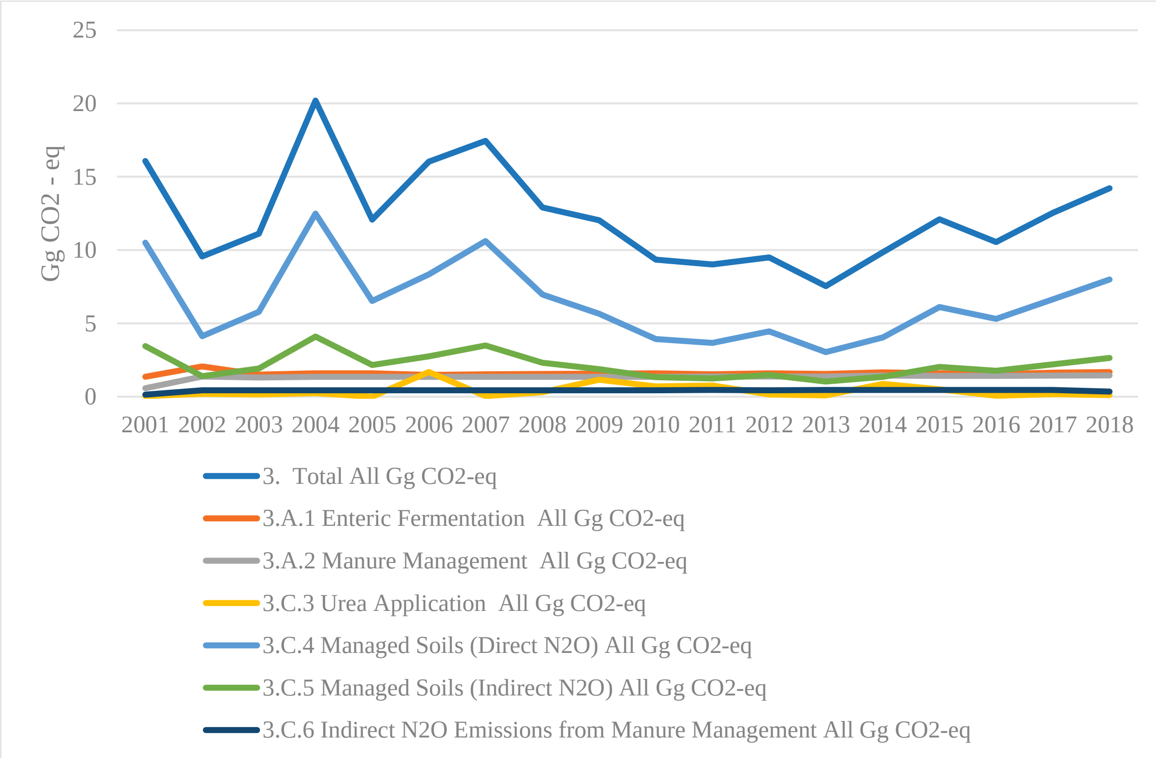
Table 27: IPCC 2006 GL categories for which Agriculture GHG emissions were estimated

IPCC Category	Category Name
3.A.1	Enteric Fermentation (CH_4)
3.A.2	Manure Management (CH_4 & Direct N_2O)
3.C.3	Urea Application (CO_2)
3.C.4	Managed Soils (Direct N_2O)
3.C.5	Managed Soils (Indirect N_2O)
3.C.6	Indirect N_2O Emissions from Manure Management

Total GHG emissions in the agriculture sector amounted to 16.08 Gg CO_2-eq in 2001 and 14.23 Gg CO_2-eq in 2018, see

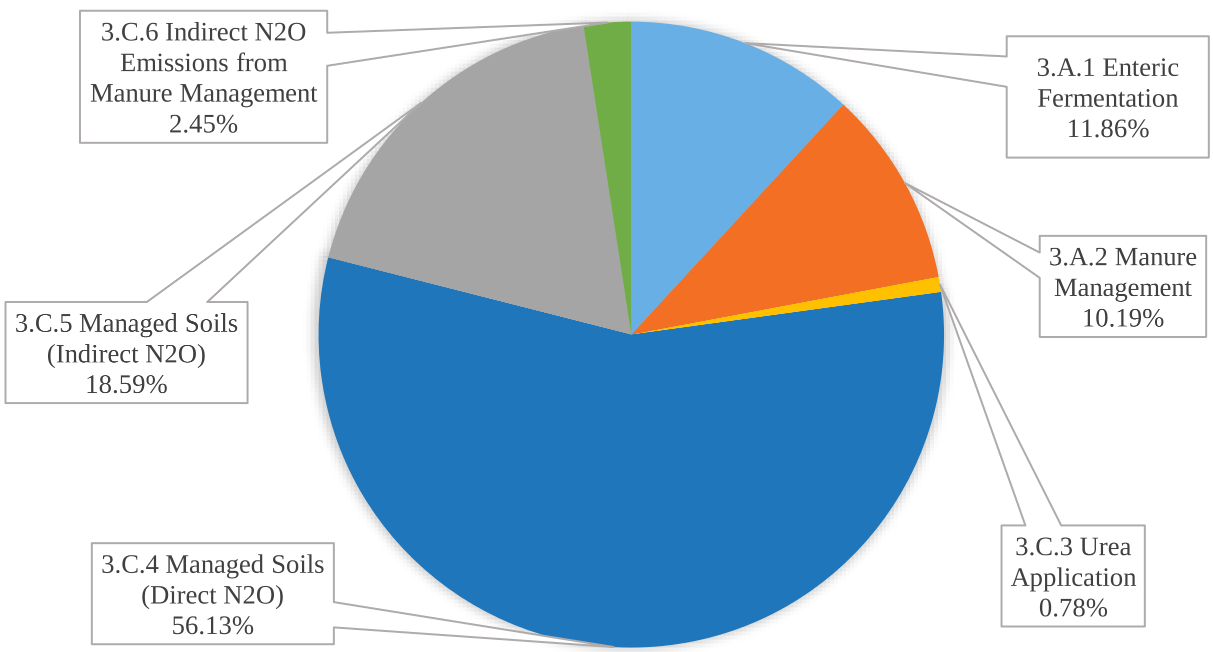
Figure 30 and Table 28. This represents a decrease by 11.54% per cent.

Figure 30: Total agriculture-sector category GHG emissions 2001-2018



Total Direct N_2O emissions on managed soils, particularly from fertilizer, was the highest contributor to sector emissions (56.13 per cent), accounting for the importation of nitrogen based fertilizers over the time series. This is followed by indirect N_2O emissions to managed soils from leaching and atmospheric volatilization from fertilizers and managed animal waste, accounting for (18.59 per cent). Emissions from enteric fermentation (livestock), 11.86 per cent, and manure management (10.19 per cent) followed. Livestock is limited in the country, and was estimated from both national and international sources, from enteric fermentation, particularly for grazing animals. Indirect N_2O emissions from manure management and urea application jointly represented about 3 per cent of sector emissions.

Figure 31: Contribution of categories to total GHG emissions in the agriculture sector in 2018



Shares of the gases in total emissions have remained similar over time, with N_2O accounting for 88.3 and 95.9 per cent in 2001 and 2018 respectively, and 11.4 and 15.6 per cent for CH_4, and for CO_2, and 0.3 and 1 per cent each both in 2001 and 2018 (see Figure 32).

Figure 32: Contribution of gases to total agriculture sector emissions in 2001 and 2018

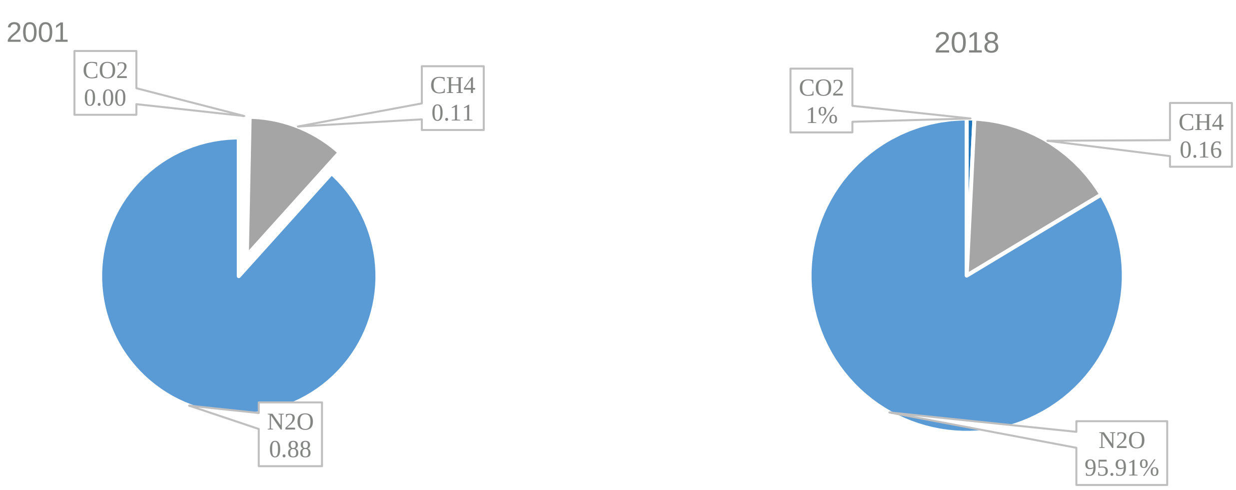


Table 28: GHG emissions in the agriculture sector, by category

IPCC Category	Gas	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% Increase 2018 vs 2001
3. Total	All	Gg CO_2-eq	**16.08**	**9.57**	**11.12**	**20.20**	**12.07**	**16.04**	**17.46**	**12.91**	**12.03**	**9.34**	**9.02**	**9.49**	**7.54**	**9.84**	**12.11**	**10.54**	**12.54**	**14.23**	-11.54%
3.A.1	All	Gg CO_2-eq	1.36	2.06	1.51	1.59	1.60	1.48	1.53	1.55	1.56	1.60	1.53	1.60	1.55	1.66	1.60	1.54	1.64	1.69	24.34%
3.A.2	All	Gg CO_2-eq	0.58	1.37	1.31	1.34	1.34	1.34	1.35	1.35	1.35	1.36	1.37	1.37	1.38	1.44	1.41	1.41	1.43	1.45	151.17%
3.C.3	All	Gg CO_2-eq	0.05	0.19	0.15	0.23	0.00	1.68	0.04	0.31	1.15	0.69	0.76	0.15	0.09	0.88	0.49	0.06	0.18	0.11	114.08%
3.C.4	All	Gg CO_2-eq	10.51	4.12	5.79	12.49	6.53	8.33	10.61	6.96	5.65	3.93	3.67	4.44	3.04	4.04	6.12	5.30	6.64	7.99	-23.99%

3.C.5	All	Gg CO_2-eq	3.45	1.40	1.92	4.10	2.16	2.75	3.49	2.31	1.88	1.32	1.24	1.49	1.03	1.36	2.03	1.77	2.20	2.65	-23.36%
3.C.6	All	Gg CO_2-eq	0.14	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.46	0.44	0.45	0.46	0.45	0.46	0.45	0.35	151.36%

Table 29: GHG emissions in the agriculture sector, by gas

IPCC Category	Gas	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% Increase 2018 vs 2001
3. Total	CO_2	Gg CO_2-eq	0.05	0.19	0.15	0.23	0.00	1.68	0.04	0.31	1.15	0.69	0.76	0.15	0.09	0.88	0.49	0.06	0.18	0.11	114.08%
3. Total	CH_4	Gg CO_2-eq	1.83	2.61	1.99	2.09	2.09	1.98	2.03	2.05	2.06	2.10	2.04	2.09	2.05	2.18	2.11	2.05	2.16	2.22	21.59%
3. Total	N_2O	Gg CO_2-eq	14.21	6.77	8.98	17.88	9.98	12.38	15.39	10.56	8.83	6.55	6.22	7.24	5.40	6.78	9.50	8.43	10.21	11.90	-16.25%

		Total	**16.08**	**9.57**	**11.12**	**20.20**	**12.07**	**16.04**	**17.46**	**12.91**	**12.03**	**9.34**	**9.02**	**9.49**	**7.54**	**9.84**	**12.11**	**10.54**	**12.54**	**14.23**	

3.9.2. Forestry and Other Land Uses

GHG emissions in the Forestry and Other Land Use sector typically come from a number of sources related to CO_2 emissions/removals from carbon stock changes in above and below-ground biomass pools of forest land, including forest land converted to other land uses such as cropland, grasslands, wetlands, and settlements. CH_4 and N_2O, and additional CO_2 emissions arise from fires and drainage of organic soils, however these emissions were not estimated due to unavailability of data on forest fires.

On this basis, GHG emission estimates for the gases CO_2 were compiled for the FOLU sector categories presented in Table 30 below.

Table 30: IPCC 2006 GL categories for which FOLU GHG emissions were estimated

IPCC Code	Category Name	
3.B.1	Forest land	3.B.1.a – Forest land Remaining Forest land 3.B.1.b – Land Converted to Forest land
3.B.2	Cropland	3.B.2.a – Cropland Remaining Cropland 3.B.2.b – Land Converted to Cropland
3.B.3	Grassland	3.B.3.a – Grassland Remaining Grassland 3.B.3.b – Land Converted to Grassland
3.B.4	Wetland	3.B.4.a – Wetlands Remaining Wetlands 3.B.4.b – Land Converted to Wetlands
3.B.5	Settlements	3.B.5.a – Settlements Remaining Settlements 3.B.5.b – Land Converted to Settlements
3.B.6	Other Land	3.B.6.a – Other land Remaining Other land 3.B.6.b – Land Converted to Other land

Total GHG emissions in the FOLU sector are dominated by the category Land conversion to Grassland in 2018, primarily from conversion from forest land to grassland. All emissions estimated from this sector were CO_2 emissions (Figure 33).

Figure 33: Contribution of categories to total FOLU GHG emissions in 2018

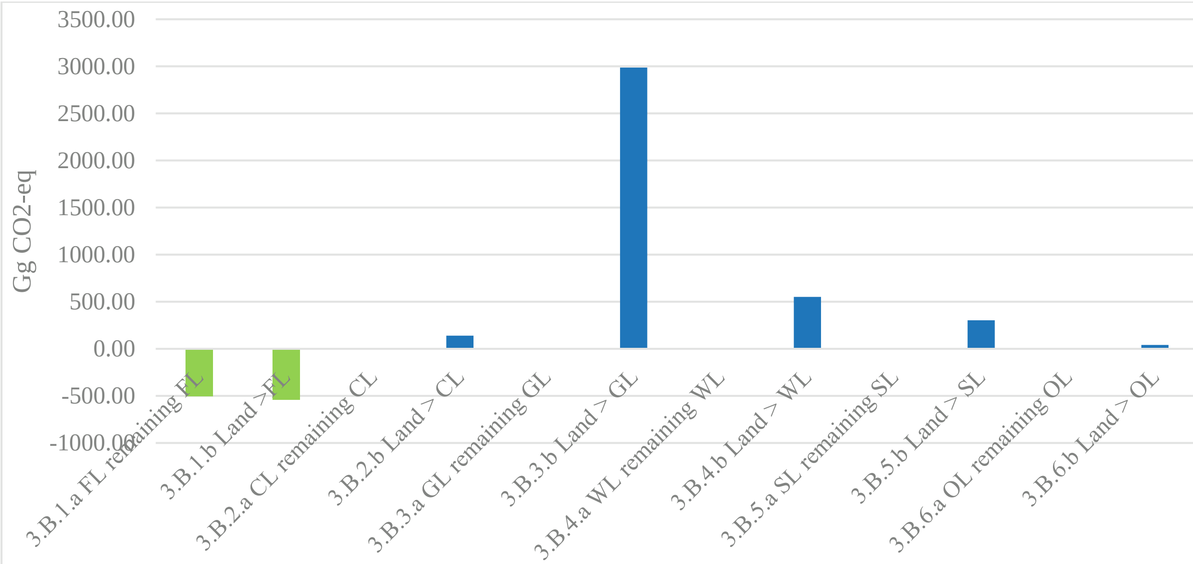
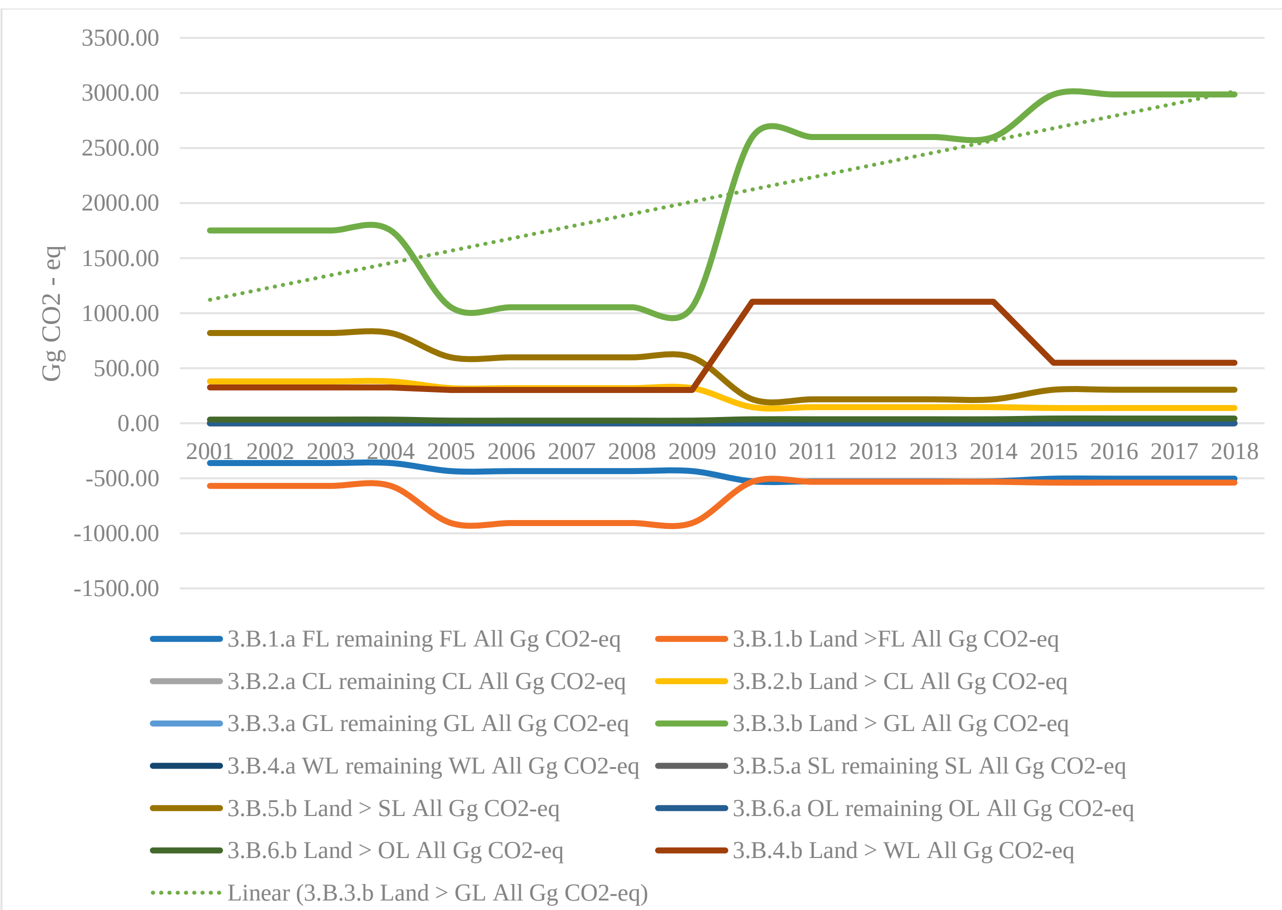


Figure 34: FOLU Sector Emissions by Category



Activity data generated from the land use change maps were multiplied with IPCC default emission factors to calculated emissions for each 5-year time interval. The yearly emissions estimated from land use change for each 5 year time interval (more information on methodology and approaches in Section 3.4.2) can be seen in Table 31 and Figure 34.

Over the time series, the trends that influence annual emissions are those with the most carbon stocks (i.e. Forest land, Grassland, and conversion to either). Lowest emissions were noted within the time period of 2005-2009 (955.66 Gg CO_2 eq yearly emissions) attributed to land conversion to forest land (more removals). This effect was noted after the passing of two hurricanes, Hurricanes Frances and Hurricane Jeanne, occurring two weeks apart in October of 2004, having severely impacted the north-western Bahamas, including Abaco, Andros, Berry, Bimini, Eleuthera, Exuma, Grand Bahama and New Providence islands (mainly forested islands). The pine forests of Grand Bahama were especially impacted with regeneration not comparable to its previous state. The effects of secondary foliage regrowth (and subsequently more removals) attributed to enhanced sinks and reduced emissions in the 2005-2010, with visual effects of this regrowth discernible by satellite imagery in the year 2010 on Grand Bahama and Abaco Islands (Figure 37).

In the following years, from 2010 to 2014 an increase in emissions in the area of 30% is noted, attributed to conversion from forestland to grassland and secondarily from a large conversion of forest land to wetlands (reduction in carbon stocks). The characteristics of these conversions require more land based studies, however the incidence of cyclical conversion of native shrubs and scrubs (classified as grasslands) to wetlands was identified as an area for future study. For more information on activity data see Section 3.4.2.

Furthermore, in more recent natural disasters, Hurricane Dorian in 2019 has demonstrated partial to severe destruction to mangroves, coral reefs, and forests of Abaco and Grand Bahama, particularly the eastern sides of Grand Bahama. Severe defoliation of pine forests on Grand Bahamas and Abaco, with moderate to severe tree uprooting and breakage in certain areas. Although previous assessments in The Bahamas indicate that ecosystems in the country have adapted over time to become resilient to tropical weather and extreme events, destruction to mangroves, coral reefs, seagrass beds and forests of Abaco and Grand Bahama, particularly the eastern sides of Grand Bahama were noted post Hurricane Dorian. Severe defoliation of pine forests on Grand Bahamas and Abaco, with moderate to severe tree uprooting and breakage in certain areas (IDB, 2019). This impact, particularly of the defoliation on Grand Bahama and Abaco can be seen on Figure 39 (Land Use Map of 2020), however the overall emissions from land use change between 2010 and 2020 were relatively constant.

Noteworthy for future improvements is the consideration of data gaps in activity data particularly from 2003 onward where Landsat 7 satellite images suffer from scan-line errors, resulting in less accurate activity data generated from Landsat 7 images.

Figure 35: Land Use Map 2000

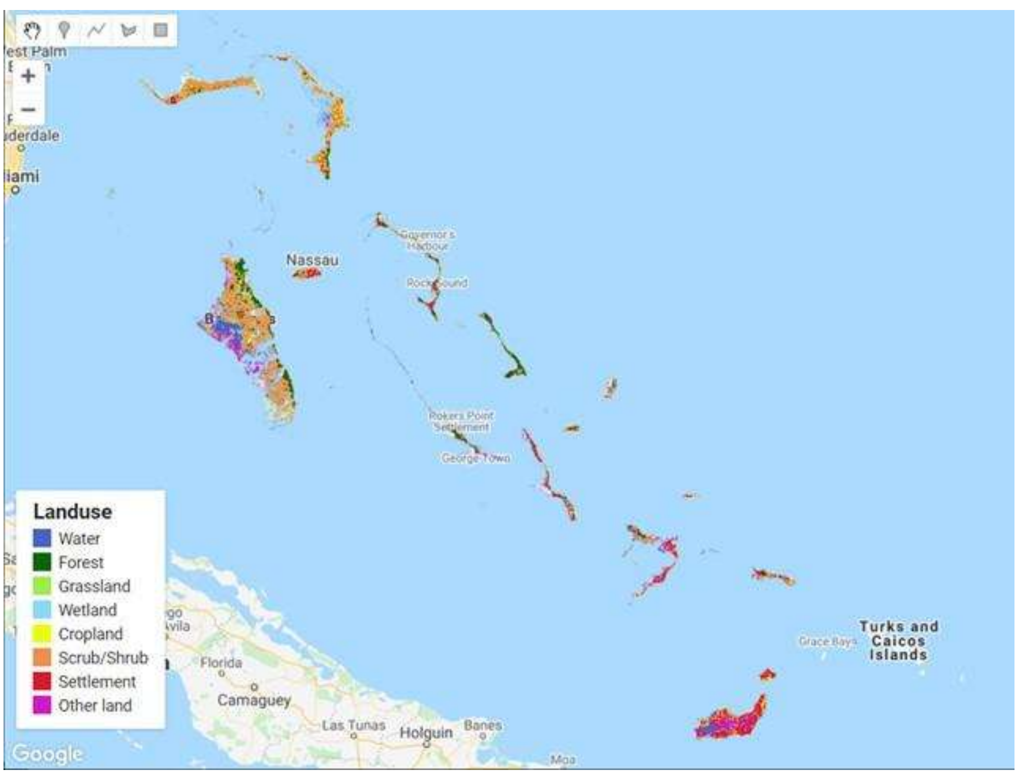


Figure 36: Land Use Map 2005

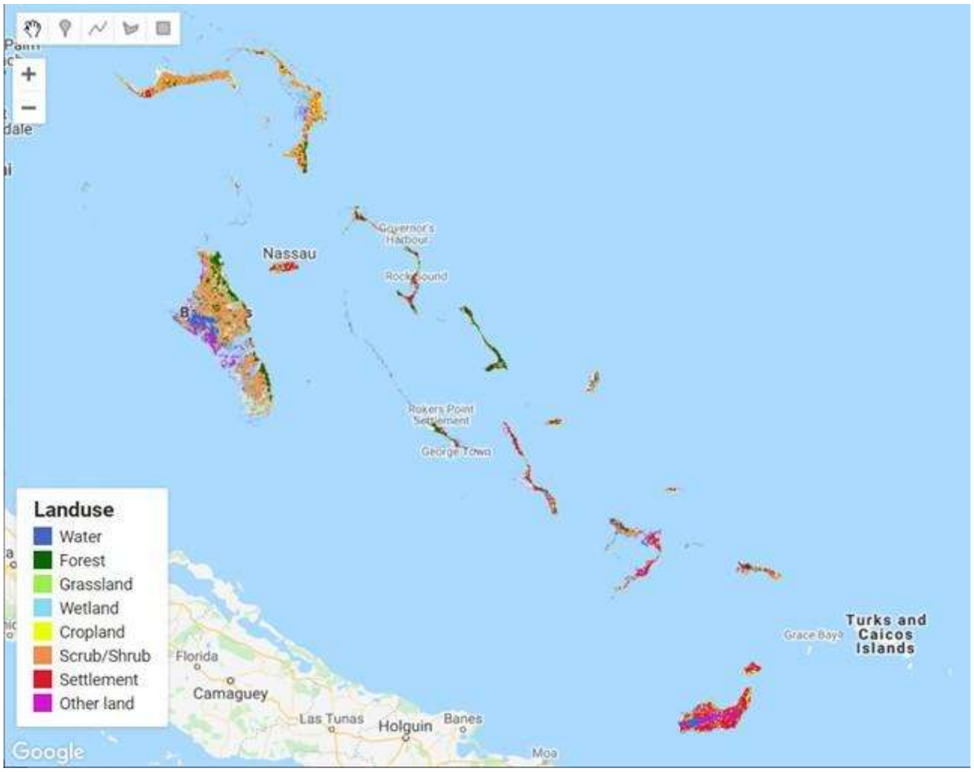


Figure 37: Land Use Map 2010

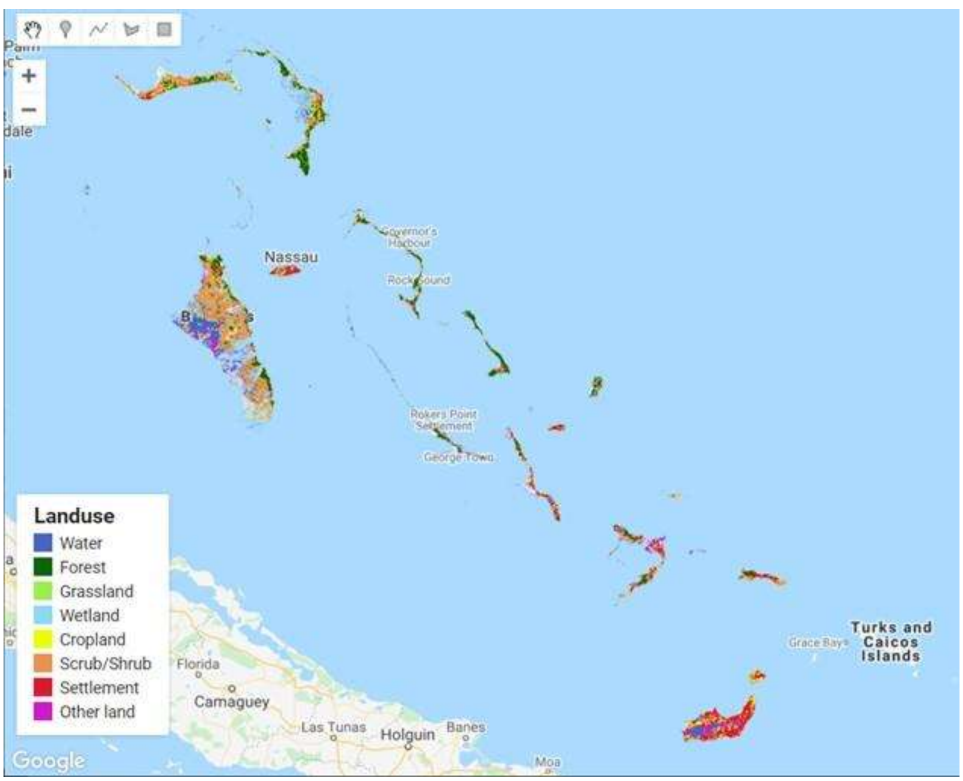


Figure 38: Land Use Map 2015

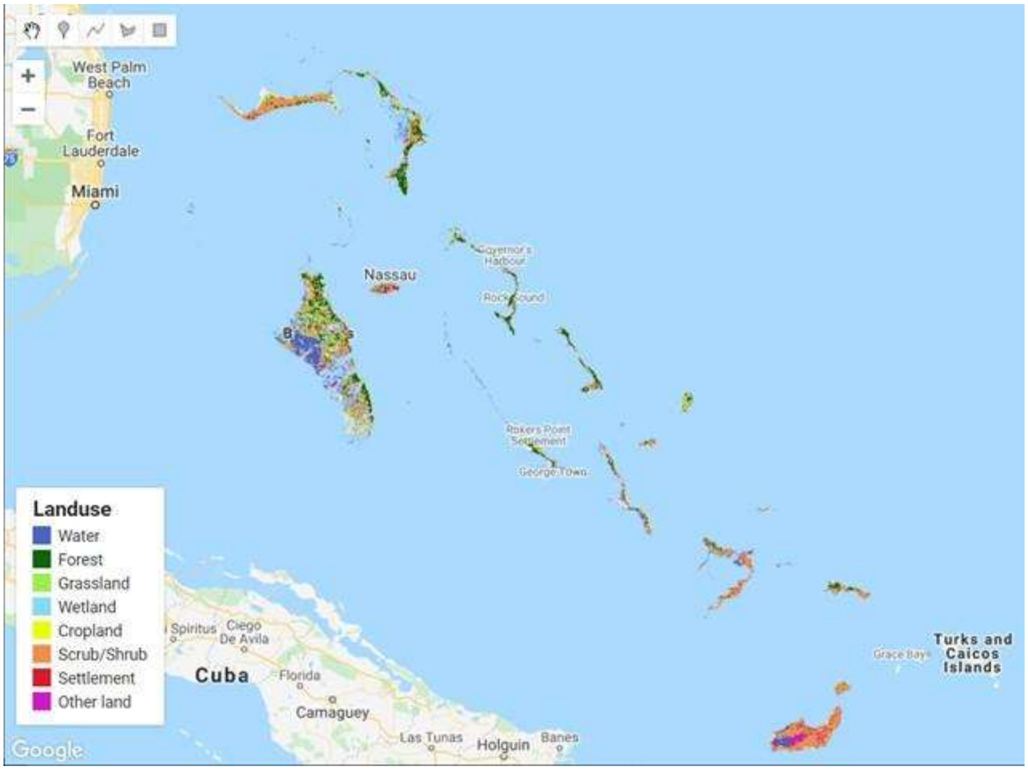


Figure 39: Land Use Map 2020

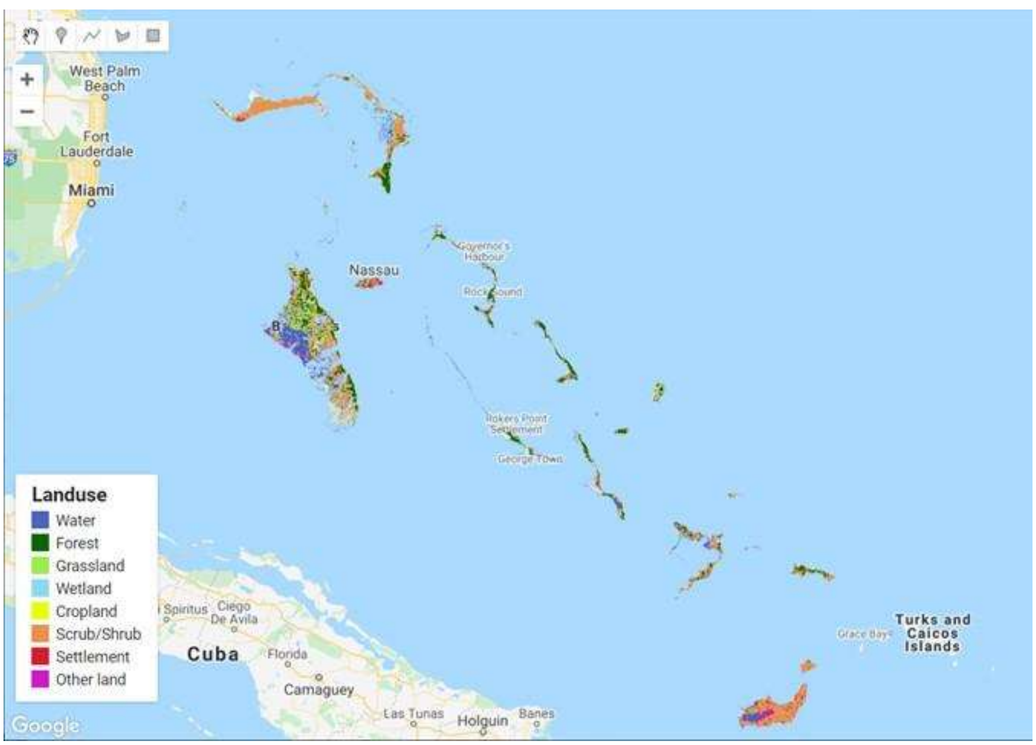


Table 31: GHG emissions in the Forestry and Other Land Use GHG sector, by category

IPCC Category	Gas	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% Increase 2018 vs 2001
3. Total	All	Gg CO_2-eq	**2377.60**	**2377.60**	**2377.60**	**2377.60**	**955.66**	**955.66**	**955.66**	**955.66**	**955.66**	**3042.82**	**3042.82**	**3042.82**	**3042.82**	**3042.82**	**2979.11**	**2979.11**	**2979.11**	**2979.11**	25.30%
3.B.1.a	All	Gg CO_2-eq	-361.60	-361.60	-361.60	-361.60	-434.70	-434.70	-434.70	-434.70	-434.70	-527.69	-527.69	-527.69	-527.69	-527.69	-503.33	-503.33	-503.33	-503.33	39.20%
3.B.1.b	All	Gg CO_2-eq	-568.94	-568.94	-568.94	-568.94	-906.32	-906.32	-906.32	-906.32	-906.32	-531.80	-531.80	-531.80	-531.80	-531.80	-539.28	-539.28	-539.28	-539.28	-5.21%
3.B.2.a	All	Gg CO_2-eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
3.B.2.b	All	Gg CO_2-eq	380.16	380.16	380.16	380.16	318.55	318.55	318.55	318.55	318.55	146.16	146.16	146.16	146.16	146.16	138.31	138.31	138.31	138.31	-63.62%
3.B.3.a	All	Gg CO_2-eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
3.B.3.b	All	Gg CO_2-eq	1750.81	1750.81	1750.81	1750.81	1053.48	1053.48	1053.48	1053.48	1053.48	2599.54	2599.54	2599.54	2599.54	2599.54	2986.35	2986.35	2986.35	2986.35	70.57%

3.B.4.a	All	Gg CO_2-eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
3.B.4.b	All	Gg CO_2-eq	324.78	324.78	324.78	324.78	302.22	302.22	302.22	302.22	302.22	1103.24	1103.24	1103.24	1103.24	1103.24	550.03	550.03	550.03	550.03	69.36%
3.B.5.a	All	Gg CO_2-eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
3.B.5.b	All	Gg CO_2-eq	819.38	819.38	819.38	819.38	598.61	598.61	598.61	598.61	598.61	217.44	217.44	217.44	217.44	217.44	304.20	304.20	304.20	304.20	-62.87%
3.B.6.a	All	Gg CO_2-eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
3.B.6.b	All	Gg CO_2-eq	33.01	33.01	33.01	33.01	23.83	23.83	23.83	23.83	23.83	35.94	35.94	35.94	35.94	35.94	42.83	42.83	42.83	42.83	29.74%

Table 32: GHG emissions in the Forestry and Other Land Use GHG sector, by gas

IPCC Category	Gas	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% Increase 2018 vs 2001
3. Total	CO_2	Gg CO_2-eq	2377.60	2377.60	2377.60	2377.60	955.66	955.66	955.66	955.66	955.66	3042.82	3042.82	3042.82	3042.82	3042.82	2979.11	2979.11	2979.11	2979.11	25.30%
3. Total	CH_4	Gg CO_2-eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3. Total	N_2O	Gg CO_2-eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		Total	**2377.60**	**2377.60**	**2377.60**	**2377.60**	**955.66**	**955.66**	**955.66**	**955.66**	**955.66**	**3042.82**	**3042.82**	**3042.82**	**3042.82**	**3042.82**	**2979.11**	**2979.11**	**2979.11**	**2979.11**	

3.10. Waste

GHG emissions in the waste sector typically come from a number of sources related to the treatment of solid waste as well as the management of wastewater. With regards to solid waste, solid waste disposal (i.e., landfilling of solid waste) and, to a small extent, open burning of waste, take place in The Bahamas. One landfill is currently being converted to a managed form, while the remaining landfills are unmanaged. Biological treatment of solid waste does not take place. Large scale waste incineration does not take place in The Bahamas according to available information and expert judgement. The incineration of hazardous waste at smaller facilities, e.g. in hospitals, might take place according to expert judgement. Information on amounts of hazardous waste and treatment approaches could not be obtained, this is clearly an area for improvement.

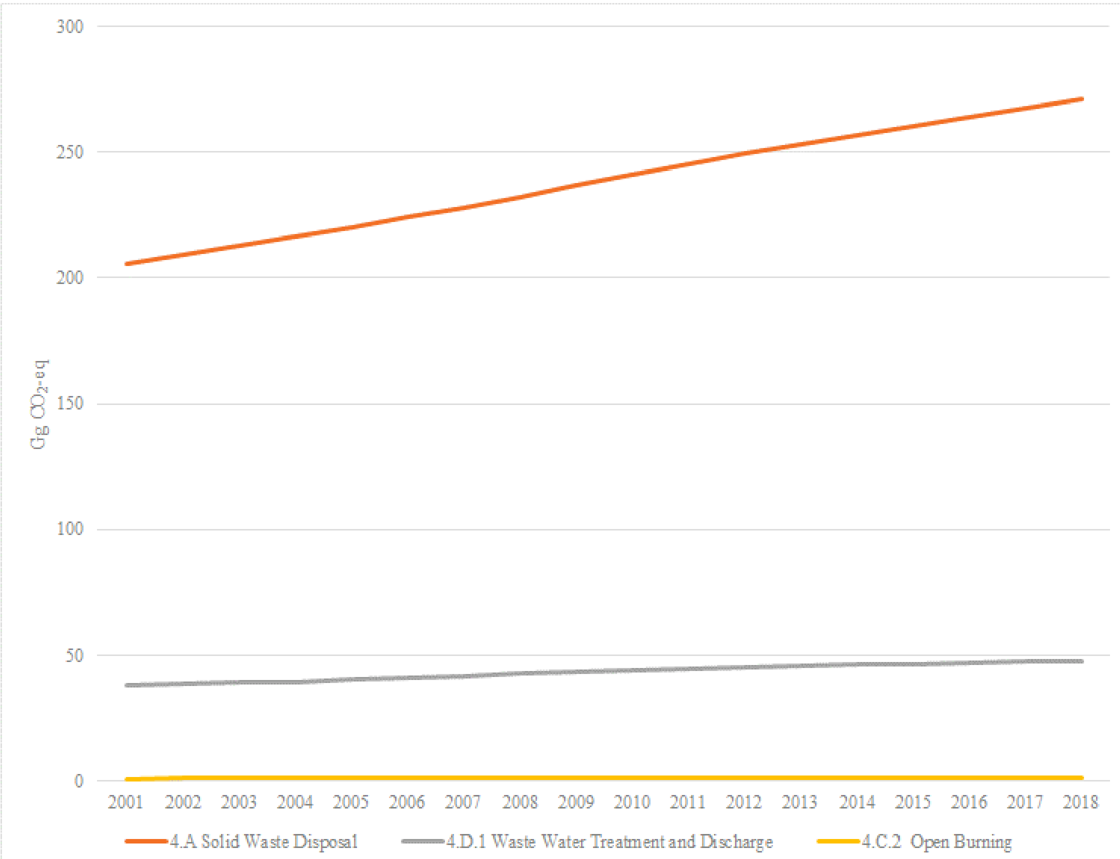
On this basis, GHG emission estimates for the gases CO_2, CH_4, N_2O were compiled for the waste sector categories presented in Table 33 below.

Table 33: IPCC 2006 GL categories for which Waste GHG emissions were estimated

IPCC Category	Category Name
4.A	Solid Waste Disposal
4.C.2	Open burning of waste
4.D.1	Domestic Wastewater Treatment and Discharge

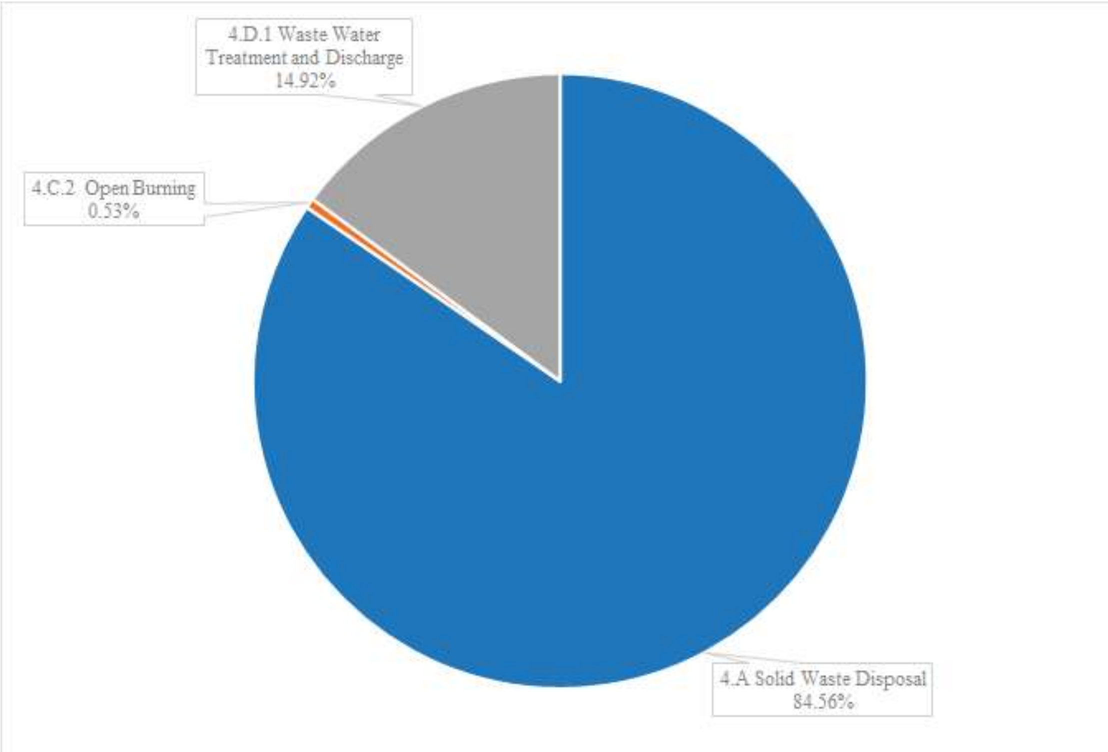
Total GHG emissions in the waste sector amounted to 245.20 Gg CO_2-eq in 2001 and 320.31 Gg CO_2-eq in 2018, see Figure 40 and Table 34. This represents an increase by 30.6 per cent. It is important to note that the calculation has heavily relied on IPCC default values and assumptions (e.g., waste generation rate, waste composition), so that the current estimations mainly reflect The Bahamas' population increase over the time series. Information indicating technological change and change in treatment approaches (e.g., moving from shallow to deep landfills over time) was not available. Generally, the increase in GDP and also tourism activity are likely to influence GHG emission developments in the waste sector, but are currently not reflected in the calculation. Annex II suggests improvements which would allow considering these drivers in the future.

Figure 40: Total GHG emissions in the waste sector 2001-2018, by categories



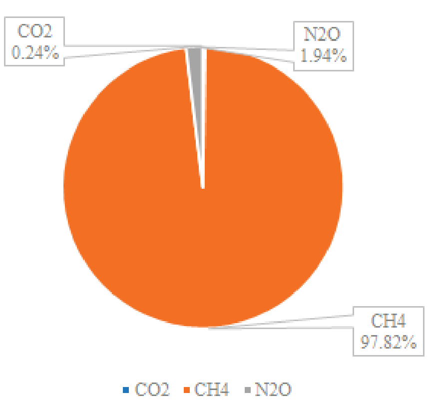
Total GHG emissions in the waste sector are dominated by the category solid waste disposal contributing 84.6 per cent in 2018. Wastewater treatment and discharge contribute 14.9 per cent and 0.5 per cent, see Figure 41. Between 2001 and 2018, the three subcategories show an upward trend with similar growth rates. GHG emissions from solid waste disposal grew by 31.6 per cent, from wastewater treatment and discharge by 27.4 cent and from open burning by 25.4 per cent.

Figure 41: Contribution of categories to total GHG emissions in 2018 in the waste sector



CH_4 dominates the waste sector with 98.1 per cent of sectoral emissions in 2018 and 97.8 in 2001. N_2O only contributes 1.7 per cent in 2018 and 1.9 per cent in 2001 and CO_2 only contributes 0.2 per cent in both years.

Figure 42: Contribution of gases to total waste sector emissions in 2001 and 2018



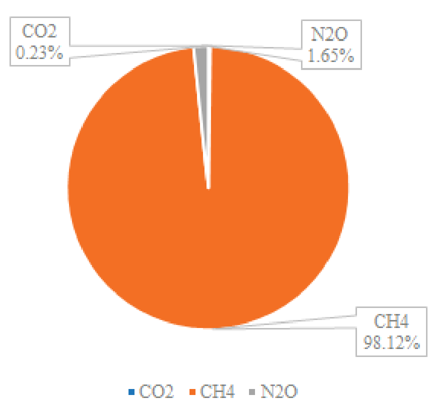


Table 34: GHG emissions in the waste sector 2001-2018, by category

IPCC Category	Gas	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% Increase 2018 vs 2001
4. Total	All	Gg CO_2-eq	245.20	249.22	253.11	257.22	261.77	266.67	271.52	276.46	281.51	286.79	291.49	295.94	300.90	304.83	308.75	312.71	316.51	320.31	30.6%
4.A	All	Gg CO_2-eq	205.78	209.13	212.62	216.27	220.07	224.02	228.10	232.32	236.62	240.94	245.20	249.32	253.25	256.98	260.56	264.04	267.46	270.85	31.6%
4.C.2	All	Gg CO_2-eq	1.32	1.34	1.37	1.39	1.42	1.45	1.47	1.50	1.53	1.55	1.57	1.59	1.60	1.62	1.63	1.65	1.67	1.68	27.4%
4.D.1	All	Gg CO_2-eq	38.09	38.74	39.12	39.56	40.28	41.20	41.95	42.64	43.37	44.29	44.72	45.03	46.05	46.23	46.55	47.02	47.38	47.77	25.4%

Table 35: GHG emissions in the waste sector 2001-2018, by gas

IPCC Category	Gas	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% Increase 2018 vs 2001
4. Total	All	Gg CO_2-eq	245.20	249.22	253.11	257.22	261.77	266.67	271.52	276.46	281.51	286.79	291.49	295.94	300.90	304.83	308.75	312.71	316.51	320.31	30.6%
4.A	CO_2	Gg CO_2-eq	0.58	0.59	0.60	0.61	0.62	0.63	0.65	0.66	0.67	0.68	0.69	0.70	0.70	0.71	0.72	0.72	0.73	0.74	27.4%
4.C.2	CH_4	Gg CO_2-eq	239.86	243.78	247.88	252.18	256.65	261.29	266.09	271.01	275.99	280.91	285.69	290.26	294.59	298.72	302.70	306.59	310.45	314.28	31.0%
4.D.1	N_2O	Gg CO_2-eq	4.76	4.85	4.63	4.43	4.50	4.74	4.78	4.79	4.86	5.20	5.11	4.98	5.60	5.40	5.33	5.39	5.33	5.30	11.3%

Approaches

3.11. Overview

Table 36 and Table 37 below present an overview on methodological tiers and data sources used for The Bahamas national GHG inventory. Generally, Tier 1 approaches were used. The Bahamas intends to move to Tier 2 over time for the categories identified as key (see section 3.3. for the key category analysis and Annex III for the improvement plan)

Detailed information on activity data, data sources, emission and other calculation factors as well as assumptions are presented by IPCC category from section 3.2 onwards.

Table 36: Activity data and emission factor tiers used for The Bahamas national GHG inventory emission estimates

IPCC Category	Category Name	Specific IPCC Categories estimated for The Bahamas	Activity Data Tier	Emission Factor Tier
1.A.1	Energy Industries	1.A.1.a.1 Main electricity and heat production	1	D
1.A.2	Manufacture and construction	1.a.2.f Construction 1.A.2.m Non-specified Industries	1	D
1.A.3.	Transport	1.A.3.a.i International aviation 1.a.3.a.ii Domestic Aviation 1.A.3.b.i Cars 1.A.3.b.ii Light duty vehicles 1.a.3.b.iii Heavy duty vehicles and buses 1.a.3.b.iv Motorcycles	1	D

1.A.4.a	Other	1.A.4.a Institutional/Commercial 1.A.4.b Residential 1.A.4.c Agriculture/Fisheries/Forestry	1	D
1.B.	Fugitive emissions	1.B.2.a.iii.3 Natural gas liquids transport	1	D
3.A.1	Enteric Fermentation	3.A.1.a – Cattle 3.A.1.a.i – Dairy Cows 3.A.1.a.ii – Other Cattle 3.A.1.c – Sheep 3.A.1.d – Goats 3.A.1.f – Horses 3.A.1.g – Mules and Asses 3.A.1.h – Swine	1	D
3.A.2	Manure Management	3.A.2.a – Cattle 3.A.2.a.i – Dairy Cows 3.A.2.a.ii – Other Cattle 3.A.2.c – Sheep 3.A.2.d – Goats 3.A.2.f – Horses 3.A.2.g – Mules and Asses 3.A.2.h – Swine 3.A.2.j – Poultry	1	D
3.B.1	Forest land	3.B.1.a – Forest land Remaining Forest land 3.B.1.b – Land Converted to Forest land	1	D
3.B.2	Cropland	3.B.2.a – Cropland Remaining Cropland	1	D

		3.B.2.b – Land Converted to Cropland		
3.B.3	Grassland	3.B.3.a – Grassland Remaining Grassland 3.B.3.b – Land Converted to Grassland	1	D
3.B.4	Wetland	3.B.4.a – Wetlands Remaining Wetlands 3.B.4.b – Land Converted to Wetlands	1	D
3.B.5	Settlements	3.B.5.a – Settlements Remaining Settlements 3.B.5.b – Land Converted to Settlements	1	D
3.B.6	Other Land	3.B.6.a – Other land Remaining Other land 3.B.6.b – Land Converted to Other land	1	D
3.C.3	Urea Application		1	D
3.C.4	Direct N_2O Emissions from managed soils		1	D
3.C.5	Indirect N_2O Emissions from managed soils (3)		1	D

3.C.6	Indirect N_2O Emissions from Manure Management		1	D
4.A.	Municipal Solid Waste		1	D
4.C	Incineration and open burning	4.C.2 Open burning	1	D
4.D.1	Domestic Wastewater Treatment and Discharge		1	CS, D

Table 37: Overview of key data sources used for The Bahamas national GHG inventory estimates

IPCC Category	Key sources of activity data	Key sources of emission factors and other calculation factors
1. A. Energy	• Central Bank of The Bahamas • Energy Balance (2010-2012) • Power generators: Bahamas Power and Light, Company Ltd. Grand Bahamas Power Company • Fuel Distributors: Rubis	IPCC 2006 Guidelines
2. Industrial Processes and Product Use	• Central Bank of The Bahamas	IPCC 2006 Guidelines

3. AFOLU	• FAO Livestock data • Customs import data on livestock • Customs import data on urea and fertilizers • Landsat 7 and 8 satellite data from Google Earth • ESRI Land Cover Map 2020	IPCC 2006 Guidelines
4.A Waste	• UN Population data • FAO protein consumption data • Regional Sanitation Study (PAHO, 2012) • IPCC 2006 waste generation default data and waste composition default data	IPCC 2006 Guidelines

3.12. Energy

3.12.1. Overview - Activity data and emission factors

Table 38 presents the key data sources available for the estimation of energy sector emissions in The Bahamas.

Table 38: Key data sources and information covered by each source

Source	Fuels	Years covered	Scope	Reference

Central Bank of The Bahamas	propane, motor gasoline, aviation gasoline, Kerosene, Bunker C (a type of fuel oil), gas oil (also referred to as diesel), lubricants and others	1990-2021	Total national consumption of each fuel	Bahamas Central Bank, Quarterly Statistical Digests[12]
Energy Balance	Firewood, LPG, Gasoline Alcohol, Jet Fuel Kerosene, Diesel Oil, Fuel Oil, Charcoal, Non-Energy	2010-2012	Total national consumption of each fuel	OLADE (Latin American Energy Organisation) (2015); The Bahamas. Energy Balances 2010-2012; http://biblioteca.olade.org/opac-tmpl/Documentos/old0348.pdf
Bahamas Power and Light Company Ltd.	Fuel oil, diesel	2000-2020	Consumption of fuels for power generation in The Bahamas excluding Grand Bahama.	Private communication from Rochelle McKinney, Bahamas Power and Light

[12] The Quarterly Statistical Digests prepared by the CBB can be found here: https://www.centralbankbahamas.com/publications/qsd.

Grand Bahamas Power Company	CO_2 emissions from fuel oil as well as from diesel consumption	2016-2020	Power generation for Grand Bahama	Private communication from Garelle Hudson, Grand Bahamas Power Company
Rubis (a fuel distributor) [13]	Sales of Aviation gasoline, aviation jet fuel, unleaded gasoline, diesel, kerosene. Unleaded gasoline and diesel were differentiated by sales to retail clients and to commercial/industrial clients	2010-2019		Private communication from Kirk Johnson , Rubis

The Central Bank of The Bahamas (CBB) compiles a quarterly overview of oil imports for domestic consumption, including international bunkers (the fuels not consumed by The Bahamas themselves, but consumed for international aviation and international waterborne navigation). Such information covered the whole time series 2001-2018 and includes the following fuels: propane, motor gasoline, aviation gasoline, Kerosene, Bunker C (a type of fuel oil), gas oil (also referred to as diesel), lubricants and others. International bunkers are not differentiated by fuel type. The CBB data does not differentiate by fuel use, e.g., whether diesel is consumed for road transport or for diesel generators used by commercial ventures like hotels.

[13] Further fuel distributors exist, e.g. SOL Group, Freeport Oil Company, from which no data was available at the time of compiling this document.

OLADE has prepared an energy balance for the years 2010-2012. The energy balance (EB) presents fuel consumption by activity. These activities show good alignment with the categories of the IPCC 2006 Guidelines. Annex III shows how the fuels and activities in the energy balance were mapped against the categories in the IPCC 2006 Guidelines.

Comparing CBB and EB fuel consumption values, the CBB data values were often lower than EB values for the timeframe 2010-2012. While potential reasons for this discrepancy were assessed, it was not possible to find evidence pointing to specific reasons, e.g., data used and assumptions made in compiling the EB or completeness of the CBB dataset. Only for the particular case of fuel oil the EB mentions that a fuel distributor indicated that the CBB data does not consider data from all fuel distributors and might thus be lower than the real consumption. Of course, this situation related to 2010-2012, and there was no data available allowing to understand whether the situation might have changed today.

Disaggregated (bottom-up) fuel consumption at category level was available only to a limited extent, e.g., information related to fuel consumption for power generation from BPL and GBPC, fuel sales to retail as well as commercial industrial clients from Rubis.

In order to estimate total fuel consumption, the data sources which are of national origin and cover the whole time series were preferred. These are CBB and BPL. Only where these were not sufficient or seemed incomplete, EB data was used to fill gaps. Table 39 presents the approaches used to estimate overall fuel consumption for each fuel.

Allocation of fuel consumption to the various IPCC categories was performed using the average shares of each activity in total fuel consumption for the years 2010-2012 from the EB.

Table 39: Approaches for the estimation of fuel consumption

Fuel	Estimation of overall consumption	Clarifications
Aviation Gasoline	Value presented by the CBB statistics	EB presents gasoline and aviation gasoline aggregated into one

		category, while CB statistics present them separately
LPG	Value presented by the CBB statistics	The CB statistics present no LPG but "propane", while the EB mentions "LPG", which is in most cases a mix of propane and butane. Based on experience in the region it was assumed the CB data related to LPG as well.
Gasoline	Value presented by the CBB statistics	
Diesel	EB data was used for 2010-2012 and extrapolated for 2001-2009 and 2013-2018 using The Bahamas' GDP as driver	CBB diesel consumption fluctuates strongly and in no relation to GDP or population over the time series. Additionally, in 2010-2015 the CBB diesel consumption is slightly lower than the consumption reported by BPL, which only accounts for the consumption for power generation, but not for consumption under the other activities like transport. This indicates that the data might be incomplete.
Fuel oil	BPL fuel oil consumption values were scaled up by the average difference between BPL and EB values (2010-2012) in %.	CBB fuel oil consumption fluctuates strongly and in no relation to GDP or population over the time series, frequently being considerably lower than the fuel oil consumption reported by BPL, which accounts for the consumption for power generation, but not other activities like transport

		and industry. However, according to the EB, consumption for power generation accounts for over 98 per cent of total fuel oil consumption.
Firewood	Average consumption for the timeframe 2010-2012 in TJ/capita rural population is calculated using EB 2010-2012 values, total population numbers (UN projections) and the share of rural population (World Bank). This value is extrapolated over the remainder of the timeframe using rural population as driver.	CBB statistics do not include firewood consumption, only the EB provides this value.
Charcoal	Total consumption from the EB 2010-2012, for the remainder of the time series GDP is used as driver for the charcoal consumption in the institutional/commercial sector and population for the charcoal consumption in the residential sector.	CBB statistics do not include charcoal consumption. The EB contains charcoal consumption and indicates the consumption takes place in the residential as well as in the institutional/commercial sector.
Kerosene	CBB data	

Table 40 presents the fuels allocated to the various IPCC categories based on information in the CBB and the EB.

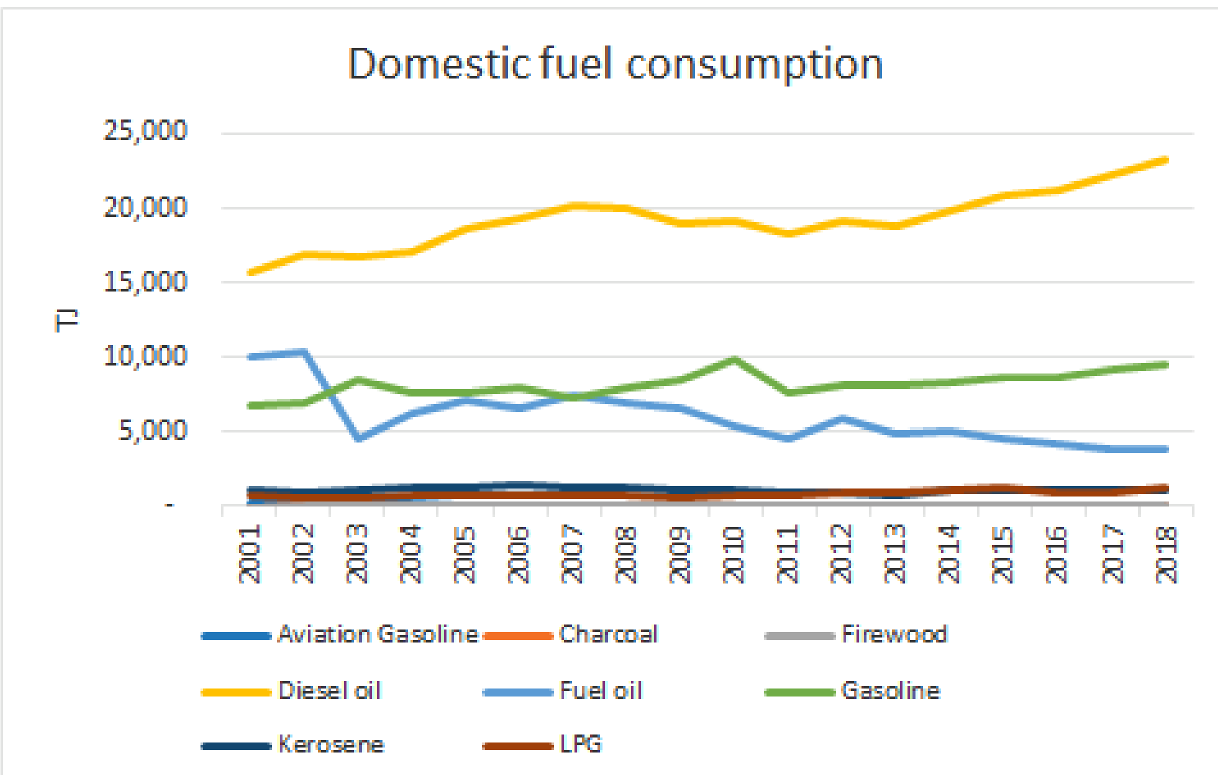
Table 40: Matching of fuels and activities in the energy balance to the categories in the IPCC 2006 Guidelines

	Firewood	LPG	Aviation Gasoline	Gaso line	Jet Fuel /Kerosene	Diesel Oil	Fuel Oil	Charcoal
1.A.1.a.1 Main electricity and heat production						X	X	
1.A.2. Manufacture and construction		X		X		X	X	
1.A.3.a. Aviation		X			X			
1.A.3.b Road Transportati on				X		X		
1.A.3.c. Navigation							X	

1.A.4.a Institutional/ commercial	**-**	**X**		**X**	**-**	**X**	**-**	**X**
1.A.4.b Residential	**X**	**X**		**X**	**X**	**X**	**-**	**X**
1.A.4.c Agriculture/fisheries	**-**	**-**		**X**	**-**	**X**	**-**	**-**

Estimated domestic fuel consumption is presented in Figure 43.

Figure 43: Domestic fuel consumption 2001-2018



The following chapters provide additional information on the national circumstances relevant for each category, data available and used as well as assumptions made with regards to the GHG estimations. The estimated GHG emissions by category in CO_2-eq. are presented in Annex I, fuel consumption by category in Annex II.

Emissions of CO_2, CH_4 and N_2O in the energy sector were estimated by using a Tier 1 approach. Activity data (fuel consumption by fuel type) was multiplied by fuel-specific default emission factors taken from the IPCC 2006 GL.

Table 41 below presents the sources of the emission factors used for the estimations. The specific emission factors used for each IPCC category are presented in the subchapters on the specific IPCC categories.

Table 41: Sources of emission factors used for The Bahamas national GHG inventory

IPCC Category	Category Name	Source of CO_2 emission factors (IPCC 2006 GL)	Source of CH_4 and N_2O emission factors (IPCC 2006 GL)
1.A.1.a.1	Main electricity and heat production	Volume 2, chapter 2, Table 2.2	Volume 2, chapter 2, Table 2.2
1.A.1.k	Construction		Volume 2, chapter 2, Table 2.3
1.A.2.m	Non-specified industry		Volume 2, chapter 2, Table 2.3
1.A.3.a.	Aviation		Volume 2, chapter 2, Table 3.6.5
1.A.3.b	Road transport		Volume 2, chapter 3, Table 3.2.2
1.A.3.c	Navigation		Volume 2, chapter 3, Table 3.5.4

1.A.4.a	Institutional/commercial		Volume 2, chapter 2, Table 2.4
1.A.4.b	Residential		Volume 2, chapter 2, Table 2.5
1.A.4.c	Agriculture/fisheries		Volume 2, chapter 2, Table 2.5
1.B.2.a.iii.3	Natural gas liquids transport	Volume 2, chapter 4, Table 4.24, Table 4.2.4	Volume 2, chapter 4, Table 4.24, Table 4.2.4 (N_2O only)

3.12.2. Reference approach

The Reference Approach is a top-down approach, using a country's energy supply data to calculate the emissions of CO_2 from combustion of mainly fossil fuels. The IPCC 2006 GL states that is good practice to apply both a sectoral approach and the reference approach to estimate a country's CO_2 emissions from fuel combustion and to compare the results of these two independent estimates. The detailed approach to calculating the Reference approach can be found in Vol. 2 Chapter 6 of the IPCC 2006 Guidelines[14].
In the case of The Bahamas, the reference approach does not provide an estimate which is independent from the estimate of the sectoral approach.

This is because the sectoral approach was not calculated based on real category-specific demands, but overall fuel consumption per fuel type, allocated to IPCC categories based on the information available. Therefore, the reference approach and the sectoral approach are both based on the same total fuel consumption per fuel. The calculation of the reference approach and the sectoral approach was nevertheless carried out as a quality control measure.

Table 42 below shows the emission levels in Gg CO_2 in the reference and the sectoral approach yield the same results.

[14] See https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_6_Ch6_Reference_Approach.pdf.

Table 42: Results of the Reference approach and comparison with sectoral approach

Item	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Aviation Gasoline	Gg CO_2-eq	11	9	10	6	6	2	0	3	3	3	3	5	4	4	3	4	3	3
Charcoal	Gg CO_2-eq	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Firewood	Gg CO_2-eq	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4
Diesel oil	Gg CO_2-eq	967	1,033	1,032	1,053	1,144	1,182	1,235	1,224	1,161	1,174	1,352	1,416	1,396	1,468	1,547	1,576	1,650	1,720
Fuel oil	Gg CO_2-eq	772	803	353	480	547	506	568	540	511	412	351	454	376	387	347	324	293	296

Gasoline	Gg CO_2 -eq	566	578	701	635	626	657	605	660	703	818	624	672	665	680	716	711	755	786
Kerosene	Gg CO_2 -eq	65	58	66	75	79	89	81	77	65	67	61	62	50	64	69	63	69	71
LPG	Gg CO_2 -eq	31	21	23	30	27	28	29	31	23	29	27	33	38	40	47	36	36	52
Total CO_2 emissions – Reference approach	Gg CO_2 -eq	2,412	2,502	2,183	2,279	2,429	2,464	2,518	2,534	2,466	2,503	2,416	2,641	2,529	2,644	2,730	2,714	2,807	2,928
Total CO_2 emissions – Sectoral approach (incl. biomass – related	Gg CO_2 -eq	2,417	2,508	2,188	2,284	2,435	2,469	2,523	2,540	2,472	2,509	2,422	2,647	2,535	2,650	2,736	2,720	2,813	2,934

memo items)																			
Difference between Reference approach and sectoral approach	Gg CO_2 -eq	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference between Reference approach and sectoral approach (incl. biomass-related memo items)	Gg CO_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3.12.3. Category-specific information

3.12.3.1. Main electricity and heat production – Category 1.A.1.a.i

Power generation in The Bahamas is in the hand of two power supply companies: The state-owned Bahamas Power and Light (Company Ltd. BPL) and The Grand Bahamas Power Company. The latter services Grand Bahama Island only, whereas BPL services the remaining major islands, (with the exception of Spanish Wells, Eleuthera and Inagua). Both companies generate electricity using fuel oil and diesel. Total power generation for The Bahamas is not available other than for the years 2010-2012 from the energy balance. From BPL, power generation was available for the years 2001-2013 only.[15] While it is known that autoproducers of power exist in The Bahamas, for example using diesel-fueled generators, no data was available to estimate emissions from the related fuel consumption under category 1.A.1.a.i. It is understood that emissions from this fuel consumption are included under category 1.A.4. Other.

Fuel consumption was available for BPL over the whole time series, but only from 2016 onwards from The Grand Bahamas Power Company. Activity data is presented in Table 45 further below.

Table 43: Emission factors used for category 1.A.1.a.i Main electricity and heat production

Fuel Type	Unit	CO_2	CH_4	N_2O
Diesel oil	kg gas /TJ	74,100	3	0.6
Fuel oil	kg gas /TJ	77,400	3	0.6

3.12.4. Manufacturing Industries and Construction (Category – 1.A.2)

With the large focus on financial services and tourism, industrial activity in The Bahamas is limited. Examples include mining (actually quarrying of aragonite, a type of limestone), construction and mixing of cement. Production of clinker does however not take place.

[15] Power generation from the IEA database (https://www.eia.gov) was compared to available power generation and found to differ strongly, e.g. IEA generation values were 45.2 per cent below reported BPL generation in 2001, 33.6 per cent in 2008 and 6.5 per cent in 2013.

The energy balance provides information on fuel consumption related to the two activities "industry" and "construction". Under Category 1.A.2 Manufacturing Industries and Construction, the IPCC 2006 Guidelines include a list of subcategories. One of the subcategories is construction (1.A.2.f); the list does however not include a category named "industry" (as listed in the EB). It is our understanding that "industry" as described in the EB could in theory include fuel consumption from any of the categories under 1.A.2 applicable for The Bahamas, except for construction. The decision was thus taken to allocate the fuel consumption under the activity "industry" in the EB to the IPCC category 1.A.2.m Non-specified industry.

Information in the EB on fuel consumption from mining is included in the activity "agriculture, fishing, mining" and could not be disaggregated due to lack of information. Emissions from fuel combustion from mining are therefore reported as part of category 1.A.4.c.

Activity data is presented in Table 46 for construction and Table 47 for non-specified industries further below.

Table 44: Emission factors used for category 1.A.2 Manufacturing and construction

Fuel Type	Unit	CO_2	CH_4	N_2O
Diesel oil	kg gas /TJ	74,100	3	0.6
Fuel oil	kg gas /TJ	77,400	3	0.6
Gasoline	kg gas /TJ	69,300	3	0.6
Kerosene	kg gas /TJ	71,500	3	0.6
LPG	kg gas /TJ	63,100	1	0.1

Table 45: Activity data for category 1.A.1.a.i Main electricity and heat production

Fuel type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Diesel oil	TJ	10,425	10,843	11,719	9,259	8,625	9,790	9,122	10,258	9,408	12,416	12,861	9,682	10,601	12,262	13,375	14,340	14,471	15,339
Fuel oil	TJ	9,754	10,144	4,456	6,063	6,905	6,386	7,168	6,816	6,457	5,209	4,432	5,735	4,749	4,892	4,379	4,092	3,704	3,739

Table 46: Activity data for category 1.A.2.f Construction

Fuel type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Diesel oil	TJ	169	199	142	319	438	397	485	403	403	221	346	607	530	486	483	446	502	507
Gasoline	TJ	280	286	345	312	307	320	294	322	343	399	305	329	325	333	350	347	369	384
LPG	TJ	22	14	16	20	19	19	20	21	16	20	18	22	26	28	33	25	25	35

Table 47: Activity data for category 1.A.2.m Non-specified industry

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Diesel oil	TJ	719	847	602	1354	1863	1686	2063	1712	1711	938	1471	2578	2253	2063	2051	1893	2132	2153
Fuel oil	TJ	22	23	10	14	16	15	16	16	15	12	10	13	11	11	10	9	8	9
Gasoline	TJ	1191	1214	1467	1324	1305	1362	1251	1369	1459	1696	1295	1398	1381	1414	1487	1477	1567	1630
LPG	TJ	91	61	66	87	80	81	85	90	66	84	77	95	110	117	138	105	105	150

3.12.5. Transport (Category 1.A.3)

3.12.5.1. Domestic Aviation (Category – 1. A. 3.a.ii)

Both domestic as well as international flights take place in / from The Bahamas. This category covers only domestic flights, i.e., flights which both start and land in The Bahamas. International flights are covered in section 3.2.6.2.

Flight data could not be obtained for domestic flights. The CBB dataset lists the consumption of aviation gasoline as well as Kerosene for domestic uses. It was assumed that all domestic aviation gasoline consumption takes place in the aviation sector. The EB, which only covers domestic use, indicates Kerosene consumption in the transport sector, which was assumed to be for domestic flights, and further use in the residential sector, which was assumed to be for lighting purposes. Consumption of aviation gasoline was taken from the CBB data. Kerosene for domestic flights was calculated by taking total Kerosene consumption from the CBB dataset and allocating the total consumption to the activities “transport” and “residential” as in the EB.

Table 48: Emission factors used for category 1.A.3.a.i domestic aviation

Fuel Type	Unit	CO_2	CH_4	N_2O
Aviation gas	kg gas /TJ	70,000	0.5	2
Kerosene	kg gas /TJ	71,500	0.5	2

3.12.6. Road Transport (Category – 1. A. 3.b)

Gasoline and diesel are the fuels consumed under this category. While a small amount of biodiesel is currently produced and consumed in the transport sector in The Bahamas, this activity has only started in 2019.

Gasoline consumption data was estimated using the CBB dataset. Registration of data for road vehicles was obtained from The Bahamas’ Department of Transport and compared with data from the energy balance for the year 2012. The Department of Transport has started digitizing registration data from 2016 onwards. Not all islands have digitized their systems. The islands which have to date, however, cover about 95% of The Bahamas' inhabitants. Registration numbers in 2016 and 2017 are considerably higher than in 2018-2021, however considerably lower than in 2012, see Table 49 below. While the general difference between 2016-2021 values to the 2012 value might indicate that the datasets provided contain only new registrations, this does not explain the differences between values for 2016/2017 and 2018-2021. On this basis, total numbers of vehicles and numbers per vehicle type could not be calculated.

Table 49: Vehicle registration numbers

Source	Year	Passenger cars	Light duty trucks	Heavy duty trucks / buses	Motorcycles	Total number of vehicles
EB	2012	134,039	4,578	841	877	140,335
Department of Transport	2016	43,439	3,875	90	25	47,429[16]
	2017	56,629	5,612	2,581	1,207	66,029
	2018	16,807	1,094	557	459	18,917
	2019	14,001	752	483	199	15,435
	2020	13,321	853	927	256	15,357
	2021	16,041	1,248	1,170	583	19,040[11]

For the time being, fuel consumption per vehicle type (cars, light duty trucks, heavy duty vehicles, motorcycles) was calculated using a total number of vehicles obtained from CEIC Data[17], standard distances driven per vehicle type and standard fuel efficiencies per vehicle type, typical fuels used. Only the average shares of vehicle types was derived from the vehicle registration numbers presented in Table 49. The assumptions used for the allocation of fuel consumption to the vehicle types

[16] Data from 2016 and 2021 did not cover the whole year, but only October 20-December 31 for 2016, and January 1-May 1 for 2021. Numbers presented have been scaled up assuming an equal activity in registration for the remainder of the year as during the time period for which data was available.
[17] https://www.ceicdata.com/en/indicator/bahamas/motor-vehicle-registered

are presented in Table 50. The resulting fuel consumption per vehicle type over the time series are presented in Table 54, Table 55,

Table 56, and Table 57 further below. The emission factors used are presented in Table 51. For gasoline, CH4 and N2O emission factors in the IPCC 2006 Guideline are related to vehicle technologies. No information on vehicle technologies per vehicle type was available for cars, LDV and motorcycles using gasoline. As CH4 and N2O emissions from these vehicle categories are not key categories, these emissions were calculated using the emission factors for "gasoline uncontrolled", as a conservative approach in line with Figure 3.2.3 of Volume 2, Chapter 3 of the IPCC 2006 Guidelines.

Table 50: Assumptions used for the allocation of fuel consumption to the subcategories

Information	Unit	Passenger cars	Light duty trucks	Heavy duty trucks / buses	Motorcycles
Share of vehicle type	%	87.9%	7.4%	3.2%	1.5%
Fuel used	N/A	Gasoline	80% Gasoline 20% Diesel	Diesel	Gasoline
Distance driven per year	km	15500	35000	20000	1000

Table 51: Emission factors used for category 1.A.3.b Road Transport

			Default Emission Factor [kg/TJ]		
Fuel type	Representative vehicle category	Subcategory	CO_2	CH_4	N_2O

Motor Gasoline	Uncontrolled	Cars	69300	33	3.2
Motor Gasoline	Uncontrolled	LDV	69300	33	3.2
Motor Gasoline	Uncontrolled	Motorcycles	69300	10	0.96
Gas/Diesel Oil			74100	3.9	3.9

3.12.6.1. Domestic Waterborne Navigation (Category – 1. A. 3.c.ii)

Detailed data about The Bahamas fleet of waterborne vessels (e.g., mailboats, tourism, private cruising) was not available. It was assumed that smaller vessels consume gasoline, larger vessels diesel or fuel oil and that thus a share of the overall gasoline, diesel and fuel oil consumption might be attributable to domestic waterborne navigation. There was however no information available allowing to split fuel consumption for domestic waterborne navigation from total gasoline and total diesel consumption in The Bahamas. Such consumption could thus not be allocated to domestic waterborne navigation and is reported under road transport.

The amount of fuel oil in domestic waterborne navigation was estimated based on data obtained from BPL and the allocation of fuel oil consumption to activities in the EB. According to the EB, about 98% of fuel oil consumption is related to power generation, while the remainder is related to transport. It was assumed any consumption of fuel oil under the transport activity in the EB is for domestic waterborne navigation.

Activity data is presented in
Table 61 further below. Emission factors are presented in Table 52.

Table 52: Emission factors used for the category 1.A.3.c.ii domestic waterborne navigation

Fuel Type	Unit	CO_2	CH_4	N_2O
Fuel oil	kg gas /TJ	77400	7	2

Table 53: Activity data for category 1.A.3.a.ii Domestic Aviation

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Aviation Gasoline	TJ	153	133	138	92	87	31	5	41	41	41	41	66	56	61	46	56	46	41
Kerosene	TJ	902	807	913	1047	1102	1231	1119	1069	902	930	841	857	696	891	963	880	958	991

Table 54: Activity data for category 1.a.3.b.i Cars

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Gasoline	TJ	3,912	4,007	4,861	4,413	4,353	4,588	4,235	4,607	4,909	5,715	4,355	4,685	4,635	4,742	5,000	4,958	5,274	5,490

Table 55: Activity data for category 1.A.3.b.ii Light duty trucks

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Diesel oil	TJ	145	171	122	273	376	340	416	346	345	189	297	521	455	417	414	382	430	435
Gasoline	TJ	1026	1051	1275	1157	1142	1203	1110	1208	1287	1499	1142	1228	1215	1243	1311	1300	1383	1440

Table 56: Activity data for category 1.A.3.b.iii heavy duty vehicles and buses

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Diesel oil	TJ	538	634	451	1014	1395	1263	1545	1283	1282	702	1102	1931	1688	1546	1536	1418	1597	1613

Table 57: Activity data for category 1.A.3.b.iv Motorcycles

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Gasoline	TJ	3	3	4	4	4	4	3	4	4	5	4	4	4	4	4	4	4	4

Table 58: Activity data for category 1.A.3.c.ii Domestic waterborne navigation

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Fuel oil	TJ	201	209	92	125	142	132	148	141	133	107	91	118	98	101	90	84	76	77

3.12.6.2. International Bunkers (Categories – 1. A. 3.a.ii and 1. A. 3.c.i)

The CB statistical data provides information on foreign bunkers throughout the whole time series. The data is presented in barrels and not disaggregated by fuel type. The Bahamas' Second national communication as submitted to the UNFCCC (2NC) indicates that a statistical assessment was conducted for 1990, 1994 and 2000 to disaggregate the data into the following: (i) gasoline for motor vehicles and small boats; (ii) jet fuel for aircraft; and (iii) gas oil for larger marine transport vessels leaving The Bahamas. While no detailed overview of international flights could be obtained at the time, there is a general understanding, that there is international air traffic involving small aircraft using aviation gasoline between The Bahamas and other countries, e.g., the US. The international bunkers fuel consumption should thus likely also include aviation gasoline from international flights. GHG emissions from the consumption of aviation gasoline for such international flights could not be estimated due to lack of data.

The 2NC does present CO_2 emissions for the categories international aviation and international navigation, but does not provide insight into the shares of gasoline and fuel oil consumed under international navigation. As a conservative approach, it was thus assumed that CO_2 emissions from international navigation resulted solely from fuel oil. This means, overestimating the consumption of fuel oil and underestimating the consumption of gasoline in international waterborne navigation.

Using IPCC default factors and the CO_2 emissions from international aviation and international navigation for the years 1990, 1994 and 2000 in the 2NC, fuel consumption of kerosene and fuel oil were estimated. The average share of each fuel type in the total fuel consumption in energy units was calculated, amounting to 56% for Kerosene and 44% for fuel oil. These shares were multiplied by the CB statistical data for international bunkers to estimate kerosene and fuel oil consumption for international bunkers over the time series. Activity data are shown in Table 60 and Table 61 below.

Table 59: GHG emission factors (defaults) used for international bunkers

			International aviation		International navigation	
Fuel Type	Unit	CO_2	CH_4	N_2O	CH_4	N_2O
Fuel oil	kg gas /TJ	77,400			7	2
Kerosene	kg gas /TJ	71,500	0.5	2		

Table 60: Activity data for category 1.A.3.a.i International aviation

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Kerosene	TJ	14999	15043	7207	8689	7934	10480	12711	10439	8548	8463	9467	12743	10877	9690	7720	7849	8774	9473

Table 61: Activity data for category 1.A.3.c.i International waterborne navigation

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Fuel oil	TJ	12496	12533	6004	7239	6610	8731	10590	8697	7121	7050	7887	10616	9061	8073	6431	6539	7310	7892

3.12.6.3. Other transportation (Category 1.A.3.e)

Emissions from pipeline transport do not occur in The Bahamas. Emissions from the Off-road use of vehicles are included in the emissions under road transport (category 1.A.3.e.ii). Emissions from mobile combustion related to fishing are very likely to occur, however, fuel consumption (e.g. diesel, gasoline) for this specific activity was not available. This fuel consumption is included in the fuel consumption for road transport.

3.12.6.4. Other (Category 1.A.4.)

The IPCC category Other contains three subcategories:

- 1.A.4.a Institutional/Commercial
- 1.A.4.b Residential
- 1.A.4.c Agriculture, Forestry, Fisheries.

Fuel consumption per subcategory and type was, with the exception of firewood and charcoal, calculated by calculating total consumption for each fuel as indicated in section 3.2.1 above and allocating fuel use to categories as indicated in the EB.

Consumption of firewood and charcoal was not available from the CBB dataset, however from the EB. The EB indicates a small amount of firewood is used in the residential sector. It was assumed that this is a practice typical for rural areas. On this basis, average firewood consumption per capita of rural population was calculated for 2010-2012 and extrapolated over the time series using rural population as driver.

For charcoal, EB 2010-2012 values were split over the categories institutional / commercial and residential based on the information in the EB. Charcoal use in the category institutional commercial, which is assumed to take place mainly in the services and tourism sector, was extrapolated over the timeline using GDP. Charcoal use in the category residential was extrapolated over the timeline using population development.

GHG emission factors used for the three sub-categories are presented in Table 62.

Table 62: Emission factors used for the categories institutional/commercial, residential, agriculture/fisheries/forestry

Fuel Type	Unit	CO_2	CH_4	N_2O
Charcoal	kg gas /TJ	112,000	200	1
Firewood	kg gas /TJ	112,000	300	4
Diesel oil	kg gas /TJ	74,100	10	0.6
Gasoline	kg gas /TJ	69,300	10	0.6
Kerosene	kg gas /TJ	71,500	10	0.6
LPG	kg gas /TJ	63,100	5	0.1

Activity data are shown below in Table 63 for Commercial / Institutional, Table 64 for Residential and Table 65 for Agriculture / Forestry / Fisheries.

Table 63: Activity data for category 1.A.4.a Commercial /institutional

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Charcoal	TJ	9	10	10	10	11	11	11	11	11	11	11	11	11	11	12	12	12	12
Firewood	TJ	29	29	30	30	31	31	32	32	33	33	34	34	34	34	34	35	35	35
Diesel oil	TJ	930	1096	779	1753	2411	2182	2669	2216	2215	1213	1904	3337	2916	2670	2654	2450	2759	2787
Gasoline	TJ	1541	1571	1899	1713	1689	1762	1619	1772	1888	2195	1676	1810	1787	1830	1924	1911	2028	2109
LPG	TJ	54	36	39	51	47	48	50	53	39	49	45	56	65	69	81	62	62	88

Table 64: Activity data for category 1.a.4.b Residential

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Charcoal	TJ	6	6	6	6	7	7	7	7	7	7	7	7	8	8	8	8	8	8
Diesel oil	TJ	42	50	35	80	110	99	121	101	101	55	87	152	133	121	121	111	125	127
Gasoline	TJ	70	71	86	78	77	80	74	81	86	100	76	82	81	83	87	87	92	96
Kerosene	TJ	7	6	7	8	8	9	8	8	7	7	6	6	5	7	7	6	7	7
LPG	TJ	331	219	238	314	288	294	307	324	241	303	279	344	400	423	501	380	380	543

Table 65: Activity data for the category 1.A.4.c Agriculture/Fisheries/Forestry

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Diesel oil	TJ	85	100	71	159	219	198	243	201	201	110	173	303	265	243	241	223	251	253
Gasoline	TJ	140	143	173	156	154	160	147	161	172	200	152	165	162	166	175	174	184	192

3.12.7. Fugitive Emissions (Category 1.B)

3.12.7.1. Natural Gas liquids transport (Category 1.B.2.a.iii.3)

Fuel production does not take place in The Bahamas. Fuel distribution of oil products and LPG however does. The IPCC 2006 guidelines indicate that low levels of emissions from CO_2 and N_2O might occur from the distribution of LPG, but that no emissions might occur from the distribution of oil products. Emissions from the distribution of LPG were estimated based on total LPG consumption for The Bahamas, based on the CBB dataset. The GHG emission factors used for this category are presented in Table 66.

Table 66 Emission factors used for category 1.B.2.a.iii.3 Natural Gas liquids transport

Gas	Unit	Value
CO_2	Gg per 1000 m3 LPG	0.00043
N_2O	Gg per 1000 m3 LPG	0.0000000022

Table 67: Activity data for the category 1.B.2.a.iii.3 Natural Gas liquids transport

Fuel Type	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
LPG	1000 barrels	154	102	111	146	134	137	143	151	112	141	130	160	186	197	233	177	177	253

3.13. IPPU

3.13.1. Lubricant use (category 2.D.1)

The Central Bank of The Bahamas (CBB) compiles a quarterly overview of oil imports for domestic consumption which includes the category “lubricants and other” and provides a time series from 2001-2018.

The IPCC 2006 GL indicate that only CO_2 emissions occur from lubricant use, but not N_2O or CH_4 emissions. The CO_2 emissions arise from the oxidation of the lubricants during use. Emissions were estimated using the carbon content of the lubricants and a default factor for oxidation during use provided by the IPCC 2006 GL.

Table 68: Factors used for the estimation of GHG emissions under category 2.D.1 Lubricant use

Factor	Unit	Value	Source
Carbon content of lubricants	t/TJ	20	V3, Ch5, Table 5.2
Oxidation during use (ODU) factor	N/A	0.2	V2, Ch1, table 1.4

Lubricant consumption in 2001-2018 is presented in Table 69

Table 69: Lubricant consumption, activity data for category 2.1 Lubricant use

Activity data	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Lubricant consumption	TJ	255.97	574.51	193.40	193.40	233.22	284.41	221.84	244.59	210.47	216.15	96.70	73.95	119.45	68.26	68.26	68.26	79.64	73.95

3.14. AFOLU

3.14.1. Agriculture

3.14.1.1. 3.A.1 and 3.A.2 Enteric Fermentation and Manure Management

The livestock values were obtained from both National Customs Imports report for livestock, in addition to FAOStat. Cattle (meat)[18], swine, sheep, goats and poultry data[19] were obtained from FAOStat, and horses, mules and asses were obtained from national sources in annual customs reports. Livestock production is generally limited in The Bahamas, with the exception of poultry[20].Livestock activity data can be seen in Table 71.

Some of the assumptions[21] applied to these categories include:

- Cattle population was assumed to be 5% dairy cow, 95% other (meat)
- Manure management practices for population of cattle, sheep, goats, horses, asses and mules is 98%open range/paddock, 2% dry lot
- Manure management practices for population of swine is 90% dry lot and 10% liquid slurry
- Manure management practices for population of poultry is 100% poultry manure with litter

Table 70 shows the default values from Volume 4, Chapter 10 of the IPCC 2006 Guidelines with regards to enteric fermentation and manure management.

[18] Cattle production is not a large industry in the Bahamas, therefore values for meat production were used, which represents the majority of the industry according to expert judgement. Future data validation of this sector was prioritized.
[19] Poultry livestock includes eggs and laying hens, however further assessments should prioritize obtaining national figures for broiler production, which has an established industry.
[20] Generally, livestock production data is not readily available at the national level, therefore there was a heavy reliance on the use of international data from FAOStat.
[21] Assumptions applied were collected based on expert judgement from agricultural experts from the Ministry of Agriculture

Table 70: Factors used for the estimation of GHG emissions under category 3.A.1 and 3.A.2 Enteric Fermentation and Manure Management

Species/Livestock category	Emission factor for Enteric Fermentation ((kg head-1 yr-1)	Emission factor for Manure Management (kg head-1 yr-1)
Dairy Cows	72	2
Other Cattle	56	1
Sheep	5	0.2
Goats	5	0.22
Horses	18	2.19
Mules and Asses	10	1.2
Swine	1	2
Poultry	0	0.02
Source	IPCC 2006 GL, Vol 4, Tables 10.10 and 10.11	IPCC 2006 GL, Vol 4, Tables 10.14 – 10.16

Table 71: Livestock Activity Data, 2001-2018

Species/ Livestock category	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Dairy Cows	6	8	8	8	8	5	5	6	6	5	5	6	6	6	6	5	5	5
Other Cattle	114	143	152	157	157	100	95	107	106	95	100	107	108	106	105	103	102	101
Sheep	1600	1830	1950	2000	2000	1700	2000	2000	2000	2000	2000	2024	2042	2045	2063	2091	2120	2142
Goats	5300	5450	5550	5700	5700	5800	6000	6000	6000	6000	6000	6172	6173	6103	6127	6089	6113	6147
Horses	15	1216	12	2	8	50	28	27	45	162	7	49	24	152	107	6	13	264
Mules and Asses[22]	59	0	0	255	255	0	0	0	0	0	0	0	65	229	97	75	390	100
Swine	6300	6250	6400	6500	6500	6500	6600	6600	6600	6600	6600	6680	6802	7046	6919	6966	7023	7059
Poultry (laying hens, eggs, in shell)	120000	123000	125000	128000	128000	130000	113000	113000	113000	113000	140000	113000	114000	113000	115000	115000	109000	114000

[22] The fluctuation of mules and asses over the time series requires detailed assessment of historical data which was not feasible for the preparation of this GHG Inventory, and is a noted improvement for subsequent reports.

3.14.1.2. 3.C.3 Urea Application

Activity data is derived from annual imports of urea fertilizer from the Customs Annual report. This can be seen in Table 72. The emission factor CO_2 emissions for urea fertilization, which is equivalent to the carbon content of urea on an atomic basis (20% for $CO(NH_2)_2$) in Table 73.

Table 72: Annual Urea Import[23], 2001-2018

Year	Urea Data- Customs Imports (tonnes)
2001	71
2002	261
2003	210
2004	314
2005	0
2006	2297
2007	54
2008	416
2009	1563
2010	946
2011	1040
2012	207
2013	116
2014	1200
2015	674
2016	83
2017	239
2018	152

[23] The fluctuations in urea import data (e.g. 0 tonne in 2005) requires detailed assessment of historical data, which was not feasible for the preparation of this GHG Inventory. It is a noted improvement for subsequent reports.

Table 73: Factors used for the estimation of GHG emissions under category 3.C.3 Urea Application

Emission factor ([tonnes of C (tonne of urea)$^{-1}$])
0.2

3.14.1.3. 3.C.4 and 3.C.5 Managed Soils (Direct and Indirect N2O)

This subcategory accounts for direct N_2O emissions from synthetic fertilizer, dung and urine from manure on grazed soils, as well as indirect N_2O emissions from leaching/runoff and atmospheric deposition of volatilised nitrogen from managed soils. The activity data for livestock, and assumptions for the fraction of total manure deposited on soils are those referred to in Section 3.4.1.1 (Enteric Fermentation and Manure Management) and Table 71. The activity data of nitrogen based fertilizer was obtained from national Customs import data, see Table 74.

The emission factors for direct N_2O emissions from synthetic fertilizer as well as from urine and dung N deposited on pasture, range and paddock can be seen in Table 75. The emission factors for indirect N_2O emissions from N_2O emission from N leaching and runoff and atmospheric volatilization can be seen in Table 76.

Table 74: Activity Data for Nutrient Nitrogen from Fertilizer for Agriculture (tonnes)

Year	Nutrient Nitrogen N from Fertilizer for Agriculture (tonnes)
2001	14,566
2002	4,548
2003	7,561
2004	17,341
2005	8,029

2006	10,288
2007	13,087
2008	8,282
2009	6,093
2010	3,770
2011	3,712
2012	4,851
2013	2,997
2014	3,907
2015	6,858
2016	5,516
2017	6,697
2018	8,747

Table 75: Emission factors for 3.C.4 direct N_2O emissions from synthetic fertilizer and urine and dung on grazed soils

Anthropogenic N input type	Emission factor for N_2O emissions from urine and dung N deposited on pasture, range and paddock by grazing animals *[kg N_2O-N (kg N input)-1]*	Emission factor for N_2O emissions from N inputs *[kg N_2O-N (kg N input)-1]*
Cattle, Poultry and Pigs, and Sheep	0.02	-
Sheep and Other Animals	0.01	-
Synthetic Fertilizers	0.01	0.01
Source	IPCC 2006 GL, Vol 4, Chapt 11, Table 11.1	

Table 76: Emission factors for 3.C.5 indirect N_2O emissions on managed soils

Fraction of all N additions to managed soils that is lost through leaching and runoff	Emission factor for N_2O emission from N leaching and runoff	Fraction of applied organic N fertilizer materials (F_{ON}) and of urine and dung N deposited by grazing animals (F_{PRP}) that volatilizes	Emission factor for N_2O emission from atmospheric deposition of N on soils and water surfaces
[kg N (kg of N additions)$^{-1}$]	[kg N_2O-N (kg N leaching and runoff)$^{-1}$]	(kg NH_3-N + NO_x-N) (kg of N applied or deposited)$^{-1}$	(kg N_2O-N) (kg NH_3-N + NO_x-N volatilized)$^{-1}$
$Frac_{LEACH-(H)}$	**EF**	**$Frac_{GASM}$**	**EF**
0.3	0.0075	0.2	0.01
Source	IPCC 2006 GL, Vol 4, Chapt 11, Table 11.3		

3.14.1.4. 3.C.6 Indirect N2O Emissions from Manure Management

This category involves the determination of indirect N_2O emissions from manure management. Emissions reported under category concern only the N_2O emissions from manure produced in animal houses, and then stored temporarily and/or processed before being transported elsewhere. The source categories include swine and poultry. The emission factors used for this category as seen in Table 77 below. Activity data for this sector for livestock can be seen in Table 71 further above.

Table 77: Emission Factors for Indirect N_2O Emissions from Manure Management

Species/Livestock category 2	Total nitrogen excretion for the MMS (kg N yr-1)	Emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces [kg N_2O-N (kg NH3-N + Nox-N volatilised)-1]
Swine	0.48	0.01
Poultry	0.4	0.01
Source	IPCC 2006 GL, Vol 4, Table 10.22	IPCC 2006 GL, Vol 4, Table 11.3

3.14.2. Forestry and Other Land Uses (Category 3.C)

Methodology used for time series analysis of satellite data to generate activity data

The Bahamas, like many developing countries, does not have a regular forest inventory data or land use mapping necessary to generate activity data for calculating GHG emissions from the FOLU sector. To address this issue Landsat satellite data was used to generate activity data using Google Earth Engine platform for the inventory period 2000 to 2020. Landsat images from 2000, 2005, 2010, 2015 and 2020 were classified into six IPCC land use classes, Forestland, Grassland, Cropland, Wetland, Settlement and Other land. IPCC default emission factors were used to calculate GHG emission for each of four time periods: 2000-2005, 2005-2010, 2010-2015 and 2015-2020. For this inventory, all lands were considered as managed land, classified as crown lands.

Classification of Satellite Imagery

It is a challenge to obtain cloud free satellite images over the Caribbean countries, The Bahamas is no exception. Therefore, cloud filtering and masking functions were used to mask out (remove) cloud and cloud shadows. Only cloudless composite images covering the country were used in this analysis. For this reason, the total land area varies for each

5 year period because of unclassified pixels which may be due to cloud and cloud shadows or absence of satellite data for a portion of the country. Activity data for Landsat images 2000 to 2010 were collected using Landsat 7 satellite and images from 2010 to 2020 were collected using Landsat 8 satellite. These two satellites have slightly different band combinations, therefore, separate classification models were developed for Landsat 7 and Landsat 8 to generate classified maps. The training points for each of six IPCC land classes were collected by sampling a global map of land use/land cover (LULC) published by ESRI[24]. The forest definition is same as the training data which came from ESRI Land Cover 2020, whereby forest is captured as trees >= 15 m.

The global land cover map was derived from ESA Sentinel-2 imagery at 10m resolution. It is a composite of LULC predictions for 10 classes throughout the year in order to generate a representative snapshot of 2020. A stratified random sampling was used to collect training data for 8 classes[25]: 1) Water, 2) Forest, 3) Grassland, 4) Wetland, 5) Cropland, 6) Scrub/Shrub, 7) Settlement and 8) Other land.

A total of 809 training points were collected, 70% of points were randomly selected from each land use type to train classification model using "Random Forest" algorithm in the

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[24] https://www.arcgis.com/home/item.html?id=d6642f8a4f6d4685a24ae2dc0c73d4ac

[25] Definitions: 1. Water- Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrop nor built up features like docks; examples: rivers, ponds, lakes, oceans, flooded salt plains.

2. Trees- Any significant clustering of tall (~15-m or higher) dense vegetation, typically with a closed or dense canopy; examples: wooded vegetation, clusters of dense tall vegetation within savannas, plantations, swamp or mangroves (dense/tall vegetation with ephemeral water or canopy too thick to detect water underneath).

3. Grassland - Open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting (i.e., not a plotted field);

4. Flooded vegetation Areas of any type of vegetation with obvious intermixing of water throughout a majority of the year; seasonally flooded area that is a mix of grass/shrub/trees/bare ground; examples: flooded mangroves, emergent vegetation, rice paddies and other heavily irrigated and inundated agriculture.

5. Cropland - Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land.

6. Scrub/shrub - Mix of small clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; scrub-filled clearings within dense forests that are clearly not taller than trees; examples: moderate to sparse cover of bushes, shrubs and tufts of grass, savannas with very sparse grasses, trees or other plants

7. Settlement - Human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages / towns / cities, paved roads, asphalt

8. Other land - Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and sand dunes, dry salt flats/pans, dried lake beds, mines.

Google Earth Engine. Remaining 30% points were used to validate the model. The model developed using Landsat 7 satellite data from 2020 was applied to Landsat 7 images from 2000, 2005 and 2010 to generate land use maps for 2000, 2005 and 2010. The same training data and procedure was used to build and validate Landsat 8 classification model using Landsat 8 satellite data from 2020. The model was then applied to 2015 to generate land use maps for 2015 and 2020. Table 78 below outlines the activity data from land use classifications from 2000 to 2020. A more detailed breakdown of land use between individual land use categories (land use matrices) for each 5 year interval from 2000-2020 can be seen in Annex V.

The CO_2 emission factors used for this category are presented in Table 79.

Table 78: Activity data for Land Use Classifications, 2000-2020 (ha).

Land Use (ha)	2000-2005	2005-2010	2010-2015	2015-2020
Forest remaining Forest	174,695	210,014	254,936	243,171
Land converted to Forest	87,564	144,763	80,390	88,664
Grassland remaining Grassland	304,151	269,032	278,697	374,237
Land converted to Grassland	142,646	107,834	220,502	139,809
Cropland remaining Cropland	16,657	16,832	3,333	2,976
Land converted to Cropland	56,364	51,321	14,665	15,507
Wetland remaining Wetland	15,502	17,064	13,051	27,961
Land converted to Wetland	52,713	47,258	66,044	47,017
Settlement remaining Settlement[26]	63,590	59,560	25,517	17,702
Land converted to Settlement	66,370	66,339	21,407	24,394
Other land remaining Other land	54,111	43,985	28,451	32,929

[26] It seems unlikely that this land use decreased over time. This might be attributable to limited resolution of the satellite imagery and has been identified as an area of improvement, see Annex III.

Land converted to Other land	22,180	12,987	22,449	16,575
Unclassified Area	331,456	341,010	358,558	357,059
Total Area (ha)	**1,388,000**	**1,388,000**	**1,388,000**	**1,388,000**

Figure 44 below shows the total land area for each land use classification for the period of 2000 to 2020. Each land use represents the sum of land use type remaining and the area converted to each land use type (e.g.: Forestland = Forestland remaining Forestland + Land Converted to Forestland). Over the time series, The Bahamas highest land use category was grassland accounting for 50% of classified land, including both pastureland and shrubland/scrubland (prevalent native species being low-scrubby coppice), followed by Forest Land which represented 32%of total area.

Figure 44: Land Use Types in 2015-2020

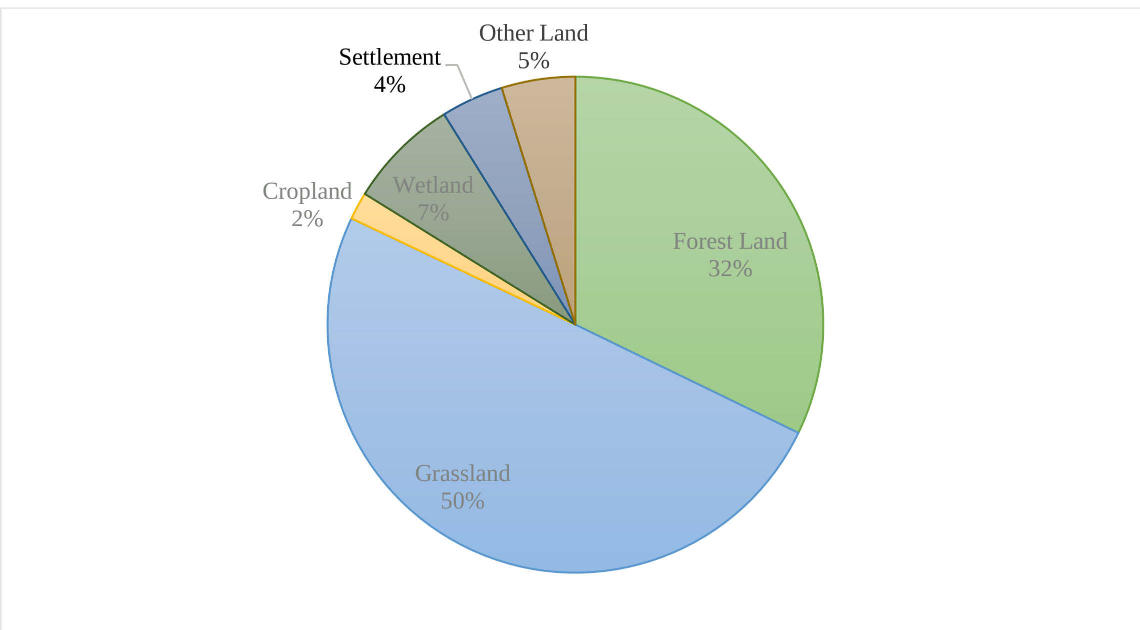


Table 79: Emission factors used for Land Use (Category 3.C)

Land use category	Carbon stock (tC/ha)	Source
Forest land[27] [Table 4.7, (AGB+BGB)*0.47]	62.04	IPCC 2006, GL, Vol. 4, Table 4.7 (above ground biomass)
<u>Non-forest land</u>		IPCC 2006, GL, Vol. 4, Table 6.4 (biomass stocks present on grassland, after conversion from other land use)
Grassland (Table 6.4)	4.09	
Cropland	0.00	
Wetland	0.00	
Settlement	0.00	
Other land	0.00	
<u>Land Converted to Forest Land (Table 4.9)</u>		
Forest growth in 5 years for trees <20 yrs		IPCC 2006, GL, Vol. 4, Table 4.9 (above-ground net biomass growth in natural forests)
Land converted to forest (2.26 tC/ha/yr)	11.28	
Forest Land Remaining Forest Land (Table 4.9)		
Forest growth in 5 years for trees >=20 yrs		
Forest Land Remaining Forest Land 0.56 tC/ha/yr)	2.82	

[27] Dominant forest type in the Bahamas is pine forest

3.15. Waste

3.15.1. Solid Waste (Category 4.A)

Over the duration of the time series, solid waste was collected and landfilled in unmanaged landfills (open dumps) with a depth of generally more than 5 meters, according to expert judgement. The landfill on New Providence, now called New Providence Ecology Park – NPEP was converted into a managed landfill from 2019, the process was finalised in early 2020. At the time data collection took place (Q2 2021) methane capture was planned to start later the same year, once a critical mass of methane capture had been reached. From 2015-2019 landfill fires were reported, which could be extinguished by mid-2019. Open burning of waste is practiced on smaller islands, where no waste collection system exists. Detailed information on which islands these are, were not available.

Only limited waste management data is available in The Bahamas at present. For the NPEP amounts landfilled of roughly 250-300 kt waste per year were estimated for the timeframe March 2019 – March 2020 based on truck numbers and loading volumes, as scales were to be installed only from roughly mid-2021 onwards. Considering New Providence's population at the time, this amount of waste is largely in line with the default value for MSW generation per capita for The Bahamas provided in the IPCC 2006 Guidelines.

Source separation of waste does not take place in The Bahamas. NPEP started diverting gardening waste as well as construction debris for the purposes of recycling from mid-2020 onwards. Since that time, composting of gardening waste takes place. In the future, diversion of food waste for composting is planned. Generally, waste composition data is not available for The Bahamas.

Methane emissions from landfilling were estimated using a Tier 1 approach which uses the first order decay model [reference to IPCC 2006 GL providing more information on the model]. Waste generation was calculated using 1950-2018 population data[28] and a waste generation default value of 950 kg / cap and year (see Volume 5, Chapter 2, Table 2A.1 of the IPCC 2006 GL).[29] In line with IPCC default, it was assumed that 70% of this waste is landfilled (see Volume 5, Chapter 2, Table 2A.1 of the IPCC 2006 GL). Table 86 further below shows the estimated waste amounts landfilled in 2001-2018. Default values from table 2.3 of Volume 5, Chapter 2 of the IPCC 2006 Guidelines were used with regards to waste composition, see Table 80.

Table 80: Assumptions for waste composition

Food	Garden	Paper	Wood	Textile	Nappies	Plastics, other inert	Total
%	%	%	%	%	%	%	(=100 %)
47 %	0%	17%	2%	5%	0%	29%	100%

Potentially landfilling of sludge from wastewater treatment plants also takes place in The Bahamas. Information on sludge was, however, not available.

Industrial waste is assumed to be collected and processed as part of municipal solid waste.

3.15.2. Open burning (Category A.C.2)

No information was available on the share of waste openly burned and the islands where such open burning might be a common practice. Based on expert judgement, 2% of total population is assumed to use open burning as waste management measure. This level of open burning is also assumed to cover landfill fires as reported for NPEP. The waste amounts assumed to be openly burned are presented further down in Table 87. It was

[28] Taken from UN World Population prospects, https://population.un.org/wpp/Download/Files/1_Indicators%20(Standard)/EXCEL_FILES/1_Population/WPP2019_POP_F01_1_TOTAL_POPULATION_BOTH_SEXES.xlsx

[29] Population numbers used do not include tourism. Waste generation might therefore potentially be underestimated.

assumed that the composition of the waste burned is the same as for the waste landfilled, see section 3.15.1.

CO_2, CH_4 and N_2O emissions from open burning were estimated using a Tier 1 methodology whereby the amount of waste openly burned is multiplied by an emission factor (CH_4, N_2O) or a combination of factors (CO_2) specific to each gas (see Volume 5, Chapter 5 of the IPCC 2006 Guidelines for national GHG inventories). The estimation approach for N_2O and CO_2 requires the amount of waste openly burned on a dry matter basis, while the one for CH_4 refers to wet matter. Table 81 presents the dry matter content for different waste types.

Table 81: Waste composition default data and default factors for the estimation of CO_2 emissions from fossil carbon in open burning and sources of default data in the IPCC 2006 Guidelines.

Source of factor	table 2.3 of Volume 5, Chapter 2 of the IPCC 2006 Guidelines	Volume 5, Chapter 2, Table 2.4			Volume 5, chapter section 5, Table 5.2	Volume 5, chapter 5.2.1.1
Type of waste	Share in MSW	Dry matter content	Fraction of carbon in dry matter	Fraction of fossil carbon in total carbon	Oxidation factor	Conversion factor 44/12
		%	%	%	%	
Food	47%	40	38	0	58	3.666667
Paper	17%	90	46	1	58	3.666667

wood	2%	85	50	0	58	3.666667
textile	5%	80	50	20	58	3.666667
plastics	29%	100	75	100	58	3.666667

Table 82: Open burning default factors for CH_4 and N_2O from open burning

Gas	CH_4 emission factor data	N_2O emission factor data
Source of default factor	EF taken from V5, Ch5, p. 5.20	EF taken from V5, Ch5, table 5.6
Unit	g CH_4 / t MSW (wet matter)	g N_2O/t waste (dry matter)
Value	6500	150

3.15.3. Domestic wastewater treatment and discharge (Category 4.D.1)

Domestic wastewater management across 700 islands and cays of The Bahamas is challenging. For this reason, The Bahamas has the highest usage of septic tanks in the region, accounting for 81% of its population (PAHO, 2012). Other domestic wastewater is managed through access to a centralized sewerage system (16%), and through pit latrines ~5%).

At present, industrial sources of wastewater are not accounted for due to limited knowledge of production values in the country for the rum and beer production sector, as well as fish and conch processing and packaging facilities.

Emissions of CO_2, CH_4 and N_2O were estimated for the category 4.D.1 Domestic Wastewater and were based on a Tier 1 approach. CH_4 emissions from domestic wastewater were estimated using a Tier 1 methodology using a combination of both default values for EFs and AD, and country specific activity data, see Table 83 and Table 84. CH_4 production depends primarily on the amount of degradable organic material in the wastewater, the temperature and the type of treatment system. Activity data includes the total amount of organically degradable material in the wastewater estimated from population data, biological oxygen demand EFs, and correction factor for industrial BOD into sewers (see Table 83). N_2O emissions were estimated using Tier 1 methods for total amount of nitrogen in effluent, accounted from annual per capita protein consumption (see Table 85).

Table 83: Domestic Wastewater Defaults for CH_4 emissions from domestic wastewater and for estimation of Organically Degradable Material in Domestic Wastewater.

Type of treatment or discharge	Maximum methane producing capacity (kg$_4$/kgBOD)	Methane correction factor for each treatment system (MCF)	EF (kg CH_4/ kg BOD)		Degradable organic component (kg BOD/cap/yr)	Correction factor for industrial BOD discharged in sewers' (I)
Latrine	0.6	0.1	0.06		14.6	1
Centralized, aerobic treatment plant (overloaded)	0.6	0.3	0.18			
Septic System	0.6	0.5	0.3			
Sea, River and Lake Discharge	0.6	0.1	0.06			

Table 84: Values for Urbanisation and Degree of Utilisation of Domestic Wastewater Treatment, discharge or Pathway for CH_4 emissions from domestic wastewater

Urbanization (Fraction of Population)			**Degree of utilization of Discharge Pathway by income group**		
Rural	Urban-high	Urban-low	Rural, Urban-high and Urban low income		
			Septic Tank	Sewer (Centralized, aerobic treatment plant)	Latrine
0.16	0.25	0.59	0.81	0.13	0.06
Source: IPCC 2006 Defaults, Table 6.5 (LAC, Brazil)[30]			**Source: National Data, PAHO (2012)**		

Table 85: Emission Factors to estimate indirect N_2O from Wastewater

Nitrogen in Effluent EF	**Fraction of nitrogen in protein**	**Fraction of non-consumption protein**
(kg N_2O-N/kg N)	(kg N/kg protein)	(-)
0.005	0.16	1.1
Source: IPCC 2006 Defaults		

[30] This default was closest to characteristics of urbanization distribution in the Bahamas than other regional defaults

Table 86: Amounts of solid waste deposited, activity data for category 4.A Solid Waste

Activity data	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Solid waste deposited	Gg	201.24	204.59	208.23	212.06	216.03	220.14	224.36	228.55	232.49	236.04	239.12	241.78	244.17	246.47	248.85	251.32	253.87	256.45

Table 87: Solid waste openly burned, activity data for category 4.C Open Burning

Activity data	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Solid waste openly burned	Gg	287.49	292.28	297.47	302.95	308.62	314.48	320.52	326.50	332.12	337.19	341.60	345.40	348.81	352.10	355.50	359.03	362.67	366.36

Table 88: Amounts of organically degradable material in wastewater, activity data for category 4.D.1 Domestic Wastewater

Activity data	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Organically degradable material in wastewater	kg BOD/yr	4418222.8	4491836	4571683.4	4655852.4	4742941	4833082	4925879	5017743	5104218	5182153	5249839	5308326	5360667	5411242	5463408	5517778	5573623	5630300

Chapter 4 – Mitigation actions and their effects, including associated methodologies and assumptions (BUR)

4.1. Introduction

The Commonwealth of The Bahamas, similar to the rest of the Caribbean islands, contributes very little to global GHG emissions (0.01%). Nevertheless, the Government of The Commonwealth of The Bahamas (GOB), conscious of the country's vulnerability as a small island developing state (SIDS) to climate change, in particular, extreme weather events, has demonstrated its commitment to combating climate change through implemented and planned actions covering the energy and forestry sectors at the national level.

This chapter presents The Bahamas' mitigation analysis and describes the mitigation actions in the five IPCC sectors of Energy, Industrial Processes and Product Use (IPPU), Agriculture, Land Use and Land Use Change and Forestry (LULUCF) and Waste. Due to the vast number of mitigation actions in the Energy sector, these have been disaggregated into Energy Demand, Electricity Generation and Transport sub-sectors.

The proposed mitigation actions for the assessment were based on desk reviews and consultations with a broad range of key stakeholders from both the public and private sectors in The Bahamas. The mitigation actions presented are in various stages of planning, preparation, and execution. The mitigation assessment provides a justified evidence base to The Bahamas for prioritising actions and registering the party's mitigation actions through the Nationally Appropriate Mitigation Action (NAMA) registry (or other climate change support mechanisms) in order to source financing for either implementation or further preparation. The chapter is organised into the following sections:

- Section 4.2: National Policies
- Section 4.3: Measures to Reduce GHG Emissions (Mitigation Actions)
- Section 4.4: GHG Emissions Projections

- Section 4.5: Barriers and Challenges to Implementation and Methods to Improve The Modelling

4.2. National Policies and Measures to Reduce GHG Emissions

4.2.1. National Policies

The Bahamas has recognised the critical role that the adverse effects of climate change play with regards to its future and highlights it as a cross-cutting challenge. As a vulnerable SIDS, the impacts of climate change are further heightened in The Bahamas by geographical location (tropical belt), topography (dispersion of islands, limited land masses), environmental conditions (high temperatures, sea-level rise, flooding, tropical cyclones) and others (Bahamas, 2015). This is despite the fact that The Bahamas contributes very little to global greenhouse gas emissions. As a result, The Bahamas' mitigation actions are enshrined within the sustainable development context. This ensures that the mitigation actions contribute to reducing emissions as well as the achievement of national economic and development goals. The Bahamas has continuously updated its many policies, plans, strategies, and initiatives to address climate change over the years. A list of the significant policies related to mitigation is highlighted in Table 89 below.

Table 89: Significant National Policies, Plans, Strategies, and Initiatives

Significant National Policies, Plans, Strategies, and Initiatives
Significant Policies and Plans
The Bahamas First and Second National Communications (2001 and 2015)
The Bahamas National Energy Policy (2013 -2033)
The Bahamas Intended National Determined Contribution (2015)

Significant National Policies, Plans, Strategies, and Initiatives
The Bahamas Building Code – 3rd edition – Ministry of Works and Utilities (2003)
The Bahamas Power and Light requirement for grid interconnection of small-scale renewable energy generation systems
Grand Bahama Power Company rules and regulations for renewable generation systems
The Civil Aviation Authority Bahamas Environmental Regulation (CAR ENV 2021)
National Policy for the Adaption to Climate Change (2005)
The Forestry Act (Amended 2014) and Forestry Regulations (2014)
Draft Vehicle Emissions Bill (2013)
Electricity Act (Renewable Energy) (Amended 2015)
Elimination of tariffs on solar panels, inverters, and LED appliances
Major Initiatives
Building the Bahamas Capacity in Transparency for climate change mitigation and adaptation (GEF) Project information
Pine Island – Forest Mangrove Innovation and Integration (Grand Bahama, New Providence, Abaco, and Andros) GEF – Project Identification document and Project Identification form
Meeting the Challenge of 2020 in the Bahamas (GEF) Project identification form
Promoting Sustainable Energy in the Bahamas – Final Draft September 2010 – Fichtner Report

Significant National Policies, Plans, Strategies, and Initiatives
The Commonwealth of The Bahamas Conditional Credit Line for Investment Projects (CCLIP) Advancing Renewable Energy in The Bahamas and Reconstruction with Resilience in the Energy Loan Proposal – IADB document
Reconstruction with Resilience in the Energy Sector in The Bahamas – Loan Contract - IADB
The Bahamas Power System Stability Study for the Implementation of a Higher Renewable Energy Penetration Level (2018)
Developing a national framework for the standardisation of stalls and procedures for a climate-smart street-side vendor throughout The Bahamas (2021)
Pilot Programme to outfit Government built homes with solar water heaters and solar panels
The Caribbean Hotel Energy Efficiency and Renewable Energy Action – Advanced Program (CHENACT-AP)
The Bahamas REEF Environment Educational Foundation
Major Strategies/Targets
30% economy-wide reduction in GHG emission when compared to BAU
30% renewables in the energy mix by 2030

4.2.1.1. Energy Policies

The Bahamas has adopted its National Energy Policy (NEP) 2013 – 2033 (Government of The Bahamas, 2013). The NEP central vision is to ensure that by 2033, The Bahamas has a modern, diversified, and efficient energy sector. This will provide Bahamians with affordable energy supplies and long-term energy security balanced with enhancing international competitiveness and sustainable prosperity.

The NEP Strategic Framework places priority on six key areas:

1. Security of energy supply through diversification of fuels;
2. Modernising the country's energy infrastructure;
3. Development of renewable energy sources such as solar, ocean energy, biofuels, waste-to-energy, and wind
4. Energy conservation and efficiency;
5. Development of a comprehensive governance/regulatory framework to support the advancement of the energy sector to be effectively able to facilitate the introduction of renewables and the diversification of fuels; and
6. Eco-efficiency in the manufacturing, agricultural and tourism sectors, and Government as leaders in energy conservation and the use of renewable energy.

The NEP is a long-term and strategic policy and contains four inter-related goals, each with specific strategies. The goals and related strategies are outlined in Table 90 below.

Table 90: Goal and Strategies from The Bahamas Energy Policy 2013-2033

Goal	Description	Strategies related to goal
Goal 1	Bahamians will become well aware of the importance of energy conservation, use energy wisely and continuously pursue opportunities for improving energy efficiencies, with key economic sectors embracing eco-efficiency	Strategies relevant to Households and Businesses related to Information, Education and Training, and Demonstration
		Strategies related to Government as a leader in energy conservation and efficiency
		Strategies related to Private Sector and Industry
		Strategies related to the Transport Sector and Buildings
		Strategies related to Legislation

Goal	Description	Strategies related to goal
Goal 2	The Bahamas will have a modern energy infrastructure that enhances energy generation capacity and ensures that energy supplies are safely, reliably, and affordably transported to homes, communities, and the productive sectors on a sustainable basis	Strategies related to Energy Generation and Distribution Infrastructure
		Strategies related to Energy Diversification
Goal 3	The Bahamas will become a world leader in the development and implementation of sustainable energy opportunities and continuously pursues a diverse range of well-researched and regulated, environmentally sensitive and sustainable energy programmes, built upon our geographical, climatic, and traditional economic strengths	Strategies related to the economic, infrastructural, and planning conditions that will ensure the sustainable development of all of The Bahamas' renewable energy resources
		Strategies related to the introduction of key policy instruments (financial and fiscal) for the promotion of renewable energy
		Strategies related to the development of a dynamic legislative and regulatory environment, responsive to growth and development in the renewable energy sector
		Strategies related to enhancing technical capacity and public awareness of renewable energy through effective support for training programmes, information

Goal	Description	Strategies related to goal
		dissemination and ongoing communication by the Government
		Strategies related to sustained research and development (R&D) and innovation in existing and emerging RETs
Goal 4	The Bahamas will have dynamic and appropriate governance, institutional, legal, and regulatory framework advancing future developments in the energy sector underpinned by high levels of consultation, citizen participation and public-private sector partnerships	Key actions are outlined in the NEP.

In addition, The GOB has reconfirmed its commitment to energy security as a priority and ensuring reliable, affordable, sustainable energy sources, including a national target to achieve a minimum of 30% renewables in the energy mix by 2030.

4.2.1.2. Nationally Determined Contribution

The Commonwealth of The Bahamas submitted its Intended Nationally Determined Contribution (iNDC) to the UNFCCC as part of its Paris Agreement commitments in 2015 (The Government of Bahamas, 2015) and ratified the agreement on 22 August 2016, which then became its Nationally Determined Contribution (NDC), and a revised and updated NDC in November 2022. The Bahamas 2015 NDC indicated a mitigation target of an economy-wide reduction of GHG emissions of 30% when compared to its Business as Usual (BAU) scenario by 2030. In addition, the document noted that the Government defined the policy framework for a low carbon development plan through the National Energy Policy, which sets a national target to achieve a minimum of 30% renewables in the energy mix by 2030 and allow for a 10% Residential Energy Self Generation Programme within the year. The target will also be achieved through the forestry sector by reducing GHG emissions from land degradation and deforestation through the establishment of a permanent forest estate, 20% of which is designated into either one of three categories (forest reserves, protected forests and conservation forests) under the Forestry Act. These forestry sector GHG emission reductions have the potential to increase carbon sequestration of approximately 5,661.077 GgCO_2-eq across several pine islands in The Bahamas, according to The Bahamas submitted NDC.

The targets were conditional on access to required technologies, energy efficiency and conservation measures appropriate for The Bahamas, as well as economic growth and socio-economic progress. The costs for implementing the NDC targets were anticipated to be met through multilateral and bilateral support from various sources. However, The Bahamas is recognised as a high-income country according to the world bank ratings and has limited access to grant and concessional financing.

4.3. Measures to Reduce GHG emissions

The measures to reduce The Bahamas' GHG emissions were assessed based on national circumstances, sustainable development goals, and national development priorities. The mitigation actions consider various aspects, including economic, social, environmental and GHG reductions capabilities. The actions are in various stages of planning, preparation and implementation. These actions were verified through multiple stakeholder engagements, including workshops, bilateral meetings, and surveys.

A review of The Bahamas’ existing climate change policies, sectoral action plans, strategies, and development priorities, as highlighted in the previous section, was undertaken to determine an initial list of mitigation actions. This list was further refined through stakeholder engagements. As a result, a total of forty-one (41) mitigation actions were identified for The Bahamas. These mitigation actions/strategies are divided into the following categories: Energy Demand, Electricity Generation, Transport, Agriculture, Land Use, Land Use Change and Forestry, Industrial Processes and Product Use and Waste. The following section describes each action included in the mitigation strategy by sector.

4.3.1. Description of Mitigation Measures

Due to challenges with data collection and access to information, only the major islands of The Bahamas were considered in these mitigation actions. Table 91 shows the number of mitigation actions by sector. These mitigation actions have been enhanced from the Second National Communication (SNC) or are newly proposed actions. The energy sector contains over 80% of the mitigation actions identified as priority areas for the GOB.

Table 91: Distribution of Mitigation Actions by Sector

Sector	Number of Mitigation Strategies
Energy Demand	13
Electricity Generation	14
Transport	7
Industrial Processes and Product Use (IPPU)	1
Agriculture	1
Land Use, Land Use Change and Forestry	3
Waste	2
Total	41

The description and status of each mitigation action are included in Sections 4.3.1.1 – 4.3.1.6**.**

4.3.1.1. Energy Demand

The mitigation actions identified in the Energy demand subsector are mainly based on the strategies identified in The Bahamas NEP 2013-2033. This subsector covers end-use consumption in the residential, commercial, tourism, industry and streetlighting areas. This sector does not include strategies and actions related to electricity generation and transport. Mitigation actions for energy demand primarily relate to affected changes in the end-use of electricity and fossil fuels. This includes changes in fuel and equipment used for cooling, refrigeration, cooking, appliance use, water heating, lighting and policies that would affect such changes. A total of **thirteen (13) mitigation actions** related to the **Energy Demand Subsector** were identified:

Table 92: Mitigation Action 1 - Adoption and Implementation of revised building code for all new buildings and renovations.

<table>
<tr><th colspan="6">Name of the mitigation action</th></tr>
<tr><td colspan="6">Adoption and Implementation of revised building code for all new buildings and renovations.</td></tr>
<tr><th>Status</th><th>Lead Agency/Agencies</th><th>Duration</th><th>Sector and subsector</th><th>Scope</th><th>GHGs covered</th></tr>
<tr><td>Ongoing</td><td>Department of Physical Planning, Ministry of Works and Utilities, Building Control</td><td>2020-2025</td><td>Energy Demand</td><td>National</td><td>Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)</td></tr>
<tr><th colspan="6">Objective of the mitigation action</th></tr>
<tr><td colspan="6">To adopt and implement the revised building codes for all new construction and renovations</td></tr>
<tr><th colspan="6">Brief description</th></tr>
<tr><td colspan="6">The Bahamas currently has a building code from 2003. The revised building code is expected to improve the minimum standards, provisions, and requirements for safe and stable building design and construction methods. Improving building design can reduce the energy demand and enhance resilience. The adoption and implementation of this revised building code will assist in the reduction of emissions for commercial and residential buildings. The revision of the building code is currently ongoing, with several stakeholder workshops and webinars. The revised building code is expected to cover the entire Commonwealth of The Bahamas except for the Port area in Grand Bahama Island. In the 2013-2033 Energy Policy, the need to encourage the integration of renewable energy in building design the physical planning process is highlighted. This is encouraged to be integrated using an appropriately revised building code (Ministry of the Environment and Housing, 2013). In addition, The Bahamas is also currently in the process of adopting the regional Energy Efficiency Building Code.</td></tr>
<tr><th colspan="6">Steps to achieve mitigation action:</th></tr>
</table>

1. Revised building code completed. 2. Adoption and Implementation of revised building code. 3. Public Awareness and Education on the revised building. 4. Training of practitioners on revised building code.
Estimated outcomes and estimated emission reductions
By 2030, the energy demand has decreased, and resilience increased due to the implementation of the revised building code and the regional energy efficiency building code. The estimated avoided GHG emissions related to the implementation of this action is 22.6 $GgCO_2$-eq by 2030.
Methodologies and assumptions
It is assumed that the adoption and implementation of The Bahamas revised building code will reduce energy used for cooling and lighting by 25% in the new residential and commercial buildings. One thousand one hundred thirty-two new residential (1132) buildings per year are assumed, with an average annual electricity consumption of 1835 kWh/household for lighting and 2618 kWh/household for air conditioning (AC). One hundred and ten (110) new commercial buildings per year are assumed, 86% of which are non-governmental. The average floor space is assumed as 1455 m^2/building, with an average annual electricity consumption of 31.2 kWh/m^2 for lighting and 58.13 kWh/m^2 for AC. It is assumed that all new residential and commercial buildings will have air conditioning systems. This revised building code will impact the new construction of residential and commercial buildings between 2024 and 2030.
Progress indicators
new and renovated buildings implemented using regional energy efficiency building and revised building codes. # education and awareness programs conducted on regional energy efficiency and revised building code. # practitioners trained in the revised building code and regional energy efficiency building code.
International Market Mechanisms
None

Table 93: Mitigation Action 2 - Energy Audits for all Government occupied buildings in New Providence

Name of the mitigation action					
Energy Audits for all Government occupied buildings in New Providence					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Department of Physical Planning,	2020 - 2025	Energy Demand	New Providence	Carbon Dioxide

	Ministry of Works and Utilities, Bahamas Power and Light				(CO_2), Methane (CH_4), Nitrous Oxide (N_2O)

Objective of the mitigation action
To conduct energy audits for all Government occupied buildings in New Providence.
Brief description
Energy audits are instrumental in the identification of energy efficiency options for buildings. This is an enabling measure for the introduction of energy efficiency building measures.
Steps to achieve mitigation action:
1. Identify buildings to be audited. 2. Develop terms of reference for audits. 3. Undertake audits of the identified buildings.
Estimated outcomes and estimated emission reductions
By 2025, mitigation measures for all government occupied buildings identified, including schools in New Providence. This action is not expected to have emission reduction potential but will help identify and quantify specific energy efficiency measures and potential reductions.
Methodologies and assumptions
This action is preparatory for actual retrofits. The buildings identified are expected to be occupied for the long term. The measures identified are also expected to be combined into specific mitigation actions for the buildings identified. This action will not be modelled.
Progress indicators
government buildings in New providence audited. # of audit reports received
International Market Mechanisms
None

Table 94: Mitigation Action 3 - Energy Audits for all existing hotels and industrial facilities and implementation of some measures.

Name of the mitigation action					
Energy Audits for all existing hotels and industrial facilities					
Status	**Lead Agency/Agencies**	**Duration**	**Sector and subsector**	**Scope**	**GHGs covered**
Ongoing	Ministry of Tourism, Investments & Aviation, The	2020 - 2025	Energy Demand	National	Carbon Dioxide (CO_2),

	Bahamas Chamber Of Commerce and Employers Confederation, Bahamas Power and Light				Methane (CH_4), Nitrous Oxide (N_2O))

Objective of the mitigation action
To conduct energy audits for all existing hotels and industries and implementation of some measures.
Brief description
Energy audits are instrumental in the identification of energy efficiency and renewable energy options for buildings. The tourism sector is a key economic factor in The Bahamas, and hotels play a critical role in energy consumption. This is an enabling measure for the introduction of energy efficiency building measures. Initial energy efficiency measures and energy audits have been undertaken for some hotels and potential measures are estimated in the mitigation analysis.
Steps to achieve mitigation action:
1. Identify buildings to be audited. 2. Develop terms of reference for audits. 3. Undertake audits of the identified buildings.
Estimated outcomes and estimated emission reductions
By 2025, mitigation measures for hotels and industrial facilities identified. The avoided GHG emissions by 2030 in the ambitious scenario is estimated at 74.6 GgCO_2-eq for replacement of diesel generators and 61.3 GgCO_2-eq for implementation improvements in energy intensity in the industry sector. The combined effect of these two measures would result in 135.9 GgCO_2-eq of avoided GHG emissions.
Methodologies and assumptions
This action is preparatory for actual retrofits. The measures identified are also expected to be combined into specific mitigation actions for the facilities identified. In the modelling an ambitious mitigation scenario was developed and proposed measured were modelled for the hotel and industrial sector. It was assumed that currently diesel is used in backup generators that provide distributed electricity in some of the service sector facilities. In this ambitious scenario, the distributed solar PV systems will displace 30% of the diesel used in the service sector. In addition, the industrial sector will experience a reduction in energy intensity by 2% annually compared to the 0.5% reduction modelled for the baseline and mitigation scenarios.
Progress indicators
hotels and industrial facilities audited. # of audit reports received
International Market Mechanisms
None

Table 95: Mitigation Action 4 - Lighting Retrofits for all Government occupied buildings in New Providence

Name of the mitigation action					
Lighting Retrofits for all Government occupied buildings in New Providence					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Department of Physical Planning, Ministry of Works and Utilities, Ministry of Environment and Natural Resources	2020-2030	Energy Demand	New Providence	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To undertake comprehensive lighting retrofits for all Government occupied buildings in New Providence. To reduce energy demand and emissions in Government buildings in New Providence. To improve energy efficiency in Government occupied buildings in New Providence.					
Brief description					
The adoption of lighting retrofits is usually seen as a quick and low-cost energy efficiency measure in buildings. This energy efficiency measure will help reduce the energy demand in government buildings. This measure is expected as one of the first results of the energy audits. Lighting retrofits have been conducted for some government buildings in New Providence. A detailed accounting of these retrofits needs to be completed.					
Steps to achieve mitigation action:					
1. Identify current lighting technology in government buildings. 2. Baseline assessment can be done with energy audits. 3. Identify suitable replacement technology replacement.					
Estimated outcomes and estimated emission reductions					
Reduction in energy demand in Government buildings in New Providence. The estimated avoided GHG emissions are 8.2 $GgCO_2$-eq by 2030.					
Methodologies and assumptions					
The assumption is that fluorescent lights in buildings are being replaced with LEDs, leading to a 60% reduction in electricity consumption for lighting in Government buildings. This reduction can be further enhanced with additional measures proposed from the energy audits. Approximately, 14% of all buildings in New Providence are Government occupied, which represent 402 buildings. The retrofits are implemented starting in 2020 and reach 100% by 2030.					
Progress indicators					
# buildings retrofitted for lighting. # and type of lights replaced					

International Market Mechanisms
None

Table 96: Mitigation Action 5 - Public Awareness Campaign for energy efficiency and energy conservation

Name of the mitigation action					
Public Awareness Campaign for energy efficiency and energy conservation					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Ministry of Environment and Natural Resources, Bahamas Power and Light, University of the Bahamas, The Bahamas Chamber Of Commerce and Employers Confederation	2022-2033	Energy Demand	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To encourage the public to adopt energy efficiency and energy conservation measures.					
Brief description					
Public Education and awareness are important mechanisms to reduce emissions. Education and awareness of the public on energy-efficient equipment available to encourage an increase in uptake and measures to conserve energy to reduce consumption. A comprehensive education and awareness plan to be developed.					
Steps to achieve mitigation action:					
1. Develop comprehensive education and awareness plan for energy efficiency and energy conservation. 2. Identify baseline for current energy efficiency uptake and energy conservation measures. 3. Continuous monitoring and reporting.					
Estimated outcomes and estimated emission reductions					
Increase uptake of energy-efficient equipment and reduce energy consumption.					
Methodologies and assumptions					
Public Awareness and Education on energy efficiency will increase the penetration of energy-efficient equipment in both the residential and commercial sectors. This action was not modelled as a single strategy due to the lack of disaggregated data of end-uses in The Bahamas.					
Progress indicators					

% per cent increase in the purchase of energy-efficient equipment. % reduction in energy demand
International Market Mechanisms
None

Table 97: Mitigation Action 6 - Streetlighting retrofits

Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Name of the mitigation action					
Streetlighting retrofits					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Bahamas Power and Light Company, Grand Bahama Power Company	2020-2033	Energy Demand	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To undertake lighting retrofits to reduce energy consumption and emissions from streetlights					
Brief description					
Retrofits of streetlights through the replacement of commonly high-pressure sodium bulbs to either LED or solar lights to help reduce energy consumption. The streetlight project is currently ongoing.					
Steps to achieve mitigation action:					
1. Identify suitable replacement of lights for different areas. 2. Complete a replacement plan for the lights. 3. Implementation of light replacement.					
Estimated outcomes and estimated emission reductions					
Reduction in streetlighting energy demand and reduced emissions. The estimated avoided GHG emissions by 2030 are 18.5 $GgCO_2$-eq.					
Methodologies and assumptions					
Assumed that current streetlights in The Bahamas will be replaced either by 100% more efficient solar lights or 60% more efficient LED lights. There are approximately 46,000 streetlights in The Bahamas, including high-pressure sodium (HPS), mercury vapour, metal halide, incandescent, LED, and solar. Streetlights are assumed to be on for 12 hours per day. 24% of the existing lights are LED, and less than 1% is solar. Starting in 2020 and by 2025, all other lights (estimated as 35,000 250 W lights) will be replaced by 70 W LED lights.					
Progress indicators					
# of Lights and type of lights retrofitted					
International Market Mechanisms					
None					

Table 98: Mitigation Action 7 - Increase solar water use by 40% for The Bahamas

Name of the mitigation action					
Increase solar water heaters use by 40% for The Bahamas					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Ministry of Environment and Natural Resources	2022-2030	Energy Demand	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the uptake of solar water heaters by 20%					
Brief description					
Replacement of electrical and LPG water heaters with solar water heaters will help reduce energy consumption and emissions.					
Steps to achieve mitigation action:					
1. Develop a plan to increase solar water heater installation. 2. Increase awareness of solar water heaters.					
Estimated outcomes and estimated emission reductions					
Reduction in energy consumption for water heating. The estimated avoided GHG emissions are 34.5 GgCO_2-eq.					
Methodologies and assumptions					
It is assumed that the current uptake of solar water heaters is 5%, and an increase in use of solar water heaters of 40% is expected by 2030. Of the current 115660 households, 60% use water heaters. The average annual energy consumption of water heaters is 1890 kWh/household. There are currently 3946 commercial buildings with an average floor space of 1455 m^2/building. 10% of commercial buildings use water heaters with an average annual energy consumption of 2.15 kWh/m^2. Currently, water heating is mainly electric or with LPG. Only 5% of water heaters are solar.					
Progress indicators					
# of new solar water heaters installed. % percentage increase in solar water heaters					
International Market Mechanisms					
None					

Table 99: Mitigation Action 8 - Introduce incentives for solar water heater installation

<table>
<tr><th colspan="6">Name of the mitigation action</th></tr>
<tr><td colspan="6">Introduce incentives for solar water heater installation</td></tr>
<tr><th>Status</th><th>Lead Agency/Agencies</th><th>Duration</th><th>Sector and subsector</th><th>Scope</th><th>GHGs covered</th></tr>
<tr><td>Planned</td><td>Ministry of Finance, Ministry of Environment and Natural Resources</td><td>2022-2025</td><td>Energy Demand</td><td>National</td><td>Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)</td></tr>
<tr><th colspan="6">Objective of the mitigation action</th></tr>
<tr><td colspan="6">To promote and increase the uptake of solar water heaters</td></tr>
<tr><th colspan="6">Brief description</th></tr>
<tr><td colspan="6">The introduction of incentives will encourage the uptake of solar water heaters. This action is an enabling action to the mitigation action 7.</td></tr>
<tr><th colspan="6">Steps to achieve mitigation action:</th></tr>
<tr><td colspan="6">1. Identify suitable incentives for solar water heater installation.
2. Develop a list of incentives for solar water heater installation.</td></tr>
<tr><th colspan="6">Estimated outcomes and estimated emission reductions</th></tr>
<tr><td colspan="6">Reduction in energy consumption for water heating. The estimated GHG emissions are bundled with mitigation action 7.</td></tr>
<tr><th colspan="6">Methodologies and assumptions</th></tr>
<tr><td colspan="6">The introduction of incentives for solar water heater installation will increase the use of solar water heaters. This action was not modelled as single mitigation strategy but is assumed to be incorporated into the modelling of mitigation action 7 as an enabling factor to increase the installation and adoption of solar water heaters.</td></tr>
<tr><th colspan="6">Progress indicators</th></tr>
<tr><td colspan="6"># concessions processed for solar water heaters</td></tr>
<tr><th colspan="6">International Market Mechanisms</th></tr>
<tr><td colspan="6">None</td></tr>
</table>

Table 100: Mitigation Action 9 - Energy Labelling program for all appliances

Name of the mitigation action					
Energy Labelling program for all appliances					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Bahamas Bureau of Standards and Quality	2022-2025	Energy Demand	National	Carbon Dioxide (CO_2)
Objective of the mitigation action					
To provide a clear and simple indication of energy efficiency of appliances and inform consumers					
Brief description					
Mandatory labelling standards to inform consumers on the energy efficiency of appliances. The Bahamas, as part of CARICOM, is involved in the CARICOM Regional Energy Efficiency Labelling Scheme. This scheme is being piloted in four countries, but others will be able to join and learn from the lessons learnt.					
Steps to achieve mitigation action:					
1. Identify appliances to be included in the labelling programme. 2. Identify the types of suitable labels for each appliance. 3. Develop an energy labelling programme. 4. Implement the energy labelling programme.					
Estimated outcomes and estimated emission reductions					
Increase uptake of energy-efficient equipment and reduce energy consumption.					
Methodologies and assumptions					
Energy labelling will give consumers a more informed decision when purchasing products and coupled with public awareness and education, will assist in the shift to more energy-efficient equipment.					
Progress indicators					
# labelling standards developed, % percentage increase in appliances with energy labels					
International Market Mechanisms					
None					

Table 101: Mitigation Action 10 - Establish finance mechanism to increase access to low-interest loans for EE and RE measures

<table>
<tr><th colspan="6">Name of the mitigation action</th></tr>
<tr><td colspan="6">Establish finance mechanism to increase access to low-interest loans for EE and RE measures</td></tr>
<tr><th>Status</th><th>Lead Agency/Agencies</th><th>Duration</th><th>Sector and subsector</th><th>Scope</th><th>GHGs covered</th></tr>
<tr><td>Planned</td><td>Ministry of Finance, The Bahamas Development Bank, Ministry of Environment and Natural Resources</td><td>2022-2025</td><td>Energy Demand</td><td>National</td><td>N/A</td></tr>
<tr><th colspan="6">Objective of the mitigation action</th></tr>
<tr><td colspan="6">To establish a finance mechanism to increase access to low-interest loans for energy and energy-efficient measures</td></tr>
<tr><th colspan="6">Brief description</th></tr>
<tr><td colspan="6">This finance mechanism is expected to facilitate the sourcing of low-cost development funds for productive enterprises for energy and energy efficiency projects. This will allow both businesses and residents to access low-interest loans to finance energy and energy-efficient projects through the establishment of a special fund.</td></tr>
<tr><th colspan="6">Steps to achieve mitigation action:</th></tr>
<tr><td colspan="6">1. Identify the most suitable financing mechanism to implement this arrangement.
2. Identify available funding.
3. Develop terms of reference and operating procedures for the financing mechanism.
4. Implement and promote funding availability.</td></tr>
<tr><th colspan="6">Estimated outcomes and estimated emission reductions</th></tr>
<tr><td colspan="6">Increase access to loans for renewable energy and efficiency projects—indirect emission reduction potential.</td></tr>
<tr><th colspan="6">Methodologies and assumptions</th></tr>
<tr><td colspan="6">The introduction of the facility will encourage the uptake of renewable energy and energy-efficient equipment.</td></tr>
<tr><th colspan="6">Progress indicators</th></tr>
<tr><td colspan="6">financing mechanism established,
# of application to receive financing,
# of loans approved</td></tr>
<tr><th colspan="6">International Market Mechanisms</th></tr>
<tr><td colspan="6">None</td></tr>
</table>

Table 102: Mitigation Action 11- Energy Efficient Standards for air conditioning systems

Name of the mitigation action					
Energy Efficient Standards for air conditioning systems					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Bahamas Bureau of Standards and Quality	2022-2025	Energy Demand	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To encourage the shift to more energy-efficient air conditioning systems					
Brief description					
Mandatory standards for air conditioning will encourage the adoption of more energy-efficient equipment. A shift to more energy-efficient air conditioning systems will reduce energy consumption and long-term costs to the consumers. In addition, seawater district cooling is practised in some hotels in the Bahamas, a technology that can significantly reduce emissions from the cooling sector.					
Steps to achieve mitigation action:					
1. Identification of suitable standards for air conditioning systems. 2. Development of implementation and enforcement plan.					
Estimated outcomes and estimated emission reductions					
Increase uptake of energy-efficient air conditioners. The estimated avoided GHG emissions by 2030 is 109.6 $GgCO_2$-eq for use of more efficient air conditioning systems. In the ambitious scenario, the use of sea water cooling in hotels is expected to have a reduction in GHG emissions by 6.2 $GgCO_2$-eq.					
Methodologies and assumptions					
The adoption of standards will improve the energy efficiency of the equipment purchased. Number of households are currently 115660, the number of commercial buildings are currently 3946 with an average floor space of 1455 m2/building. Approximately 60% of households in The Bahamas have AC, with an average annual electricity consumption for AC of 2618 kWh/household. All commercial buildings have AC, with an average annual electricity consumption for AC of 58.13 kWh/m2. The standards are assumed to consider a 30% increase in efficiency by 2030. In the ambitious scenario, the adoption of seawater cooling in hotels was modelled for more efficient cooling. Currently, there are approximately 300 hotels in The Bahamas, with an average of 3425 m2/building and average annual electricity consumption for cooling of 50.4 kWh/m2. By 2030, 20% of all hotels will implement sea water cooling. This technology reduces energy consumption for cooling by 80%.					
Progress indicators					
% percentage increase in energy-efficient appliances on island					

Number of new hotels using seawater cooling technology
International Market Mechanisms
None

Table 103: Mitigation Action 12 - Promotion of Energy Efficiency in Water production

Name of the mitigation action					
Promotion of Energy Efficiency in Water production					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Water and Sewage Corporation	2022-2033	Energy Demand	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To improve energy efficiency in the water sector.					
Brief description					
Water production in The Bahamas is a high energy-intensive process (reverse osmosis). The introduction of energy-efficient measures will reduce energy costs and reduce emissions. The Bahamas is constantly seeking methods to improve energy efficiency in water production.					
Steps to achieve mitigation action:					
1. Identify areas for energy-efficient measures. 2. Implement energy-efficient measures and replace inefficient equipment.					
Estimated outcomes and estimated emission reductions					
Reduction in energy intensity for water production, thereby reducing emissions.					
Methodologies and assumptions					
Due to constraints with energy consumption data in the water production process, this action was not modelled.					
Progress indicators					
% per cent reduction in energy demand in the water sector					
International Market Mechanisms					
None					

Table 104: Mitigation Action 13 - Five (5) carbon-neutral Marine Protected Area facilities (photovoltaic substitute for diesel generators)

Name of the mitigation action					
Five (5) carbon-neutral Marine Protected Area facilities (photovoltaic substitute for diesel generators)					
Status	**Lead Agency/Agencies**	**Duration**	**Sector and subsect or**	**Scope**	**GHGs covered**
Ongoing	DEPP, Bahamas National Trust, Department of Marine Resources	2017-2030	Energy Demand	Exuma Cays, West Andros, New Providence	Carbon Dioxide equivalent (CO_2-eq)
Objective of the mitigation action					
To demonstrate the viability of photovoltaic systems in creating carbon-neutral facilities					
Brief description					
Substituting diesel generators for photovoltaic systems will demonstrate the social, environmental, and economic feasibility of climate change mitigation through implementing innovative carbon-neutral solutions that will contribute to the effective management of marine protected areas and reduce risks associated with the use of diesel, such as “pollution/storage”. Diesel fuel requires the storage of bulk fuels on the islands and the transfer of fuel from bulk storage to monthly storage for daily use. This storage and transfer increase the risk of a spill into the water or ground resources of the park. The proposed sites are (i) Visitors Centre for Warderick Wells (ECLSP), (ii) West Andros Fee collection booth, (iii) Bonefish Pond high visibility demo, pilot. Meeting the Challenge of 2020 in the Bahamas is an ongoing project that is currently funded by the GEF.					
Steps to achieve mitigation action:					
1. Collect and verify baseline information at each of the sites. 2. Design renewable energy systems for each site. 3. Develop terms of reference for the service. 4. Contract service providers.					
Estimated outcomes and estimated emission reductions					
Reduced emissions for three sites identified. Estimated total GHG emissions reduction is 3.5 Gg CO_2-eq.					
Methodologies and assumptions					
Solar PV systems will be installed to completely replace the diesel generators at the facility. The assumption is that each location currently has a 100kW generator in use. Each gallon of diesel fuel produces, on average, 10,084 g of CO_2. 60 kW Diesel Generator at ¾ load fuel consumption = 5.8 gallon/hr32. By 2030, 5x100 kW generators at 75% load factor and 25% efficiency will be replaced by PV systems.					

Progress indicators
# of kW of PV systems installed. # emissions reductions of CO_2-eq.
International Market Mechanisms
None

4.3.1.2. *Electricity Generation*

The electricity generation sector covers the electricity supply from centralised and distributed generation, policies to enhance mitigation strategies for electricity generation and plans to improve electricity supply. This sector encompasses all fuels combusted for electricity generation. These mitigation actions include renewable energy generation, renewable energy assessments and improvement in the transmission and distribution network. A shift to more renewables in the energy generation subsector will significantly reduce total national GHG emissions.

The GOB has made efforts to increase its energy security by including in its NDCs specific targets for renewable energy penetration and developing The Bahamas National Energy Policy. A major strategy in The NEP is the diversification of energy. Furthermore, with the Inter-American Development Bank's (IDB) support, approval was given for a USD 170 million Conditional Credit Line for Investment Project (CCLIP). This project is expected to advance the deployment of renewable energy in The Bahamas. In addition, several renewable energy systems have been installed on some of the smaller islands in The Bahamas, including but not limited to, Over Yonder Cay with a 1MW solar facility, 300kW wind facility and 6MW battery bank, Chub Cay with 4MW solar plant and a 2MW battery bank and Ragged Island with the installation of a 390kW solar system and 1.26MWh battery storage system.

A total of **fourteen (14) mitigation actions** related to the **Electricity Generation Subsector** were identified.

Table 105: Mitigation Action 14 - Assessment of Renewable Energy Potential Across all occupied Islands

Name of the mitigation action					
Assessment of Renewable Energy Potential Across all occupied Islands					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Ministry of Environment and Natural Resources, Bahamas Power and Light, Grand Bahama Power Company, Morton Salt Company	2022-2025	Electricity Generation	National	N/A
Objective of the mitigation action					
To undertake a complete assessment of the renewable energy potential across The Bahamas.					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared a target of 30% renewables in electricity generation by 2030. An assessment of renewable energy potential will help identify possible locations for renewable energy projects and/or interventions					
Steps to achieve mitigation action:					
1. Develop terms of reference for the assessment. 2. Identify renewable energy that will be assessed. 3. Source funding to conduct an assessment. 4. Contract services for assessment.					
Estimated outcomes and estimated emission reductions					
Renewable energy potential is identified, and projects are developed based on the assessment. The emission reduction potential will be determined upon completion of the assessment.					
Methodologies and assumptions					
The assumption is that The Bahamas has an abundance of renewable energy potential, but the exact size, location and type of the renewable energy potential has not been completed. This action is an enabling activity and is not modelled. It will help to further refine mitigation action for the electricity generation subsector in the future.					
Progress indicators					
# of assessments completed per technology					
International Market Mechanisms					
None					

Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030

Name of the mitigation action					
30% Renewables on each major island by 2030					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Ministry of Environment and Natural Resources, Bahamas Power and Light, Grand Bahama Power Company	2022 - 2030	Electricity Generation	Grand Bahama, New Providence , Family Islands	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. 30% renewable energy is proposed on the major islands, New Providence, Grand Bahama, and the Family Islands as a group. This is currently ongoing. The Ministry of Environment and Natural Resources is currently undertaking assessments to develop the best course of action.					
Steps to achieve mitigation action:					
1. Projects identified to increase renewable energy penetration.					
Estimated outcomes and estimated emission reductions					
Increased renewable energy penetration. An estimated reduction in emissions of 412.6 $GgCO_2$-eq is estimated.					
Methodologies and assumptions					
The utility grids are able to handle the increase in renewables without undergoing major upgrades to their system. To achieve 30% in renewable energy penetration, the following was modelled 174MW of Solar PV systems, 30kW of OTEC, 15MW of Waste to Energy and 20MW of wind. This was a bundled mitigation scenario that incorporated the several mitigation actions numbered; 16-21, 23,24,26 and 27.					
Progress indicators					
# kW of installed renewable energy systems # of GHG emissions avoided					
International Market Mechanisms					
None					

Table 107: Mitigation Action 16 - 3MW Solar farm in Grand Bahama

Name of the mitigation action					
3MW Solar farm in Grand Bahama					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Grand Bahama Power Company	2020-2025	Electricity Generation	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. Installation of renewable energy systems will help achieve this goal as well as significantly assist in achieving emission reduction. This project has been planned by GBPC; the site has been identified.					
Steps to achieve mitigation action:					
1. Installation of the system					
Estimated outcomes and estimated emission reductions					
Increase renewable energy penetration. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030					
Methodologies and assumptions					
The utility grids are able to handle the increase in renewables without undergoing major upgrades to their system. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.					
Progress indicators					
# kW of installed solar PV system					
International Market Mechanisms					
None					

Table 108: Mitigation Action 17- 3MW of distributed generation in Grand Bahama through the Renewable Energy Rider programme

Name of the mitigation action					
3MW of distributed generation in Grand Bahama through the Renewable Energy Rider program					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Grand Bahama Power Company	2016-2025	Electricity Generation	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. Installation of renewable energy systems will help achieve this goal as well as significantly assist in achieving emission reduction. This includes renewable energy systems installed for residential and commercial buildings that are grid-connected in Grand Bahama. The renewable energy rider (RER) introduced by the Grand Bahama Power Company allows for customers to connect up to 150kW of wind power or solar system through distributed generation to the grid. The systems are allowed to be sized to produce 1.5 times the average monthly consumption up to a limit of 150kW.					
Steps to achieve mitigation action:					
1. Promotion of benefits of distributed solar systems for customers.					
Estimated outcomes and estimated emission reductions					
Increase renewable energy penetration. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.					
Methodologies and assumptions					
The utility grids are able to handle the increase in renewables without undergoing major upgrades to their system. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.					
Progress indicators					
# kW of installed renewable energy systems					
International Market Mechanisms					
None					

Table 109: Mitigation Action 18 - Additional 30MW of Solar PV Installed

Name of the mitigation action					
Additional 30MW of Solar PV Installed					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Proposed	Ministry of Environment and Natural Resources, Bahamas Power and Light	2022-2030	Electricity Generation	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. Installation of renewable energy systems will help achieve this goal as well as significantly assist in achieving emission reduction.					
Steps to achieve mitigation action:					
1. Identification of suitable locations for projects. 2. Full project proposals developed. 3. Funding identified to implement projects.					
Estimated outcomes and estimated emission reductions					
Increase renewable energy penetration. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.					
Methodologies and assumptions					
The utility grids are able to handle the increase in renewables without undergoing major upgrades to their system. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.					
Progress indicators					
# kW of installed solar PV systems					
International Market Mechanisms					
None					

Table 110: Mitigation Action 19 - Installation of 20MW of wind power Installed

Name of the mitigation action					
Installation of 20MW of wind power Installed					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Idea	Ministry of Environment and Natural Resources, Bahamas Power and Light	2022-2030	Electricity Generation	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. Installation of renewable energy systems will help achieve this goal as well as significantly assist in achieving emission reduction.					
Steps to achieve mitigation action:					
1. Identification of suitable locations for projects. 2. Full project proposals developed. 3. Funding identified to implement projects.					
Estimated outcomes and estimated emission reductions					
Increase renewable energy penetration. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030					
Methodologies and assumptions					
The utility grids are able to handle the increase in renewables without undergoing major upgrades to their system. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030					
Progress indicators					
# kW of installed wind power systems					
International Market Mechanisms					
None					

Table 111: Mitigation Action 20 - Installation of 10MW of distributed generation on rest of islands

Name of the mitigation action					
Installation of 10MW of distributed generation on rest of islands					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Bahamas Power and Light, Ministry of Environment and Natural Resources	2017-2030	Electricity Generation	Family Islands	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. Installation of renewable energy systems will help achieve this goal as well as significantly assist in achieving emission reduction. This includes renewable energy systems installed for residential and commercial buildings that are grid-connected in the Family Islands. Bahamas Power and Light (BPL) has established a small-scale renewable generation (SSRG) programme. Abaco, Eleuthera and Exuma: For residential customers, the capacity limit is 3kW + Average Customer Demand with a ceiling limit of 50kW. For commercial customers, the limit is 25kW + average customer demand with a ceiling of 50kW. The maximum allowed capacity is 500kW. Long Island, Bimini, San Salvador, North Andros, Central Andros, South Andros, Inagua, Cat Island, Great Harbour Cay, Black Point and Staniel Cay (Exuma): For residential customers, the capacity limit is 2kW + Average Customer Demand with a ceiling limit of 30kW. For commercial customers, the limit is 15kW + average customer demand with a ceiling of 30kW. The maximum allowed capacity is 250kW. All other Family Islands: For residential customers, the capacity limit is 1kW + Average Customer Demand with a ceiling limit of 10kW. For commercial customers, the limit is 5kW + average customer demand with a ceiling of 10kW. The maximum allowed capacity is 25kW.					
Steps to achieve mitigation action:					
1. Promotion of benefits of distributed solar systems for customers. 2. Studies to enable the increase in the allowable limits.					
Estimated outcomes and estimated emission reductions					
Increase renewable energy penetration. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.					

Methodologies and assumptions
The utility grids are able to handle the increase in renewables without undergoing major upgrades to their system. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.
Progress indicators
kW of installed solar PV system
International Market Mechanisms
None

Table 112: Mitigation Action 21 - Upgrade incentives for renewable energy systems

Name of the mitigation action					
Upgrade incentives for renewable energy systems					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Ministry of Finance, Ministry of Environment and Natural Resources	2022-2030	Electricity Generation	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. The upgrade of incentives will encourage the installation and implementation of renewable energy systems.					
Steps to achieve mitigation action:					
1. Identify areas where upgrades to incentives are possible. 2. Develop a plan to upgrade incentives. 3. Prepare necessary documents for approval of upgrade of incentives.					
Estimated outcomes and estimated emission reductions					
Increase renewable energy penetration. No direct GHG emission reductions were estimated from this mitigation action.					
Methodologies and assumptions					
Assumption that the upgrade of incentives would increase the use of renewable energy systems. This action is considered an enabling factor to accelerate the adoption of renewables, as identified in Table 32.					
Progress indicators					
# of upgrade of incentives approved					
International Market Mechanisms					
None					

Table 113: Mitigation Action 22 - Integrated resource and resilience plan for Grand Bahama Power Company and Bahama Power and Light

<table>
<tr><th colspan="6">Name of the mitigation action</th></tr>
<tr><td colspan="6">Integrated resource and resilience plan for Grand Bahama Power Company and Bahama Power and Light</td></tr>
<tr><th>Status</th><th>Lead Agency/Agencies</th><th>Duration</th><th>Sector and subsector</th><th>Scope</th><th>GHGs covered</th></tr>
<tr><td>Newly Proposed</td><td>Bahamas Power and Light, Grand Bahama Power Company, Ministry of Environment and Natural Resources</td><td>2022-2025</td><td>Electricity Generation</td><td>Grand Bahama, New Providence, Family Islands</td><td>Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)</td></tr>
<tr><th colspan="6">Objective of the mitigation action</th></tr>
<tr><td colspan="6">To identify the best mix of renewable energy systems to increase resilience, energy independence and maintain low system costs</td></tr>
<tr><th colspan="6">Brief description</th></tr>
<tr><td colspan="6">The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. Integrated Resource and Resilient Plans (IRRP) will identify how the country can supply its electricity needs in the future. This will take into consideration the goals and renewable energy resource assessments conducted. The Bahamas has been impacted by several hurricanes over the years. Resource and resilience planning is something that is being discussed at various levels to be implemented. As a member of CARICOM, the Council for Trade and Economic Development (COTED) has highlighted the need for all members to undertake IRRPs.</td></tr>
<tr><th colspan="6">Steps to achieve mitigation action:</th></tr>
<tr><td colspan="6">1. Prepare terms of reference.
2. Source funding for integrated resource and resilience plans.</td></tr>
<tr><th colspan="6">Estimated outcomes and estimated emission reductions</th></tr>
<tr><td colspan="6">Identification of suitable renewable energy mix. This action is not expected to have emission reduction potential but will help identify and quantify specific renewable energy installations and potential reductions</td></tr>
<tr><th colspan="6">Methodologies and assumptions</th></tr>
<tr><td colspan="6">The integrated resource and resilience plans are undertaken by each power provider to improve planning for renewable energy introduction and improve resilience. Assumption that integrated resource and resilience plan will provide a comprehensive overview of necessary upgrades, improvements and additions to the systems required in each time frame. It will also help identify the best mix of renewables for The Bahamas.</td></tr>
<tr><th colspan="6">Progress indicators</th></tr>
</table>

# of integrated resource and resilience plans undertaken
International Market Mechanisms
None

Table 114: Mitigation Action 23 - 10 MW of installed distributed generation through a Renewable Energy Rider for Bahamas Power and Light (BPL) customers in New Providence

Name of the mitigation action					
10 MW of installed distributed generation through a Renewable Energy Rider for Bahamas Power and Light (BPL) customers in New Providence					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Bahamas Power and Light. Ministry of Environment and Natural Resources	2017-2024	Electricity Generation	New Providence	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. Installation of renewable energy systems will help achieve this goal as well as significantly assist in achieving emission reduction. This includes renewable energy systems installed for residential and commercial buildings that are grid-connected in New Providence and excludes the 1.2MW identified through the Solar Assessment report. Bahamas Power and Light (BPL) has established a small-scale renewable generation (SSRG) programme. New Providence: For residential customers, the capacity limit is 5kW + Average Customer Demand with a ceiling limit of 100kW. For commercial customers, the limit is 50kW + average customer demand with a ceiling of 100kW. The maximum allowed capacity is 10MW.					
Steps to achieve mitigation action:					
1. Promotion of benefits of distributed solar systems for customers.					
Estimated outcomes and estimated emission reductions					
Increase renewable energy penetration. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.					
Methodologies and assumptions					

The utility grids are able to handle the increase in renewables without undergoing major upgrades to their system. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.
Progress indicators
kW of installed solar PV system
International Market Mechanisms
None

Table 115: Mitigation Action 24 - Installation of approximately 1.2MW of distributed generation on 9 Government Facilities

Name of the mitigation action					
Installation of approximately 1.2MW of distributed generation on 9 Government Facilities					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Ministry of Environment and Natural Resources	2019-2030	Electricity Generation	New Providence	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas energy mix is currently dominated by fossil fuels. The Bahamas has declared 30% renewables in electricity generation by 2030. Installation of renewable energy systems will help achieve this goal as well as significantly assist in achieving emission reduction. This project was identified through the solar assessment report. The Ministry of Environment and Natural Resources has undertaken a detailed design of PV systems at the various locations and estimated the capacity of the system possible at each location. Funding for the project needs to be sourced in order to commence implementation.					
Steps to achieve mitigation action:					
1. Preparation of terms of reference for service contracts. 2. Source funding for the installation of the system. 3. Engage with BPL for interconnection agreements.					
Estimated outcomes and estimated emission reductions					
Increase renewable energy penetration. Reduction in emissions at the public buildings. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030.					
Methodologies and assumptions					
The following is assumed for this project; 1.2 MW will consist of the following: Roof-mounted systems: 12.0 kW at the House of Assembly and Senate Buildings. 51.0 kW at C.I. Gibson Senior High School; 56.1 KW at Uriah McPhee Primary School. 83.1 kW at Doris Johnson Senior High School. 136.2 kW at T.G. Glover Primary School. 76.5 kW at Customs Headquarters.					

73.2 kW at the Ministry of Education Building. 167.1 kW at C.V. Bethel Senior High School. Carport Systems: 475.5 kW at the Office of the Prime Minister. The following rates were assumed for the project: 1. $2.50/W for PV system under 20kW (roof-mounted). 2. $2.25/W for PV systems between 21kW and 100kW (roof-mounted). 3. $2.00/W for PV systems over 100kW (roof-mounted). 4. $5.00/W for carport port systems. The total cost of the installation is estimated at $3.78 Million dollars (BSD)
Progress indicators
#kW of installed solar PV system on public institutions.
International Market Mechanisms
None

Table 116: Mitigation Action 25 - Reduce Transmission and Distribution losses by 2%

Name of the mitigation action					
Reduction Transmission and Distribution losses by 2%					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Bahamas Power and Light	2022-2030	Electricity Generation	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the energy efficiency of the transmission and distribution system by reducing losses					
Brief description					
Reducing transmission and distribution losses reduces the amount of electricity to meet demand. Capital investments are required in transmission equipment and meters.					
Steps to achieve mitigation action:					
1. Necessary upgrades to transmission and distribution systems to be assessed and implemented.					
Estimated outcomes and estimated emission reductions					
Improved energy efficiency in the transmission and distribution system. Estimated GHG emissions reduction of 32.4 GgCO_2-eq.					
Methodologies and assumptions					
Assumed that reduction by 2% of losses in transmission and distribution is achieved by 2030, and further reduction is achieved by 2050. The average T&D losses in the Bahamas will be reduced from 10% in 2018 to 8% by 2030.					
Progress indicators					
% reduction in transmission and distribution losses					
International Market Mechanisms					
None					

Table 117: Mitigation Action 26 - Pilot Project for a 30kW OTEC Plant

Name of the mitigation action					
Pilot Project for a 30kW OTEC Plant					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Ministry of Environment and Natural Resources	2022-2030	Electricity Generation	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the penetration of renewable energy by 30% by 2030					
Brief description					
The Bahamas is currently in discussions with CARICOM, CCRREE, CCCCC and SIDS DOCK to develop a pilot OTEC plant. However, OTEC is still seen as being in its experimental stage globally. Still, The Bahamas has a reverse geothermal energy profile, and it may be possible to obtain the necessary temperature difference for OTEC from deep wells rather than cold seawater.					
Steps to achieve mitigation action:					
1. Undertake necessary feasibility study 2. Drill wells and build plant					
Estimated outcomes and estimated emission reductions					
Increase renewable energy penetration. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030					
Methodologies and assumptions					
Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030					
Progress indicators					
#kW of OTEC produced					
International Market Mechanisms					
None					

Table 118: Mitigation Action 27 - Installation of 15MW Waste to Energy

<table>
<tr><th colspan="6">Name of the mitigation action</th></tr>
<tr><td colspan="6">Installation of 15MW Waste to Energy</td></tr>
<tr><th>Status</th><th>Lead Agency/Agencies</th><th>Duration</th><th>Sector and subsector</th><th>Scope</th><th>GHGs covered</th></tr>
<tr><td>Ongoing</td><td>Ministry of Environment and Natural Resources/ Department of Environment Health Services/ Bahamas Power and Light</td><td>2020-2030</td><td>Electricity Generation</td><td>National</td><td>Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)</td></tr>
<tr><th colspan="6">Objective of the mitigation action</th></tr>
<tr><td colspan="6">To increase the penetration of renewable energy by 30% by 2030</td></tr>
<tr><th colspan="6">Brief description and activities planned under the mitigation action</th></tr>
<tr><td colspan="6">Fossil fuels currently dominate the Bahamas energy mix. The Bahamas has declared 30% renewables in electricity generation by 2030. Installation of renewable energy systems will help achieve this goal and significantly assist in achieving emission reduction. The proposal is currently being developed to be submitted to the Green Climate Fund for assessment and funding</td></tr>
<tr><th colspan="6">Steps to achieve mitigation action:</th></tr>
<tr><td colspan="6">1. Complete and submit the proposal to Green Climate Fund for assessment and funding.
2. Prepare relevant documents for the implementation of the project.</td></tr>
<tr><th colspan="6">Estimated outcomes and estimated emission reductions</th></tr>
<tr><td colspan="6">Increase renewable energy penetration. Improved waste management. Reduction in land required for waste. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030</td></tr>
<tr><th colspan="6">Methodologies and assumptions</th></tr>
<tr><td colspan="6">The utility grids are able to handle the increase in renewables without undergoing major upgrades to their system. Bundled with other renewable energy actions, refer to Table 106: Mitigation Action 15 -30% Renewables on each major island by 2030</td></tr>
<tr><th colspan="6">Progress indicators</th></tr>
<tr><td colspan="6">#kW of installed waste to energy plant.
# of kg of waste processed through the plant.</td></tr>
<tr><th colspan="6">International Market Mechanisms</th></tr>
<tr><td colspan="6">None</td></tr>
</table>

4.3.1.3. *Transport*

From the latest National Inventory Report of The Bahamas, the transport sector remains the second-largest GHG emitting subsector for Energy in The Bahamas. The majority of these emissions are estimated from road transport. Since 2013, The Bahamas has drafted regulations to limit vehicle emissions for road transport. These regulations highlight the maximum emissions standards for vehicles by type and model year (Environment Health (Vehicle Emissions) Regulations, 2013). In addition, the NEP identifies specific strategies for the transport sector, some of which are incorporated in the mitigation actions.

Significant gaps in data and information on energy usage, total number, and types of vehicles in The Bahamas still exist. As a result of this lack of data, the mitigation actions in the transport sector are related to changes in energy use in passenger road vehicles only because sufficient data is available for this subset of vehicles. Mitigation actions for marine, aviation and freight sectors are not included. Historical information on total fuel and the number and type of vehicles was estimated based on available local, regional, international data, and expert reviews.

The mitigation actions in the transport sector include electrification of the transport fleet, improvement in public transit and improvement in vehicle efficiency standards. A total of **seven (7) mitigation actions** related to the **Transport subsector** were identified.

Table 119: Mitigation Action 28 - Standards implemented for vehicle fuel efficiency

Name of the mitigation action					
Standards implemented for vehicle fuel efficiency					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	The Bahamas Bureau of Standards and Quality	2022-2025	Transport	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To encourage the uptake of more energy-efficient vehicles					
Brief description and activities planned under the mitigation action					
Improved fuel efficiency reduces the demand for fuel in vehicles and therefore reduce the consumption of fossil fuels.					
Steps to achieve mitigation action:					
1. Develop fuel efficiency standards for vehicles. 2. Adopt and implement efficiency standards.					
Estimated outcomes and estimated emission reductions					
Increase efficiency of vehicles, improve vehicle fuel economy.					
Methodologies and assumptions					
Due to a lack of data related to the standard, this mitigation was not modelled.					
Progress indicators					
fuel efficiency standard for vehicles developed. % increase in vehicle fuel economy.					
International Market Mechanisms					
None					

Table 120: Mitigation Action 29 - Improved Incentives for electric vehicle

Name of the mitigation action					
Improved Incentives for electric vehicle					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Ministry of Finance, Ministry of Environment and Natural Resources	2022-2025	Transport	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To encourage the purchase of electric vehicles					
Brief description					
Improved incentives for electric vehicles will enhance the attractiveness of electric vehicles for the public, increase the purchase of electric vehicles, and reduce fossil fuel consumption. The Bahamas currently has incentives on electric vehicles with import duties reduced to 10% for vehicles with a landing price of $50,000 (BSD). These incentives need to be revised to encourage increased uptake of electric vehicles.					
Steps to achieve mitigation action:					
1. Incentives revised, and proposed changes included. 2. Incentives approved and implemented.					
Estimated outcomes and estimated emission reductions					
Increased uptake of electric vehicles. This mitigation action is considered an enabling activity and does not contribute directly to emissions reduction.					
Methodologies and assumptions					
Improved incentives will encourage the increased adoption of electric vehicles. Therefore, it is considered an enabling activity for the adoption of electric vehicles.					
Progress indicators					
improved incentives developed. % increase of electric vehicles from the implementation of improved incentives					
International Market Mechanisms					
None					

Table 121: Mitigation Action 30 - Assessment of Government vehicles and program for replacement of suitable vehicles to electric vehicles

Name of the mitigation action					
Assessment of Government vehicles and program for replacement of suitable vehicles to electric vehicles					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Ministry of Finance, Ministry of Environment and Natural Resources	2022-2025	Transport	National	N/A
Objective of the mitigation action					
To identify suitable electric vehicle replacement in the Government fleet					

Brief description
To effectively conduct a transition to electric vehicles and prevent stranded assets, a fleet assessment should be conducted. This fleet assessment will identify suitable electric vehicle replacement for internal combustion engine (ICE) vehicles and create a plan for replacement based on age and use of vehicles
Steps to achieve mitigation action:
1. Obtain inventory of government vehicle fleet. 2. Conduct an assessment of vehicle fleet, noting the age and mileage of the vehicle, use suitable replacement electric vehicles and expected year of replacement. This assessment should also include associated costs and emission reduction potential.
Estimated outcomes and estimated emission reductions
Government vehicle transition plan developed.
Methodologies and assumptions
A thorough assessment of vehicles in the Government fleet will be conducted and suitable replacement vehicles identified. The plan will be developed for the transition of ICE vehicles to electric vehicles. The assumption is that the government fleet has suitable replacement electric vehicles, and vehicles are constantly being upgraded, and therefore they can be transitioned to electric vehicles.
Progress indicators
Assessment completed. Vehicle transition plan for government fleet developed
International Market Mechanisms
None

Table 122: Mitigation Action 31 - Introduction of electric vehicles to Government Fleet

Name of the mitigation action					
Introduction of electric vehicles to Government Fleet					
Status	**Lead Agency/Agencies**	**Duration**	**Sector and subsector**	**Scope**	**GHGs covered**
Ongoing	Ministry of Finance, Ministry of Environment and Natural Resources	2019 - 2030	Transport	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase penetration of electric vehicles in the government fleet					
Brief description					
Based on the vehicle transition plan developed, The Government of The Bahamas will begin the implementation of the transition. Through the office of the Prime Minister, the Government of the Bahamas began a pilot project in 2016 with the leasing of 12 electric vehicles. The lease was renewed, and vehicles replaced in 2020, but no further initiatives have been undertaken in the Government.					
Steps to achieve mitigation action:					
1. Procurement plan for transition to electric vehicles					
Estimated outcomes and estimated emission reductions					
Reduction in emissions in the transport sector through increased electric vehicles; Reduction energy demand for government fleet. The estimated emissions reductions were bundled with mitigation action 33; refer to Table 124: Mitigation Action 33 - Increase sales of electric vehicles to 35%.					
Methodologies and assumptions					
This action was assumed to be incorporated within mitigation action 33; refer to Table 124: Mitigation Action 33 - Increase sales of electric vehicles to 35%.					

Progress indicators
Government Internal Combustion Engine (ICE) vehicles transitioned to electric vehicles
International Market Mechanisms
None

Table 123: Mitigation Action 32 - Installation of charging stations for electric vehicles

Name of the mitigation action					
Installation of charging stations for electric vehicles					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Ministry of Environment and Natural Resources	2019 - 2030	Transport	National	N/A
Objective of the mitigation action					
To increase penetration of electric vehicles					
Brief description					
Proper infrastructure such as charging stations need to be installed to transition to electric vehicles. This is an enabling factor to the increasing penetration of electric vehicles and eases customer range anxiety. The Government of the Bahamas currently has one level 3 charger installed at the Thomas A. Robinson Sports Stadium from the Abu Dhabi Caribbean Renewable Energy Fund; another 12 chargers are located at business locations included The National Art Gallery of The Bahamas (NAGB) and over 100 personal charging stations have been installed in New Providence. The installation of charging stations is currently ongoing.					
Steps to achieve mitigation action:					
1. Identify suitable location and type of chargers required for installation. 2. Develop terms of reference for service providers and the use of charging stations. 3. Procure and install charging stations.					
Estimated outcomes and estimated emission reductions					
Increase penetration of electric vehicles. This action is not expected to have emission reduction potential but will help increase the penetration of electric vehicles on the islands					
Methodologies and assumptions					
Geographic wide installation of electric chargers. The installation of electric chargers geographic wide will increase the penetration of electric vehicles on the island.					
Progress indicators					
# of charging station installed					
International Market Mechanisms					
None					

Table 124: Mitigation Action 33 - Increase sales of electric vehicles to 35%

Name of the mitigation action					
Increase sales of electric vehicles to 35% and hybrid vehicles to 15% by 2030					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Ministry of Finance, Ministry of Environment and Natural Resources	2016 - 2030	Transport	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase the sale of electric vehicles by 35% by 2030. To increase energy efficiency in the transport sector. To reduce emissions in the transport sector.					
Brief description					
Adoption of electric vehicles simultaneous with the transition to renewables will help reduce fossil fuel consumption in the transport sector. The Bahamas currently has approximately 7% electric vehicles share of the new car sales locally. There is one EV company, but other local importers are on the island. In addition, the government began a pilot project in 2016 to introduce electric vehicles in the government fleet.					
Steps to achieve mitigation action:					
1. Increase public awareness of electric vehicles. 2. Encourage sales of electric vehicles by retailers. 3. Implementation of actions related to incentives and installation of charging stations					
Estimated outcomes and estimated emission reductions					
Reduction in emissions in the transport sector through an increase in electric and hybrid vehicles. The total GHG emission reduction potential is estimated at 1.1 $GgCO_2$-eq by 2030.					
Methodologies and assumptions					
Electric vehicles are assumed to represent 35% of the sales of vehicles by 2030. This represents an electric vehicle stock share of 13% by 2030. Hybrid vehicles are assumed to represent 15% of the sales by 2030. This corresponds to a vehicle stock share of 5%. Only road transport vehicles were considered in this methodology.					
Progress indicators					
% of vehicles sales are electric					
International Market Mechanisms					
None					

Table 125: Mitigation Action 34 - Promotion of the use of Public Transport

Name of the mitigation action					
Promotion of the use of Public Transport					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Planned	Ministry of Transport and Housing	2022 - 2030	Transport	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O))

Objective of the mitigation action
To increase the use of public transport. To increase energy efficiency in the transport sector. To help reduce commute times by reducing the number of private vehicles on the road.
Brief description
Increased access to public transportation and increased reliability may help reduce the use of private vehicles, causing a modal shift and thereby reducing the fossil fuel consumption in the transport sector and assisting in traffic management. The public transportation system requires reform as well to encourage public use. Gender-sensitive training was recommended during the stakeholder workshop for bus drivers.
Steps to achieve mitigation action:
1. Development of comprehensive public transit strategy to increase use. 2. Training for bus drivers to improve the service provided to the public including, but not limited to gender sensitivity. 3. Incentives to encourage public transports to improve the transport system. 4. Public education and awareness to encourage the use of the public transportation system.
Estimated outcomes and estimated emission reductions
Increase use of public transportation. Reduced commute time. Reduced emissions for the transport sector. The estimated GHG emissions reduction potential is 12.9 GgCO_2-eq by 2030.
Methodologies and assumptions
The number of public transits trips will increase and reduce the distance travelled using personal vehicles. The shift of demand from private passenger vehicles to public transit vehicles. After 2025, the number of private cars will stop growing due to the increased availability of public transport. Private cars are assumed to drive 14484 km/vehicle per year and have an average of 1.5 passengers per car. The avoided passenger kilometres from the private cars are assumed to be absorbed by buses with an average occupancy rate of 21 passengers per vehicle and an annual mileage of 40000 km per vehicle.
Progress indicators
minutes of reduced commute times, # reduced private vehicles on the road during peak hours
International Market Mechanisms
None

4.3.1.4. Industrial Processes and Product Use (IPPU)

The Industrial Processes and Product Use (IPPU) Sector includes anthropogenic emissions from industry productions processes that are not related to or as a result of fuel combustion. Based on stakeholder consultations and data collection efforts, there does not appear to be industrial production in The Bahamas that leads to significant industrial processes GHG emissions. The only direct GHG emissions are related to hydrofluorocarbons (HFCs) imported into The Bahamas through the stock of refrigerators and air conditioners that contain HFCs and bulk imports used to recharge refrigeration and air conditioning products. Although it is known amongst experts in the country that HFCs exist on the islands, there is a significant lack of data and information on the exact amount.

The Bahamas is actively preparing to implement the Kigali amendment to the Montreal Protocol, which will phase down the consumption of HFCs in the case of The Bahamas.

As a result, mitigation action for the IPPU sector is related to the phase-down of HFCs due to The Bahamas eventual ratification of the Kigali Amendment.

The latest GHG Inventory does not include estimates for this sector due to lack of data, and as a result, baseline emissions for this sector were unavailable. **One (1) mitigation action** related to **IPPU Sector** was identified and is outlined below.

Table 126: Mitigation Action 35 - 20% Phase-Out of HFC

<table>
<tr><th colspan="6">Name of the mitigation action</th></tr>
<tr><td colspan="6">20% Phase Out of HFC</td></tr>
<tr><th>Status</th><th>Lead Agency/Agencies</th><th>Duration</th><th>Sector and subsector</th><th>Scope</th><th>GHGs covered</th></tr>
<tr><td>Preparation</td><td>Ozone Unit, Department of Environmental Health Service</td><td>2022-2030</td><td>Industrial Processes and Product Use (IPPU)</td><td>National</td><td>hydrofluorocarbons (HFCs)</td></tr>
<tr><th colspan="6">Objective of the mitigation action</th></tr>
<tr><td colspan="6">To reduce the use of HFC refrigerants</td></tr>
<tr><th colspan="6">Brief description</th></tr>
<tr><td colspan="6">Encouraging alternatives to HFC refrigerants through ratification of Kigali Amendment and improving energy efficiency in the sector. The Government of The Bahamas is preparing the necessary instruments and planning its execution of national requirements in support of the ratification of the Kigali Amendment. The Government is conducting activities needed to enhance its capacity within the refrigeration and air conditioning servicing sector through the management (use, storage, transportation, and disposal) of current-controlled substances and the introduction of alternative sources. Additionally, the strengthening of existing regulatory import/export licensing systems for substances including hydrofluorocarbons (HFCs) and hydrofluorocarbon alternatives are being assessed to maintain a registry and provide a proper management system for these products.</td></tr>
<tr><th colspan="6">Steps to achieve mitigation action:</th></tr>
<tr><td colspan="6">1. Facilitation and support of the ratification of the Kigali Amendment.
2. Establishment of an overall national policy framework to address the hydrofluorocarbon phase-down process.
3. Creation of coordination mechanisms to highlight gaps and determine capacity needs to support the Kigali Amendment implementation.
4. Technical assistance for safe adoption of alternative HFC technologies with the local market.
5. Revisions to the current licensing and data reporting systems to include hydrofluorocarbons (HFCs).
6. Baseline data and information compiled on the existing hydrofluorocarbon products and information on alternative options available to support the phase-down plan.
6. Education and awareness throughout the public and private sectors on the ratification and implementation of the Kigali Amendment.</td></tr>
<tr><th colspan="6">Estimated outcomes and estimated emission reductions</th></tr>
<tr><td colspan="6">Reduced GHG emissions and increased energy efficiency in the sector</td></tr>
<tr><th colspan="6">Methodologies and assumptions</th></tr>
<tr><td colspan="6">The assumption is a 20% phase-down of HFC use by 2030. Assumption is that each year from the implementation, a fraction of the imported HFCs will be replaced by</td></tr>
</table>

alternative refrigerants, which are estimated to have at least a 90% lower global warming potential than HFCs. Due to data constraints the GHG emissions related to this mitigation was not estimated And thus, this mitigation action was not modelled.
Progress indicators
% reduction in the importation of HFC's
International Market Mechanisms
None

4.3.1.4.1. *Agriculture*

The Bahamas agricultural activities contribute to GHG emissions through a range of different processes. Based on the latest national inventory estimates, methane (CH_4) and nitrous oxide (N_2O) are the major contributors to GHG emissions in this sector.

Mitigation in the agriculture sector comes from improved sequestration through the sustainable practices of agroforestry. In the Pine-Island Forest/Mangrove Innovation and Integration (Grand Bahama, New Providence, Abaco and Andros) project, one component is sustainable agroforestry practices, funded by the GEF. Under the Ministry of Agriculture, more agroforestry projects are currently being developed, but planning is in the very early stages. **One (1) mitigation action** related to **Agriculture Sector** was identified and is outlined below.

Table 127: Mitigation Action 36 - Sustainable agroforestry practices in Andros, Grand Bahama, Acklins, Crooked Island, Planna and Samana Cays

Name of the mitigation action					
Sustainable agroforestry practices in Andros, Grand Bahama, Acklins, Crooked Island, Planna and Samana Cays by 2025					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Ministry of Agriculture, Marine Resources and Family Island Affairs	2015 - 2025	Agriculture	Andros, Grand Bahama, Acklins and Crooked Island	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase emission sinks in the agriculture sector. To improve biodiversity in selected areas. To increase the use of agroforestry management practices among coastal communities.					
Brief description					
The Pine-Island project will target non-timber forest products with a multi-pronged approach to improving livelihoods while ensuring the sustainability of the resources. Two projects areas were selected as Palm cultivation on Andros and Grand Bahama and sustainable Cascarilla cultivation on Acklins and Crooked Island. Integrating natural biodiversity, species and trees with crops and livestock will increase emission sinks from native trees, less fertiliser use, increase habitat and build resilience against one-off diseases. Under the Pine Islands project – Forest/Mangrove Innovation and Integration (Grand Bahama, New Providence, Abaco, and Andros), these measures have been identified, and sites have been assessed. During the stakeholder workshops, the importance of consultation with the existing farmers is essential to the success of the project.					

Steps to achieve mitigation action:
1. Public consultation with existing farmers. 2. Native palm cultivation to support indigenous craft industry on Andros and Grand Bahama 3. Sustainable agroforestry practices for Cascarilla bark cultivation and processing of Cascarilla oil in Acklins and Crooked Islands
Estimated outcomes and estimated emission reductions
Increased sequestration potential for emissions. Due to data constraints on the hectares of land to be converted and the sequestration potential, this mitigation action was not modelled.
Methodologies and assumptions
With a view towards preserving biodiversity, a technical guide will be developed for the identification and utilization of degraded forest lands for sustainable oil palm expansion and a site selection guide for identifying high potential areas for sustainable palm oil. Furthermore, through the development of alternative livelihoods, including agroforestry and non-timber forest products, pressure on forest resources will be relieved while providing opportunities for the generation of income in remote coastal communities hard hit by the economic downturn and loss of tourism revenues.
Progress indicators
Ha of agricultural lands converted to agroforestry
International Market Mechanisms
None

4.3.1.5. Land use, Land Use Change and Forestry (LULUCF)

Land Use, Land Use Change and Forestry (LULUCF) covers removals by sinks on managed lands and protected areas. The LULUCF sector includes estimates of emissions and removals of GHGs associated with the increase or decrease of carbon in living biomass; this occurs as land-use changes occur over time. The Bahamas lies within the tropical belt, and therefore its Forestry sector is prone to extreme weather-related events such as intense Hurricanes and other factors, including illegal harvesting. As a result, emissions in the sector fluctuate, which makes it difficult to project and estimate potential future emissions and removals. Despite these many challenges, The Bahamas Forestry Department continues the efforts to improve the data for the LULUCF sectors; efforts are on the way to establishing permanent plots to monitor growth rates and carbon sequestration rates. **Three (3) mitigation actions** related to **LULUCF Sector** were identified and are outlined below.

Table 128: Mitigation Action 37 - Conservation and Sustainable management practices and the establishment of a Forestry Estate on Abaco, Andros, Grand Bahamas and New Providence

Name of the mitigation action					
The establishment of a Forestry Estate on 283,750.18 hectares (20% of the total land cover of The Bahamas) comprised of areas to be established as: Conservation Forests (149, 396.99 hectares), Forest Reserves (96,542.61 hectares), and Protected Forests (37,810.58 hectares) on Abaco, Andros, Grand Bahamas and New Providence by 2025					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered

Ongoing	Forestry Unit	2015 - 2025	Land use, Land Use Change and Forestry	Grand Bahama, New Providence , Abaco, and Andros	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To improve the sustainable management practices of existing and new forest reserves. To increase emission sinks. To improve biodiversity in the selected area.					
Brief description					
The Pine Island project seeks to innovate community management plans for newly gazetted forest areas. Natural biodiversity, species and trees with crops and livestock will increase emission sinks from native trees, reduce fertiliser use, increase habitat and build resilience against one-off disease. Under the Pine Islands – Forest/Mangrove Innovation and Integration (Grand Bahama, New Providence, Abaco, and Andros), these measures have been identified, and sites have been assessed.					
Steps to achieve mitigation action:					
1. Establishment of a forestry assessment and monitoring system. 2. Integration of sustainable land-use and sustainable forest management principles into national land-use planning through development.					
Estimated outcomes and estimated emission reductions					
Increased sequestration potential. The estimated GHG emission reduction is 381.151 $GgCO_2$-eq.					
Methodologies and assumptions					
Annual carbon savings by the benefit of the project through integration of forest domain into land-use planning improved forest management. The avoided deforestation together with mangrove rehabilitation efforts is estimated to reduce up to 381.151 $GgCO_2$- eq. This data was entered into the model as recommended by the project.					
Progress indicators					
# of ha of reforested areas in degraded areas					
International Market Mechanisms					
None					

Table 129: Mitigation Action 38 - Reestablishment & Rehabilitation of 50 ha of Davis Creek, Andros Ecosystem

Name of the mitigation action					
Reestablishment & Rehabilitation of 50 ha of Davis Creek, Andros Ecosystem					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Ongoing	Forestry Unit	2015-2025	Land Use, Land-use Change and Forestry	Davis Creek, Andros	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To increase emission sinks; to rehabilitate and re-establish Davis Creek in Andros					
Brief description					

Reestablishment and rehabilitation of Davis Creek in Andros will improve sequestration potential. Under the Pine Islands project – Forest/Mangrove Innovation and Integration (Grand Bahama, New Providence, Abaco, and Andros), these measures have been identified, and sites have been assessed.
Steps to achieve mitigation action:
1. Rehabilitation of Mangrove Ecosystem in Davis Creek, Andros and increase carbon sequestration up to 14,563 tCO_2-eq.
Estimated outcomes and estimated emission reductions
Increased sequestration potential. The estimated GHG emission reduction is 14.563 GgCO_2-eq.
Methodologies and assumptions
According to recent studies, mangroves contain an average of 1,023 tonnes of carbon per hectare. This model will pilot restoration efforts for up to 50 hectares across a potential 500 hectares of mangrove forest, increasing carbon sequestration up to 14.563 GgCO_2-eq. This data was entered into the model as recommended by the project.
Progress indicators
# of ha of seagrass beds, reefs, mangroves protected and rehabilitated
International Market Mechanisms
None

Table 130: Mitigation Action 39 - Sustainable Land Use practices to result in zero emissions in the LULUCF Sector by 2045

Name of the mitigation action					
Sustainable Land Use practices to result in zero emissions in the LULUCF Sector by 2045					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Newly Proposed	Ministry of Environment and Natural Resources, Forestry Unit	2022-2030	LULUCF	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To reduce emissions from the LULUCF Sector					
Brief description					
The Bahamas LULUCF sector contributes more than 45% of the total emissions. This action is considered ambitious owing to the various challenges posed to the LULUCF sector.					
Steps to achieve mitigation action:					
National plan developed to reduce emissions in the LULUCF sector Improved data collection of the LULUCF sector					
Estimated outcomes and estimated emission reductions					
Increased sequestration potential. Estimated GHG emissions reduction of 1,324.0 Gg CO_2- eq. and 2979.1 Gg CO_2-eq by 2045.					
Methodologies and assumptions					
In the ambitious scenario: sustainable land-use practices will result in zero emissions from the LULUCF sector by 2045					
Progress indicators					
Reduction in emission in the LULUCF Sector					
International Market Mechanisms					
None					

4.3.1.6. Waste

The waste sector includes emissions from solid waste disposal and wastewater treatment. The Bahamas recently changed ownership of the New Providence Sanitary Landfill from the Department of Environmental Health Services to the New Providence Ecology Park (NPEP) in 2019. Although the NPEP is only on one island, it is estimated that it handles close to eighty per cent (80%) of the waste in The Bahamas. The NPEP has remediated the existing dumpsite and significantly reduced subsurface fires. The plans are to implement modern waste handling practices, including environmental monitoring, upgrade to collect landfill gas, expand composting and recycling systems. Historical data for the site before 2019 is very limited and therefore hinders the selection of mitigation actions.

Currently, close to twenty per cent (20%) of the waste stream is diverted to composting at the NPEP, of which sixteen per cent (16%) is green waste, and four per cent (4%) is construction debris. The expectation is that within 3-5 years, all organic waste, which is about thirty per cent (30%) of the total waste stream, will be diverted to composting.

The NPEP also plans to introduce a recycling facility at the current location. The recycling facility will be able to sort and shred plastics, aluminium, and cardboard, to name a few. It is estimated that more than nine per cent (9%) of the total waste stream is plastics. The Government has recently included a recycling programme to their list of initiatives. The recycling facility and programme coupled with the composting programme will significantly reduce waste directed to the landfill.
Mitigation in the waste sector comes from waste management, composting practices, and recycling programmes. **Two (2) mitigation actions** related to **Waste Sector** were identified and is outlined below.

Table 131: Mitigation Action 40 - Development of a waste management system to include composting systems

Name of the mitigation action					
Development of a waste management system to include composting systems					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Newly Proposed	Ministry of Environment and Natural Resources, Department of Environmental Health Services	2022-2030	Waste	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To improve waste management and encourage composting in an effort to reduce waste to the landfill					
Brief description					
Composting breaks down food and green waste for soil creation. This reduces the amount of organic waste going into landfills. Good composting practices assist in minimising GHG emissions. This proposed action is modelled after other Caribbean islands mitigation action for waste					
Steps to achieve mitigation action:					

1. Develop a comprehensive education and awareness plan;
Estimated outcomes and estimated emission reductions
Reduced waste to the landfill, reduction in emissions in the waste sector.
Methodologies and assumptions
Waste management and composting will reduce the amount of organic waste landfills, thereby reducing emissions. However, due to limited data availability, this action was not modelled. The Bahamas is currently working on improving their data collection in the waste sector.
Progress indicators
% increase in composting systems
International Market Mechanisms
None

Table 132: Mitigation Action 41 - Introduction of a National Recycling Programme

Name of the mitigation action					
Introduction of a National Recycling Programme					
Status	Lead Agency/Agencies	Duration	Sector and subsector	Scope	GHGs covered
Newly Proposed	Ministry of Environment and Natural Resources, Department of Environmental Health Services	2022-2030	Waste	National	Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)
Objective of the mitigation action					
To reduce waste at the landfill					
Brief description					
Recycling is the reprocessing of materials (mainly used) into new products. This programme will help reduce the waste entering the landfills, reduce consumption of raw materials, reduce energy usage and GHG emissions. It is a key component to waste management practices.					
Steps to achieve mitigation action:					
Development of recycling strategy Development of public awareness strategy Implementation of the two strategies developed.					
Estimated outcomes and estimated emission reductions					
Reduced waste to the landfill, reduction in emissions in the waste sector. Behavioural change to waste sorting.					
Methodologies and assumptions					
A recycling programme will enhance the behavioural change for recycling. The assumption made is waste originally destined for the landfill will be diverted to the recycling facility.					
Progress indicators					
Amount of waste diverted from the landfill					
International Market Mechanisms					
None					

4.3.2. International Market Mechanisms

The Bahamas is a non-Annex 1 Party to the Kyoto Protocol, and was therefore eligible to participate in the Clean Development Mechanism (CDM). However, The Bahamas currently has no projects registered with the CDM or other international markets.

Following the conclusion of negotiations on Article 6 of the Paris Agreement, specifically the Glasgow Climate Pact and Sharm-el-Sheikh Implementation Plan, highlighted the need to encourage small and micro business in the mechanism, particularly in the least developed countries and small island developing states.

The Government of The Bahamas has indicated a strong interest in pursuing suitable, beneficial projects in the International Markets, and has put in place legislation and is advancing institutional arrangement to participate in Article 6 Cooperative Approaches and Voluntary Carbon Markets.

4.4. GHG Emissions Projection

4.4.1. Overview of methodology

The analysis of the GHG mitigation potential in The Bahamas was developed using the Low Emissions Analysis Platform[31] (LEAP), a software tool developed by the Stockholm Environment Institute (SEI) and widely used for energy policy analysis and climate change mitigation assessments. LEAP is an integrated, scenario-based modelling tool that can be used to quantify energy consumption and production and resource extraction in all sectors of the economy and under different scenarios. In addition, it allows for the consideration of both sources and sinks of GHG from the energy sector and the non-energy sector.

The model for The Bahamas developed in LEAP simulates the evolution of energy demand and supply in the country, as well as the emissions corresponding to the energy and non-energy sectors, and the mitigation potential of a series of sectoral measures. The model covers The Bahamas as a whole, with a regional resolution for the three major island groupings: New Providence, Grand Bahama, and The Family Islands. It covers the period from 2010 to 2050, with projections starting in 2019, as the inventory data was only available up to 2018. The 2000-2018 period provides historical context, reflects the most recent economic, demographic and energy statistics in The Bahamas, and has been calibrated to closely match the most recent GHG inventory (within 0.4% of total emissions).

The prospective period (2019-2050) uses GDP and population growth projections as the main drivers of energy demand, and to the extent possible, captures the estimated economic impact of COVID-19. Energy consumption has been disaggregated by sector and fuel, including residential, transportation, industrial, services, and agriculture. Projections are based on historical energy balances, trends, and expected economic and demographic growth. The transport sector has been supplemented by a more detailed stock-turnover analysis that represents the stock and sales of different types of vehicles.

[31] https://leap.sei.org/

The model represents power generation in terms of capacity expansion and dispatch of power plants and transmission and distribution losses on the supply side. The non-energy sector encompasses these emission categories from the inventory: fugitive emissions, industrial processes, product use (IPPU), agriculture, land use and land-use change (LULUCF), non-CO_2 sources on land, and waste.

Three future scenarios were developed to assess GHG mitigation potential: a baseline and two mitigation scenarios as described further below. Emissions were projected for each of the three scenarios, and the results were compared under the various scenarios. The mitigation effects reported in this chapter are based on comparing the baseline scenario to the mitigation scenarios.

The three scenarios developed for The Bahamas are:

- **Baseline:** Illustrates where emissions for The Bahamas are headed, assuming current trends in demographic and macroeconomic drivers, as well as in sectoral energy intensity. It also assumes modest energy efficiency improvements, which can be expected even in the absence of government policies.
- **Mitigation:** It uses the same macroeconomic and demographic assumptions as the baseline and explores the implementation of a set of mitigation actions and measures as highlighted in section 4.2.1.1 - 4.2.1.2**,** which were assessed for data availability and applicability for mitigation modelling. Actions are mainly concentrated in the energy and LULUCF sectors and were modelled either as single strategies or bundled with similar strategies. On top of these actions, this scenario considers the additional buildup of solar PV to meet the 30% renewable target from the NDC by 2030. However, results indicate that this was not enough to reach the NDC's 30% GHG reduction target by 2030.
- **Ambitious Mitigation:** It includes the same assumptions and mitigation actions as above but also explores further solar PV development, higher integration of electric vehicles, zero emissions from the LULUCF sector by 2045, and other additional mitigation measures in various sectors. This scenario meets the 30% renewable and 30% GHG reduction targets from the NDC by 2030 (as seen in sections 4.3.1.1 – 4.3.1.6).

By building the model for The Bahamas' mitigation assessment analysis within LEAP, the model is readily available for future updated mitigation assessments. In addition, in-country experts were trained on using LEAP to ensure that the government institutionalises the capacity to use the model.

A stakeholder validation workshop was held to review and validate the assumptions, analysis, and conclusions of The Bahamas Mitigation Assessment with LEAP. The model was updated to reflect feedback from the stakeholder validation workshop.

4.4.2. Baseline Scenario Description

The baseline scenario corresponds to the counterfactual scenario used to compare emissions and to estimate the mitigation potential of the modelled actions. The baseline scenario explicitly does not consider the targets, goals, and projects of the mitigation strategy; rather, the scenario reflects a continuation of existing trends and modest energy efficiency improvements and shifts in technologies that are expected to happen even in the absence of new policies.

In the baseline, future emissions are estimated based on the modelling of the energy demand, supply and non-energy sectors, which in turn are driven by historical trends and by projected macroeconomic indicators, such as population, number of households, GDP, and GDP per capita. The same macroeconomic drivers are used for the baseline and the mitigation scenarios.

Based on projections from United Nations World Population Prospects (United Nations-World Population Prospects, 2021), the total population in The Bahamas will grow from 393 thousand in 2020 to 427 thousand in 2030 and 463 thousand in 2050 (Figure 45a). The total number of households will grow from 117 thousand in 2020 to 161 thousand by 2050 (Figure 45b). In terms of economic growth, near term projections from the International Monetary Fund (IMF) World Economic Outlook were used until 2025 (IMF WEO, 2021). These projections consider the impacts of COVID-19 on GDP (Figure 46), where a decrease of 16.6% in the GDP for 2020 was estimated. From 2025 to 2050, national-level GDP growth rates from the Shared Socioeconomic Scenarios database (SSP2="Middle of the Road") were used (Keywan Riahi et al, 2017). The same GDP growth rates were used for all island groups.

Figure 45: Population (a) and household (b) trends to 2050

(a) Population (b) Households

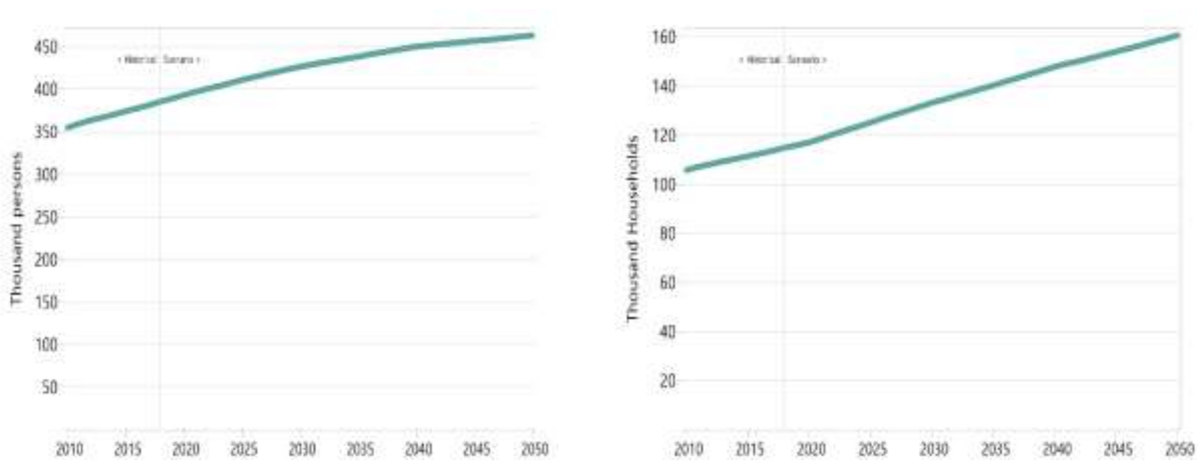
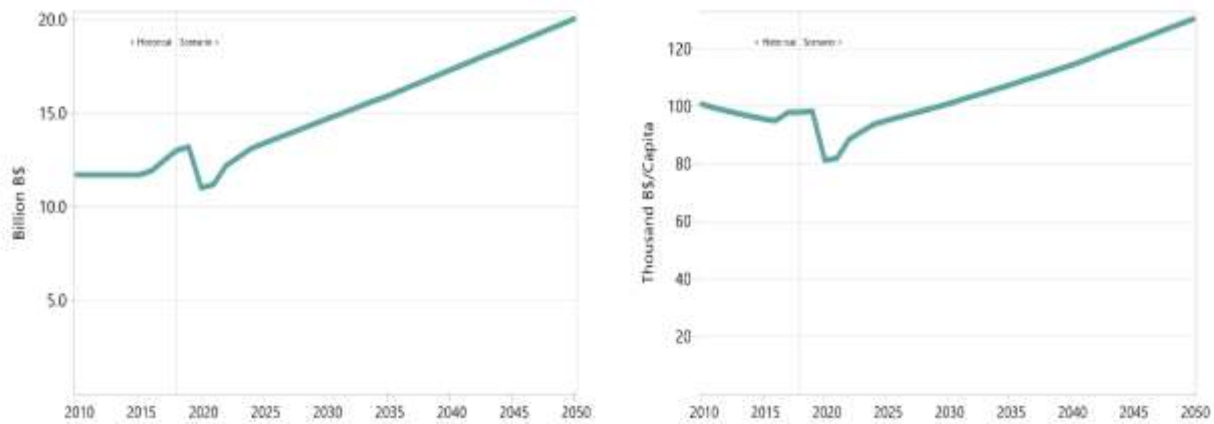


Figure 46: GDP (a) GDP per capita (b) trends to 2050

(a) GDP (b) GDP per capita



Baseline GHG emissions for all sectors, gases and regions are shown in Figure 47 to Figure 49. Total GHG emissions for 2010 and 2018 were estimated at approximately 6133.2 GgCO_2-eq and 6144.3 GgCO_2-eq, respectively. For the prospective period, the baseline presented corresponds to the best available realistic projection of future emissions based on current trends and market influences. The key driver used for the baseline GHG emissions projections in the majority of the sectors is GDP except residential demand, which is the number of households; waste, which is the population; and the LULUCF sector, which is estimated to remain constant through the projections at 2979.1 GgCO_2-eq. The final energy intensity for all sectors is expected to decline by 0.5% annually. Projected GHG emissions in the residential sector are expected to increase by 9.3% from 2018 to 2030. In the services sector and industrial sector, the projected GHG emissions are expected to increase by 6% from 2018 to 2030. The road transport and waste sector projected GHG emissions are expected to increase by 7% and 10.6%, respectively, from 2018 to 2030.

The total projected emissions reach approximately 6364.7 GgCO_2-eq in 2030 and 7173.5 GgCO_2-eq in 2050. As observed, LULUCF is an important net emitter of CO_2 and is responsible for more than 45% of the total emissions. From the energy sector, electricity generation and transportation are the most carbon-intensive sectors, contributing to 23% and 13% of the total emissions in 2030. Around 94% of the total emissions correspond to CO_2 (Figure 48), and it is estimated that New Providence contributes to 70% of the total emissions in The Bahamas (Figure 49).

Figure 47: Projected GHG emissions in the baseline by sector

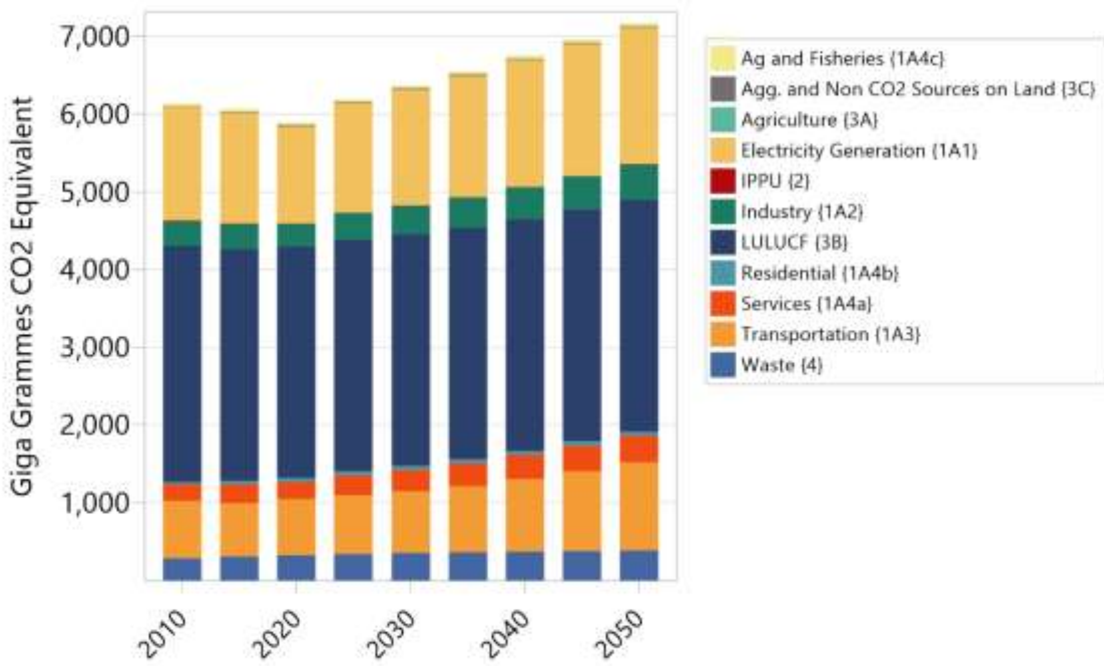


Figure 48: Projected GHG emissions in the baseline by gas

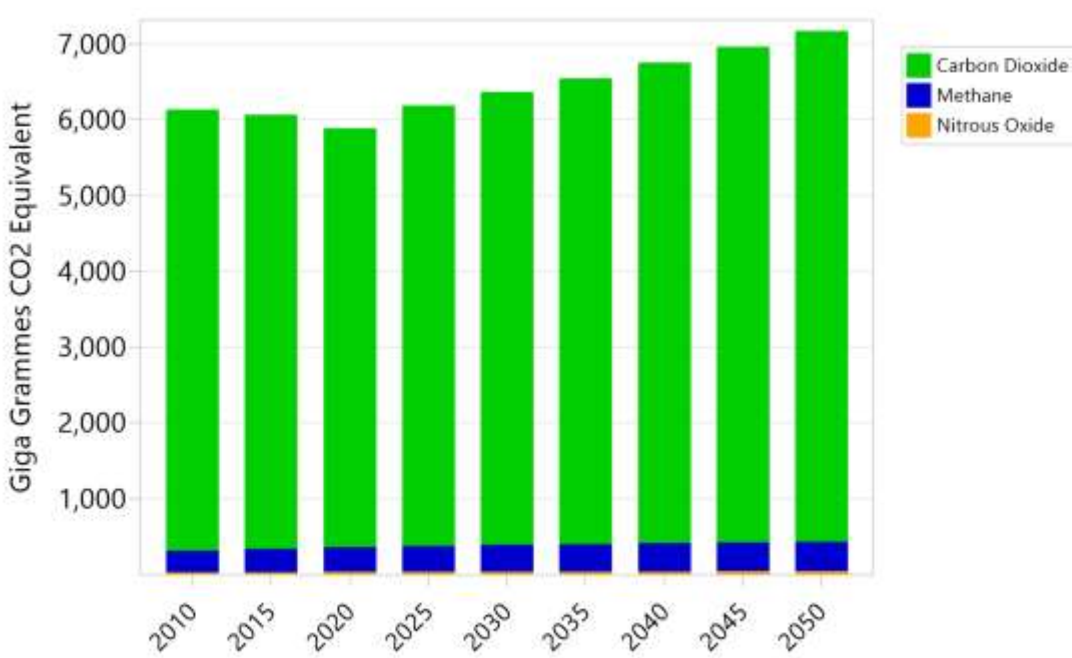
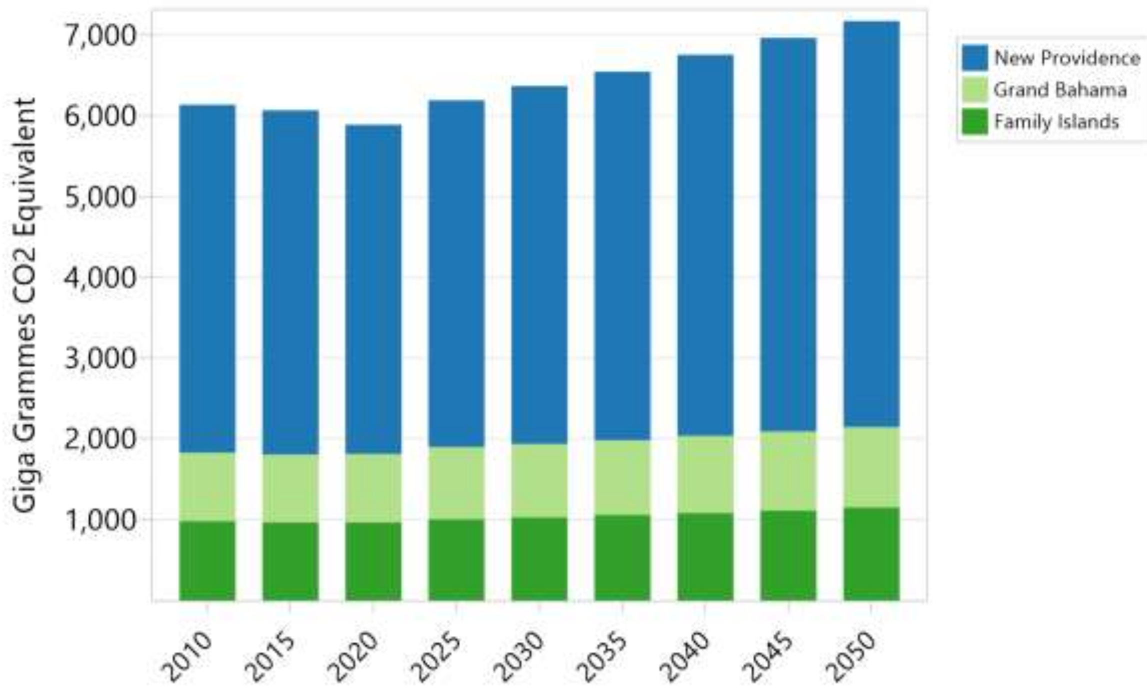


Figure 49: Projected GHG emissions in the baseline by region



4.4.3. Mitigation Scenarios(s) Description

4.4.3.1. GHG Emissions Projection Assumptions, by Sector

4.4.3.1.1. Energy Demand

The estimates of historical total energy consumption were mainly based on data obtained from The Bahamas' most recent inventory up to 2018. The data sources include 2010-2012 energy balances from the Latin American Energy Organisation (OLADE) (Latin American Energy Organisation (OLADE), 2015), The Central Bank of The Bahamas, Power Generators and Fuel Distributors - Rubis. A historical profile for fuel consumption in The Bahamas was developed using these data sets.

The historical energy consumption trends, together with key demographic and macroeconomic drivers, were used to project future energy demands by sector. The lack of more recent energy balances and the limited data available on energy end-use by sector limited the ability to conduct a bottom-up analysis of energy demand in The Bahamas. Therefore, the energy demand projections were only disaggregated by sector and fuel, and the policy measures in the residential, commercial and services sectors were represented as expected gradual energy savings, estimated outside of LEAP based on the technical characteristics, uptake rates, and other assumptions as described below in Table 133.

Table 133: Assumptions for mitigation actions in the residential, commercial and services sectors

Modelled action	Description	Main assumptions
Revised building codes	Adoption and implementation of a	- The implementation of the revised code will reduce energy used for cooling and lighting

Modelled action	Description	Main assumptions
	Revised Building Code that will impact all new construction of residential and non-government buildings between 2024 and 2030.	by 25% in the new residential and commercial buildings. - 1132 new residential buildings per year are assumed, with average annual electricity consumption of 1835 kWh/household for lighting and 2618 kWh/household for air conditioning (AC). - 110 new commercial buildings per year are assumed, 86% of which are non-governmental. The average floor space is assumed as 1455 m^2/building, with average annual electricity consumption of 31.2 kWh/m^2 for lighting and 58.13 kWh/m^2 for AC. It is assumed that all new residential and commercial buildings will have AC.
Government building lighting retrofits	Lighting Retrofits for all government occupied buildings in New Providence.	- Approximately 14% of all buildings in New Providence are Government occupied, which represent 402 buildings. - The shift towards more efficient lighting will result in savings of 60% of the electricity used for lighting in these buildings. The retrofits are implemented starting in 2020 and reach 100% by 2030.
Street lighting retrofits	Streetlighting retrofits by 2033.	- There are approximately 46,000 streetlights in The Bahamas, including high-pressure sodium (HPS), mercury vapour, metal halide, incandescent, LED, and solar. - Streetlights are assumed to be in use for 12 hours per day. - 24% of the existing lights are LED, and less than 1% are solar. Starting in 2020 and by 2025, all other lights (estimated as 35,000 250 W lights) will be replaced by 70 W LED lights.
Solar water heaters	Increase adoption of solar water heaters by 40% for the Bahamas by 2030.	- Of the current 115,660 households, 60% use water heaters. The average annual energy consumption of water heaters is 1890 kWh/household. - There are currently 3946 commercial buildings with an average floor space of 1455

Modelled action	Description	Main assumptions
		m^2/building. 10% of these buildings use water heaters with an average annual energy consumption of 2.15 kWh/m^2. - Currently, water heating is mainly electric or fueled with LPG. Only 5% of water heaters are solar. - By 2030, 40% of all water heaters will be solar
Efficient AC	Energy Efficient Standards for air conditioning systems by 2025.	- Same number of households, commercial buildings, and floor space as described above. - 60% of households have AC, with an average annual electricity consumption for AC of 2618 kWh/household. - All commercial buildings have AC, with an average annual electricity consumption for AC of 58.13 kWh/m^2. - The standards are assumed to consider a 30% increase in efficiency by 2030. In the ambitious scenario, the adoption of seawater cooling in hotels was modelled for more efficient cooling. - Currently, there are approximately 300 hotels in The Bahamas, with an average of 3425 m^2/building and an average annual electricity consumption for cooling of 50.4 kWh/m^2. - By 2030, 20% of all hotels will implement sea water cooling. - This technology reduces energy consumption for cooling by 80%.
Carbon neutral marine protected area facilities	Five (5) carbon-neutral Marine Protected Area facilities (photovoltaic substitute for diesel generators) by 2030.	- By 2030, 5x100 kW generators at 75% load factor and 25% efficiency will be replaced by PV systems

Modelled action	Description	Main assumptions
Distributed PV to replace diesel generators	Energy Audits for All existing Hotels and Industrial facilities by 2025. In addition, two actions were implemented 1. A fraction of the backup diesel generators in the service sector will be replaced by distributed solar PV systems. 2. Energy intensity improvements in the industrial sector.	For the ambitious scenario, in addition to the energy audits, some mitigation actions are considered. This includes the replacement of diesel generators with PV systems and a reduction in the energy intensity for the industrial sector. Currently, diesel is used in backup generators that provide distributed electricity in some of the service sector facilities. - In the ambitious mitigation scenario, by 2030, distributed solar PV systems will displace 30% of the diesel used in the service sector. - In the baseline and mitigation scenarios, energy intensity in industry decreases 0.5% per year. - In the ambitious mitigation scenario, energy intensity in the industry decreases by 2% per year.

4.4.3.1.2. Electricity Generation

The electricity generation assumptions determine the underlying GHG emissions from the supply and production of electricity. Data on electricity sales by sector was very limited and therefore constrained the ability to calibrate the energy supply from the model to observed historical data. Nevertheless, the LEAP model estimates projected electricity requirements and power generation capacity and dispatch from different types of power plants in each major island group.

In 2018, there were 767 MW of installed electricity generation capacity in The Bahamas, all of which corresponded to thermal power plants running on diesel and residual fuel oil. Based on the information provided by BPL, the transmission and distribution (T&D) losses in the BPL operated grid are estimated at 10.88%. The average T&D losses in the country are assumed to be 10% for the 2018-2030 period. In terms of generation capacity, the baseline scenario assumes that all additional capacity requirements are met by diesel generators.

The main assumptions for the renewable energy supply and T&D losses under different scenarios are described below in Table 134.

Table 134: Assumptions for mitigation actions in the power generation sector

Modelled action	Description	Main assumptions
T&D loss reduction	Reduction in the Transmission & Distribution losses in The Bahamas of 2 percentage points by 2030	The average T&D losses in the Bahamas will be reduced from 10% in 2018 to 8% by 2030.
Renewable power generation	Integration of renewable power generation in The Bahamas	- In the mitigation scenarios, the following renewable generation capacity is added to the system: • 3 MW utility-scale PV in Grand Bahama by 2025 • 3 MW distributed PV in Grand Bahama by 2025 • 30 MW of PV split among regions by 2026 • 20 MW of wind among regions by 2030 • 30 kW of OTEC by 2030 • 15 MW of Waste to Energy • 10MW distributed PV in New Providence by 2024 • 10 MW distributed PV on Family Islands by 2030 • 1.2 MW of distributed generation on 9 Government Facilities 117 MW of additional solar PV capacity were added to the system in both the mitigation and ambitious mitigation scenarios to meet the NDC goal of 30% renewable generation by 2030.

The following Table 135 shows the expected generation capacity by type in key years under each of the modelled scenarios. Note that a fraction of the existing thermal capacity in the ambitious mitigation scenario is expected to retire after 2030, approximately 24%. However, this thermal capacity is only fractionally replaced by renewables because the reserve margin in The Bahamas will be sufficient to meet the anticipated demand.

Table 135: Expected Installed Capacity by Type in Baseline and Mitigation Scenarios

Scenario	Year	Thermal (MW)	Solar PV (MW)	OTEC (MW)	MSW (MW)	Wind (MW)	Total (MW)
Baseline	2018	767.2	-	-	-	-	767.2
	2025	845.2	-	-	-	-	845.2
	2030	845.2	-	-	-	-	845.2
	2050	845.2	-	-	-	-	845.2
Mitigation	2018	767.2	-	-	-	-	767.2
	2025	845.2	87	-	-	-	932.2
	2030	845.2	174	0.03	15	20	1054.2
	2050	845.2	174	0.03	15	20	1054.2
Ambitious mitigation	2018	767.2	-	-	-	-	767.2
	2025	845.2	87	-	-	-	932.2
	2030	845.2	174	0.03	15	20	1054.2
	2050	645.83	204	0.03	15	20	884.9

Table 136: Expected Electricity Generation by Type in Baseline and Mitigation Scenarios

Scenario	Year	Thermal (GWh)	Solar PV (GWh)	OTEC (GWh)	MSW (GWh)	Wind (GWh)	Total (GWh)
Baseline	2018	2062.6	-	-	-	-	2062.6
	2025	2100.9	-	-	-	-	2100.9
	2030	2221.2	-	-	-	-	2221.2
	2050	2629.2	-	-	-	-	2629.2
Mitigation	2018	2062.6	-	-	-	-	2062.6
	2025	1765.6	228.6	-	-	-	1994.2
	2030	1366.8	457.3	0.2	105.1	52.6	1981.9
	2050		457.3	0.2	105.1	52.6	2441.1
Ambitious mitigation	2018	2062.6	-	-	-	-	2062.6
	2025	1767.0	228.6	-	-	-	1995.7
	2030	1377.4	457.3	0.2	105.1	52.6	1992.6
	2050	1891.4	536.1	0.2	105.1	52.6	2585.4

4.4.3.1.3. Transport

The historical energy consumption in the transportation sector was based on The Bahamas most recent inventory up to 2018 and was disaggregated by mode (road, domestic aviation, and domestic maritime navigation) and fuel. This information was supplemented by vehicle registration information to develop a stock turnover model in

LEAP for road transport. The stock and sales data from the vehicle registration information was calibrated to allow the bottom-up fuel consumption projections to align with historical transport sector energy requirements. The resulting stock turnover model represents the future stocks and sales of different types of passenger and freight vehicles, including cars, motorcycles, golf carts, minibuses, buses, taxis, trucks and other miscellaneous equipment.

Based on this model, the total stock of road vehicles, including passenger and freight, grows from 136 thousand in 2018 to 150 thousand in 2030, which is equivalent to an annual growth rate of 0.82%. In 2018, hybrid and electric vehicles (EV) represented less than 1% of the total vehicle stock in The Bahamas. In the baseline, hybrid and EVs represent around 8% of car sales between 2018-2030, which results in the stock of hybrid and EVs increasing to 4% of the total stock by 2030.

The electrification of vehicles was modelled in the mitigation and ambitious mitigation scenarios, using a different set of assumptions regarding the share of hybrid and EV sales, as described in Table 137 below. The resulting share in the total stock of vehicles is also indicated.

Table 137: Assumptions for mitigation actions related to the electrification of vehicles

<table>
<tr><th>Scenario</th><th>Description</th><th>Baseline</th><th>Mitigation</th><th>Ambitious mitigation</th></tr>
<tr><td>Share of sales of EVs in 2030</td><td rowspan="4">Increase sales of electric vehicles to 35% and hybrid vehicles to 15% by 2030</td><td>3.8%</td><td>35%</td><td>50%</td></tr>
<tr><td>Share sales of hybrids in 2030</td><td>3.8%</td><td>15%</td><td>40%</td></tr>
<tr><td>Resulting share of EVs in total 2030 stock</td><td>2%</td><td>13%</td><td>16%</td></tr>
<tr><td>Resulting share of hybrids in total 2030 stock</td><td>2%</td><td>5%</td><td>11%</td></tr>
</table>

In addition to the higher integration of hybrid and electric vehicles, the mitigation assessment also considered the impact of increasing public transport to offset growth in car sales. The main assumptions used to model this mitigation action are described below.

Table 138: Assumptions for public transport mitigation action

Modelled action	Description	Main assumptions
Public transport offsetting growth in cars	Promotion of the use of Public Transport by 2033	- After 2025, the number of private cars will stop growing due to the increased availability of public transport. - Private cars are assumed to drive 14,484 km/vehicle per year and have an average of 1.5 passengers per car. The avoided passenger kilometres from the private cars are assumed to be absorbed by buses with an average occupancy rate of 21 passengers per vehicle and an annual mileage of 40,000 km per vehicle.

4.4.3.1.4. Land Use and Land Use Change and Forestry (LULUCF)

The LEAP model includes the historical non-energy sector emissions from the most recent emissions inventory up to 2018. From 2019 onwards, GDP is used as the key driver to project future emissions for the non-energy subsectors, with the exception of emissions from LULUCF and non-CO_2 sources on land, which are projected to remain constant and waste, which used population as the key driver. The following table describes the main assumptions for the mitigation actions modelled for this sector.

Table 139: Assumptions for mitigation actions in the LULUCF sector

Modelled action	Description and main assumptions
Sustainable management practices	The establishment of a Forestry Estate on 283,750.18 hectares (20% of the total land cover of The Bahamas) comprised of areas to be established as: Conservation Forests (149, 396.99 hectares), Forest Reserves (96,542.61 hectares), and Protected Forests (37,810.58 hectares) on Abaco, Andros, Grand Bahamas and New Providence which will avoid up to 381.151GgCO_2-eq by 2025.
Davis Creek rehabilitation	Reestablishment and rehabilitation of 50 ha of Davis Creek, Andros Ecosystem, which will increase carbon sequestration up to 14.6 GgCO_2e by 2025.
Zero LULUCF emissions by 2045	In the ambitious scenario: sustainable land-use practices will result in zero emissions from the LULUCF sector by 2045.

4.4.3.1.5. IPPU, Agriculture, Waste

There are four (4) mitigation actions for IPPU, Agriculture and Waste Sectors. Due to data constraints in the baseline, these four mitigation actions were not modelled. The Bahamas is working on improvements in their data collection methods and procedures, and it intends to model these mitigation actions for these sectors in coming years.

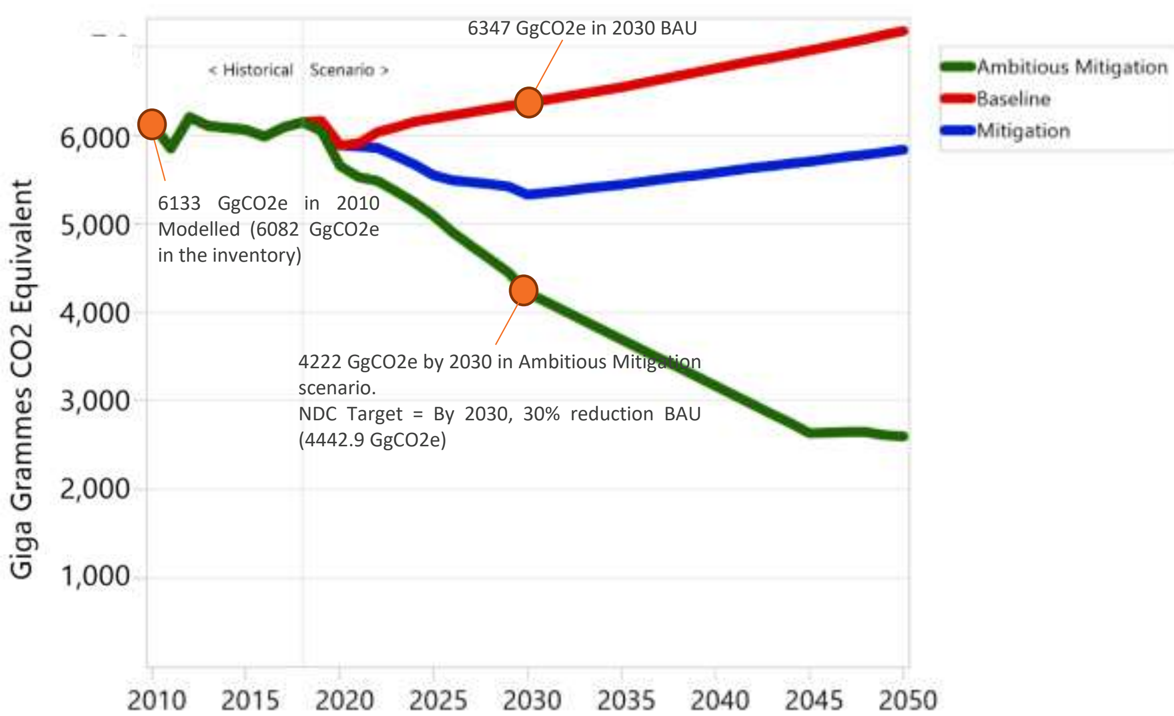
4.4.4. GHG Emission Projection Results

As discussed above, two mitigation scenarios were modelled, which have the same demographic and macroeconomic assumptions as the baseline, and consider a series of mitigation actions as highlighted in 4.2.1.1 - 4.2.1.2, as well as additional measures in order to reach the NDC targets of 30% renewable generation by 2030 (Mitigation scenario) and an economy-wide reduction of GHG emissions of 30% when compared to its Business as Usual (BAU) scenario by 2030 (Ambitious mitigation scenario).

Figure 50 shows the results of the total emissions in the three modelled scenarios, as well as the 2010 emissions[32], 2030 emissions in the baseline and the NDC target for 2030 as reference.

Figure 51 shows the total emissions by sector in 2010, 2030 and 2050 for the three scenarios. Figure 52 shows the current and projected shares of fossil-based and renewable power generation in the three scenarios.

Figure 50: Projected total emissions in The Bahamas under three scenarios



[32] The Bahamas NDC is expressed both as relative to BAU and relative to 2010 baseline emissions

Figure 51*:* Projected total emissions by sector under three scenarios

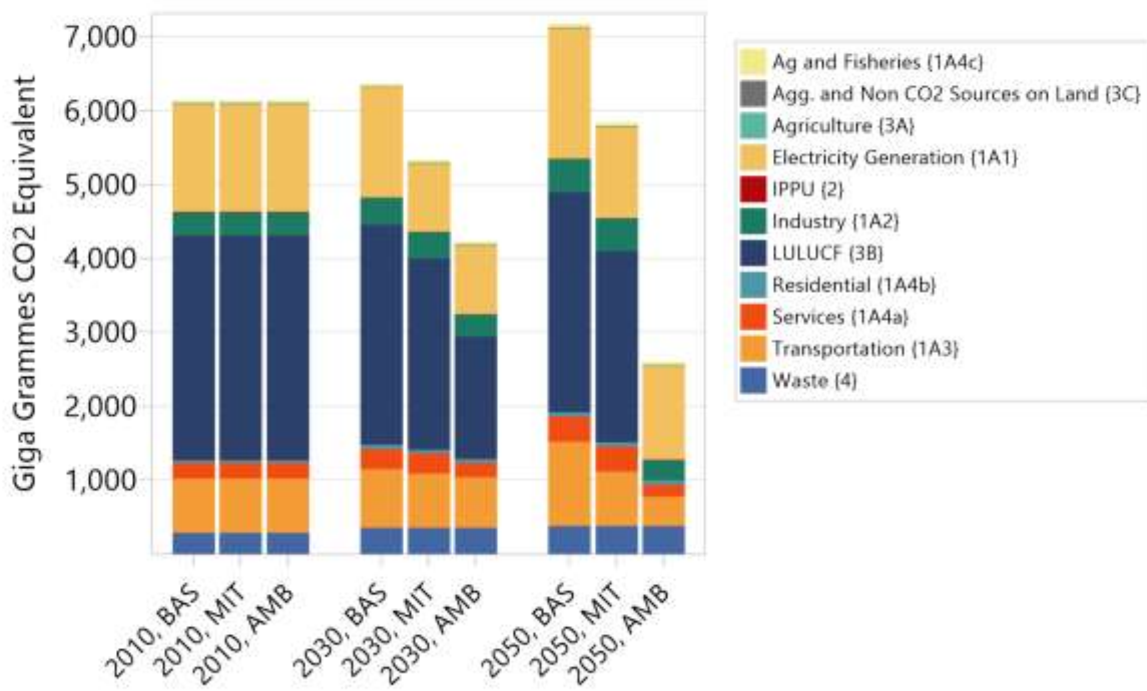
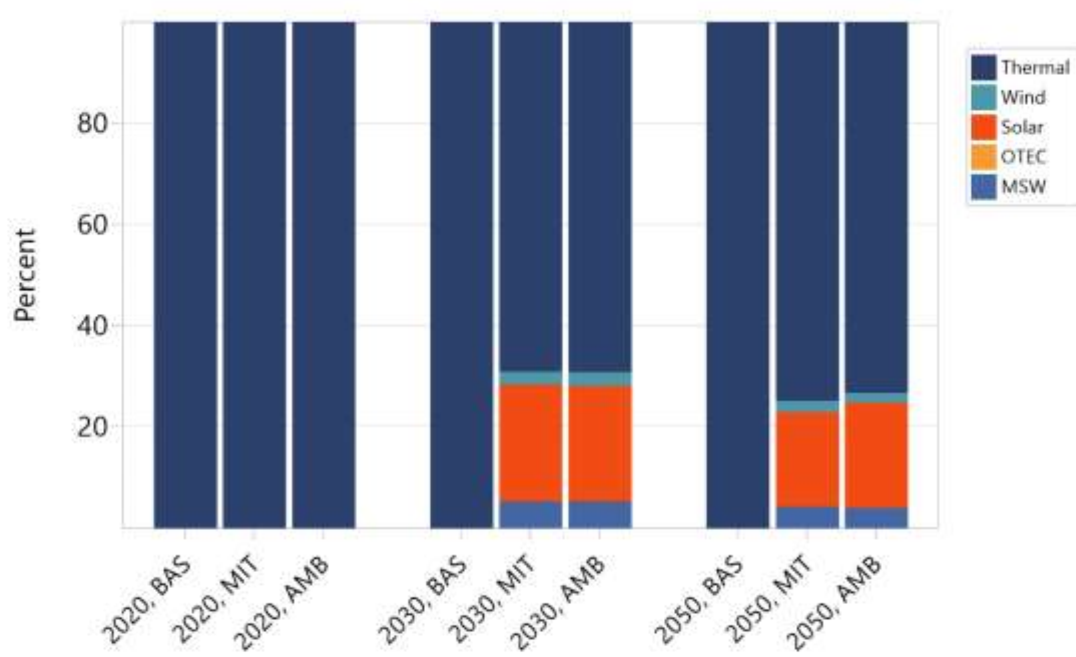
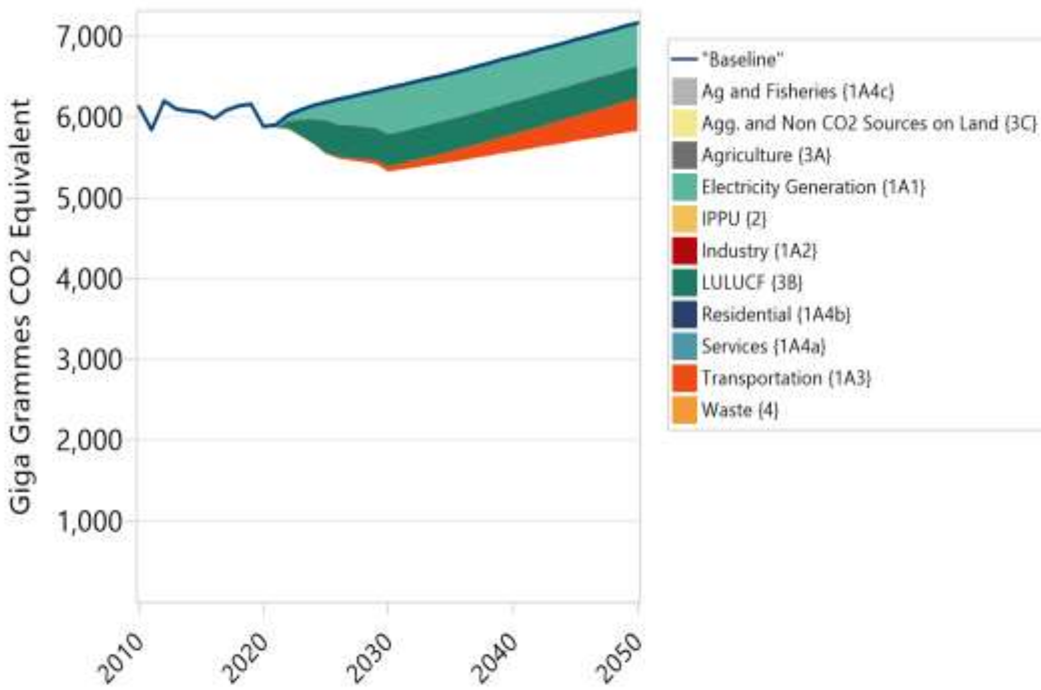


Figure 52*:* Current and projected share of thermal fossil-based and the renewable generation under three scenarios



In the mitigation scenario, the installed renewable capacity by 2030, which includes 174 MW of solar, results in 31% of the total generation coming from renewable sources, therefore meeting the NDC target of 30% renewable generation by 2030. However, in terms of total emissions, the mitigation scenario projects 5,328.8 $GgCO_2$-eq by 2030, which corresponds to a 16% reduction from the 2030 baseline value of 6,364.7 $GgCO_2$-eq. Therefore, the mitigation actions considered under this scenario are not sufficient to meet the overall target of a 30% reduction by 2030 from the NDC. After 2030, the total emissions in the mitigation scenario continue to increase over time. Figure 53 shows the emission reductions by sector in the mitigation scenario compared to the baseline scenario, where it can be seen that electricity generation is the largest contributor to the mitigation potential, followed by LULUCF and the transport sector.

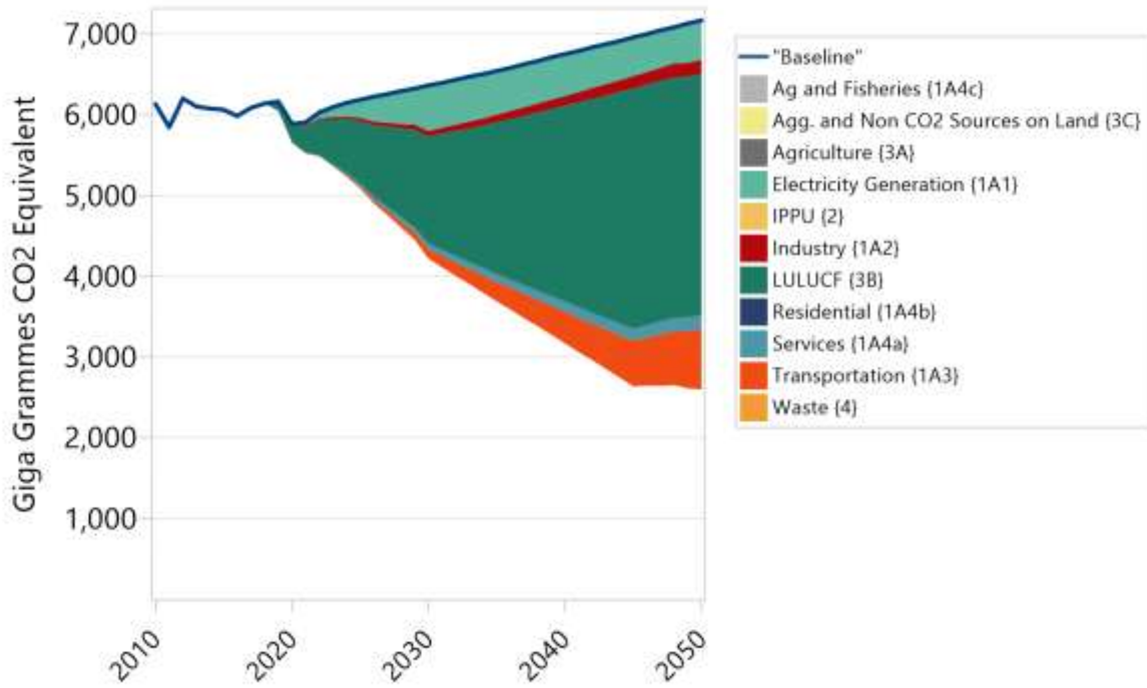
Figure 53: Projected emission reductions by sector in the mitigation scenario compared to the baseline



The ambitious mitigation scenario explores additional measures required to achieve both NDC targets: 30% renewable generation by 2030, and 30% reduction in total GHG emissions in 2030 compared to baseline/BAU value. As described previously, the additional measures include the replacement of diesel generators by PV in the commercial sector, seawater cooling in hotels, energy efficiency in industry, more ambitious electrification of the transport sector, and reaching net-zero emissions from LULUCF by 2045.

Under the ambitious mitigation scenario, total emissions in 2030 reach 4,222.0 $GgCO_2$-eq, corresponding to a 33% reduction compared to BAU values. After 2030, total emissions continue to decrease, reaching 2,598.0 $GgCO_2$-eq in 2050 (63% reduction compared to BAU of 2050). Additionally, 30% of the total electricity generation in 2030 comes from renewable sources. Therefore, this scenario meets the two mitigation targets from the NDC. From Figure 51 and Figure 54, it can be observed that reaching net-zero emissions in the LULUCF sector plays a major role in achieving the NDC targets.

Figure 54: Projected emission reductions by sector in the ambitious mitigation scenario compared to the baseline



4.4.4.1. Summary of GHG Reductions

For reference purposes, Figure 55 shows the difference in total direct GHG emissions that result from the individual implementation of each one of the modelled measures by 2030 compared to the baseline scenario.

Table 140 shows the total net mitigation by measure for 2030 and 2050. Although these results provide an overview of the magnitude of mitigation potential from each measure, it should be noted that interactions exist between measures, so the mitigation that results from implementing multiple measures may not necessarily be the sum of those individual measures. For example, when considered alone, the electrification of vehicles results in an increase in emissions from the power generation sector and a reduction in emissions from the transport sector due to the higher efficiency of electric vehicles compared to internal combustion engines (ICEs). Even though the net result is lower emissions than in the baseline, the overall mitigation potential is very limited if the electricity generation continues to be entirely based on fossil fuels. However, if the electrification of vehicles were to be implemented in parallel to increasing the share of renewables in the power generation sector, the mitigation potential would be significantly augmented.

Figure 55: Emission differences that result from the individual implementation of each modelled action in 2030 compared to the baseline

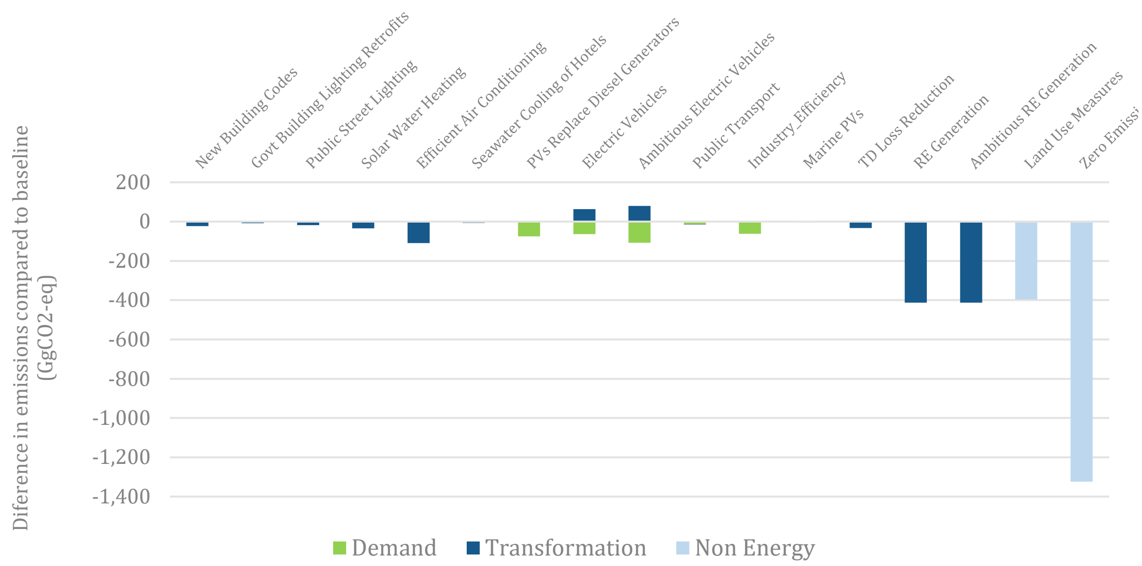


Table 140: Avoided emissions from the individual implementation of each modelled action compared to the baseline

Sector	Mitigation action	Avoided emissions compared to baseline (GgCO₂e avoided)	
		2030	2050
Energy demand in Residential, commercial and services sectors	New Building Codes	-22.6	-22.6
	Govt Building Lighting Retrofits	-8.2	-8.2
	Public Street Lighting	-18.5	-18.4
	Solar Water Heating	-34.5	-64.0
	Efficient Air Conditioning	-109.6	-145.8
	Seawater Cooling of Hotels	-6.2	-15.4
	PVs Replace Diesel Generators	-74.6	-177.6
	Energy Audits & Implementation of improve energy intensity	-61.3	-175.2
Transport	Electric Vehicles	-1.1	-195.2
	Ambitious Electric Vehicles	-29.0	-361.0
	Public Transport	-12.9	-123.6
	Marine PVs	-3.5	-3.5
Power generation	TD Loss Reduction	-32.4	-74.9
	RE Generation	-412.6	-412.6

Sector	Mitigation action	Avoided emissions compared to baseline ($GgCO_2e$ avoided)	
		2030	2050
	Ambitious RE Generation	-412.6	-429.4
LULUCF	Land Use Measures	-395.7	-395.7
	Zero Emissions from Land Use	-1,324.0	-2,979.1

4.5. Barriers and Challenges to Implementation and Methods to Improve The Modelling

A summary of the main barriers and challenges to conducting the mitigation assessment and estimate barriers to the implementation of the mitigation are highlighted below. These barriers were verified during the stakeholder workshop as part of the Mitigation Assessment:

4.5.1. Barriers and Challenges

- Lack of Adequate Data - Data quality and availability were identified as the main challenges throughout the development of the model. Insufficient data will result in limited accuracy in the modelling and also create major challenges for monitoring, verification and reporting in the future.
- Willingness to supply data to relevant authorities. This creates a lack of transparency, and it is closely aligned to the issues noted in the first bullet point.
- Political Will – Implementing mitigation actions requires broad political support and effective planning to maximise opportunities. Therefore, it is essential that sensitisation and education of high-level decision-makers to the climate change needs are sustained.
- Weak Governance – Although the mitigation actions are clearly identified under separate sectors, the Governance of some of these actions are not always clearly defined across Ministries and Departments. It is important that coordination through the National Climate Change Committee, which consist of people from various ministries are continued to minimise this challenge.
- High Capital Costs – Renewable Energy Initiatives normally require high capital costs. Although The Bahamas is considered a high-income country, the unique challenges of SIDS need to be taken into consideration. It is essential that access to climate finance grants and low-interest loans be made available to SIDS to help reduce the costs of implementation.
- Technology Suitability/Availability – The Bahamas, in its mitigation assessment, have proposed some common technologies and others that are still in their infancy. In addition, The Bahamas archipelago is vast and therefore, it is essential that studies and testing be conducted in various regions in The Bahamas to identify the

most suitable technology for each territory based on national circumstances. Furthermore, it is essential that capacity building in the suitable technologies be conducted for the sustainability of implementation.

- Natural Disasters – The Bahamas lies within the tropical belt and is the direct path of hurricanes and tropical storms, with the latest being Nicole (2022), Isaias (2020), Dorian (2019), Irma (2017), Matthew (2016). Hurricane Dorian was the strongest to hit The Bahamas, causing major destruction not only to livelihood but to the forested areas. With increasing global warming, it is expected that extreme weather events will become more frequent and intensify. This creates a major challenge for the implementation of the mitigation action of net zero emissions in the LULUCF sector by 2045. Major efforts are required by the Forestry Unit to monitor effects from natural disasters versus human-induced deforestation to distinguish between the two activities.
- Land Availability – The Bahamas has limited surface area and therefore, there is a need to balance the enhancement and protection of the LULUCF sector as well as increasing renewable energy penetration through the installation of solar PV systems. Land-use zoning and innovative use of solar PV systems will be of critical importance.

4.5.2. Key Needs for Improving Modelling

- Improvement in data collection, having more disaggregated and updated data for energy consumption and production in The Bahamas would allow for more detailed modelling of the energy sector and its GHG emissions. This would create a more transparent assessment of mitigation actions in this sector, which for the purpose of this study were mainly estimated outside of the main modelling framework.
- Assessment of data transparency issues and development of agreements to facilitate data sharing among institutions, for example, by anonymizing data (e.g. sharing semi-aggregate information by power plant type instead of by individual facilities so that interests of private companies are protected while also contributing to the public knowledge).
- Improvement in the baseline projections for the LULUCF sector. Better data collection in the LULUCF sector will allow for improvement in the assessments of the trends and the baseline emissions for the LULUCF sector.
- The LEAP model can be a useful tool for monitoring the implementation of projects. Therefore, further examination of the model needs to be conducted and adequately skilled persons identified for monitoring the implementations projects and updating the LEAP model.

Chapter 5 – Constraints, gaps and related financial, technical and capacity needs, including information on support received for preparation and submission on BUR

5.1. Constraints, gaps, and prioritized needs

In its previous submissions to the UNFCCC (FNC, SNC, and NDC), The Bahamas has identified data gaps and transparency issues that have hindered complete and accurate reporting. Lack of timely improvement and the detailed modalities, procedures, and guidelines (MPGs) that elaborate the enhanced reporting requirements under the ETF has guided the Government of The Bahamas to identify the following during the TNC/BUR1 reporting process:

- Constraints and gaps in GHG inventory, mitigation, adaptation, and climate finance reporting
- Prioritised needs and improvements to facilitate improved reporting for future cycles in adherence with the TACCC principles

The following Table 141 and Table 142 provides a summary of observed constraints and gaps provided by the relevant compilation teams and validated by in-country stakeholders as well as identified prioritised needs.

Table 141: Constraints and gaps by reporting type

Reporting Type	Constraints and gaps observed during TNC/BUR1 reporting process
GHG Inventory	**Lack of adequate data** – Data quality and availability from national sources for key emitting sectors were main challenges for estimating emissions and removals for this GHG inventory. **Limited coordination for GHG inventory cycle** – The institutional and legal arrangements for coordinating timely GHG Inventory reports was noted as a limiting factor in this reporting cycle, while noting that efforts have been made to identify roles and responsibilities of coordinating entity, data providers, and sector experts. **Capacity constraints in applying GHG inventory methodologies** – The lack of technical capacity was noted and affected the overall flow of information from data collection, to emissions estimations, and then to reporting.

	Limited understanding of all GHG emitting activities in the country – A clear understanding of all emitting categories was difficult to determine during the data collection process, however as capacity increases in understanding the scope and necessity of reporting, this is expected to improve. **Lack of archiving from previous reporting cycles** – The data, methods, and calculations from previous GHG Inventories has not been successfully documented, requiring all new efforts to source historical data for its time series
Mitigation	**Lack of adequate data** - Data quality and availability were identified as the main challenges throughout the development of the model. Insufficient data will result in limited accuracy in the modelling and also create major challenges for monitoring, verification and reporting in the future. **Willingness to supply data** to relevant authorities which creates a lack of transparency. **Intra-ministerial coordination and communication** - Although the mitigation actions are clearly identified under separate sectors, the Governance of some of these actions were not always clearly defined across Ministries and Departments. It is important that continued efforts of coordination through the National Climate Change Committee, which consist of persons from various ministries to minimise this challenge. **High capital costs** – Renewable energy initiatives normally require high capital costs. Although The Bahamas is considered a high-income country, the unique challenges of SIDS need to be taken into consideration. It is essential that access to climate finance grants and low-interest loans be made available to SIDS to help reduce the costs of implementation.

	Technology suitability/availability – The Bahamas, in its mitigation assessment, have proposed some common technologies and others that are still in their infancy. In addition, The Bahamas archipelago is vast and therefore, it is essential that studies and testing be conducted in various regions in The Bahamas to identify what is most suitable for each territory based on national circumstance. In addition, capacity building in the technologies identified as most suitable is important for the sustainability of implementation. **Data transparency issues** – There is a lack of development and implementation of agreements to facilitate data sharing among institutions.
Adaptation	**Stakeholders with technical capacity constraints,** both in terms of human resource numbers, and ability to meet the technical demands for consistent V&A reporting. **Intra-organizational/inter-organization coordination and communication** - Lack of coordination across ministries, local government, private sector, academia, NGOs and other stakeholders who participate in climate change actions across all sectors. **Lack of regulatory framework to support and promote** V&A data collection, tracking, monitoring, reporting and dissemination, resulting in gap in data and knowledge needed to inform policy and decision making **Lack of key equipment** to support V&A MRV due to high costs for procurement, implementation and ongoing use, supply chain matters, etc. **Lack of adequate data** - Data quality and availability were identified as a challenge throughout the development of impact chains/models **High capital costs** – Adaptation initiatives can cost even more than mitigation initiatives to implement. With The Bahamas classification as a high-income country is a major barrier in access to capital, therefore, its unique

	challenges of SIDS need to be taken into consideration. It is essential that access to climate finance grants and low-interest loans be made available to SIDS to help reduce the costs of implementation.
MRV Assessment	**Intra-organizational coordination and communication** - Lack of coordination across ministries, local government, private sector, and other stakeholders who participate in climate change actions across all sectors. **Need for greater public awareness** around climate change initiatives through planned education and awareness campaigns from primary education to broader public awareness campaigns. **Limited staff**, particularly full-time staff, to keep up with the demands of new national commitments for enhancing national climate MRV systems, and other related permanent functions such as participation in National GHG Inventory preparation, tracking of NDC goals, gender experts, climate support tracking. **Lack of adequate funding** to implement climate goals and monitor execution in the medium to long term. **Limited legislation or compliance mechanisms** in place to mandate the execution and continuity of climate related activities that are internationally binding (reporting under the Paris Agreement, Montreal Protocol, etc.) **Stakeholder hesitation** in participation in meeting nationally determined climate change goals as a result of limited incentives offered to the private sector and other significant stakeholders. **Difficulty in collecting data** and reporting across all sectors, as data is not collected for the purpose of reporting on climate change indicators

Table 142: Identified prioritized needs by reporting type

Reporting Type	Prioritised Needs identified during TNC/BUR1 reporting process
GHG Inventory	Set up appropriate institutional, procedural, legal arrangements, and documentation for recurring preparation of the national GHG inventory. Appoint a national GHG inventory compilation team. Fully establish and implement QA/QC procedures for the national GHG inventory. Fully establish data collection and archiving procedures for the national GHG inventory.
Adaptation	Assessment of data transparency issues and development of agreements to facilitate data sharing among institutions Improve intersectoral linkages between sectors (public and private) to avoid duplication of efforts, this will help to take advantage of common challenges and opportunities: i.e. improvement in data collection, disaggregation, usefulness, and implementation of adaptation initiatives Training and increased capacity of individuals across agencies, particularly those highlighted in priority adaptation areas, to ensure they understand role in the national (cyclical) adaptation MRV process, and support future reporting efforts Advancing a national climate research agenda to support the availability of recent (up-to-date) data is available for modelling and adaptation MRV purposes Enhanced legislative agenda, including regulations and policies for land use and conservation to improve efficacy in planned adaptation interventions
Mitigation	Improvement in data collection, having more disaggregated and updated data for energy consumption and production in The Bahamas would allow for more detailed modelling of the energy sector and its GHG emissions. This would create a more transparent assessment of mitigation actions in this sector, which for the purpose of this study were mainly estimated outside of the main modelling framework. Assessment of data transparency issues and development of agreements to facilitate data sharing among institutions,

	for example, by anonymizing data (e.g. sharing semi-aggregate information by power plant type instead of by individual facilities so that interests of private companies are protected while also contributing to the public knowledge). Improvement in the baseline projections for the LULUCF sector. Better data collection in the LULUCF sector will allow for improvement in the assessments of the trends and the baseline emissions for the LULUCF sector. The LEAP model can be a useful tool for monitoring the implementation of projects. Therefore, further examination of the model needs to be conducted and adequately skilled persons identified for monitoring the implementations projects and updating the LEAP model.
MRV Assessment	Ensure that all relevant government agencies are involved in the inventory process. Initiate appropriate legislation to facilitate access to data and data collection. Contact the main industries in the country and open a communication channel for data collection/exchange, considering the confidentiality option. Establish a process to ensure a common understanding of data needs and a consensus on data to use. Organise enough joint meetings between all parties to ensure a good and common understanding of the data needs and communication throughout the inventory process. Produce meeting reports explaining the objectives and the conclusions and include a link in the NIR as a reference of these activities. Set up a national inventory management system, that includes the procedural arrangements to produce the inventory in timely manner.

	Set up a National GHG Inventory Management System, that includes legal arrangements for inventory planning, preparation, and management.

5.2.1. Progress towards addressing constraints and gaps

The Bahamas has made progress towards addressing constraints and gaps since submission of its SNC (See Table 143). The identified next steps for the future reporting cycle provide an overview of the outstanding needs for human resource development, research, monitoring and evaluation, technology transfer, and broader domestic MRV system infrastructure development.

Table 143: Progress made from SNC to TNC

Gaps identified in SNC	Progress identified during TNC/BUR1	Identified next steps for future reporting cycle
High Capital Costs/ Lack of access to funding	Scoping and set-up of initial framework for climate finance MRV though the GCF Readiness and Support Programme to improve transparency in reporting and improve chances of climate funding	Building on the outputs of the MRV GCF Readiness project- The Bahamas will continue to address data gaps in financial flows and address barriers outlined in the feasibility study produced as an output.
Lack of Awareness/knowledge and skills	Capacity building activities undertaken by local stakeholders in the fields of GHG inventory, mitigation and MRV	Continuation of planned capacity building within the scope of persons identified for GHG, Mitigation, Adaptation and Finance technical working groups
Availability and Suitability of Technology	Conducting country driven Technology Needs Assessment (TNA) in prioritised sectors	Implement action plan of the TNA based on final outputs (2023 completion)
Applicable laws and regulation to allow for IPPs	-	Conduct analysis of current legislation and policies through CBIT and use recommendation for drafting of new policies that mandate the execution and continuity of climate-

		related institutional arrangements and activities that are internationally binding.
Lack of incentives	-	-
Data gaps in particularly the transport sector	Identified and engaged key stakeholders in the transportation sector, and identified main data sources for improvement	Bottom-up data collection activities through customs, licensing, and fuel providers
Establishing a measurement, reporting and verification (MRV) mitigation system for The Bahamas	Conducted an MRV Assessment during the TNC/BUR1 reporting cycle and indicated prioritised actions to implement an integrated National MRV System comprising all reporting sectors	Set up an integrated National MRV System comprising all reporting sectors, that includes legal arrangements for inventory planning, preparation, and management.
Updating of the information relevant for the reporting on Mitigation actions.	Scoping of potential mitigation actions as well as compilation into a mitigation action database	Improvements in data collection and archiving system to capture historic and current mitigation activities, including a monitoring system for tracking of mitigation actions
Provision of training to build or improve the capacities of the relevant stakeholders to complete all or portions of the research, assessments, studies, inventories, and any other capacities required for reporting requirements taking into consideration the new	Capacity building activities undertaken by local stakeholders in the fields of GHG inventory, mitigation and MRV. Stakeholders were trained not just in technical elements of the reporting requirements but procedural elements as well to increase institutionalised memory of local stakeholders/experts	Continued capacity building training of relevant stakeholders involved in the TNC/BUR1 compilation and review process.

reporting requirements
of the Paris Agreement.

5.2. Technology needs

The Technology Needs Assessment (TNA) is a country-driven process that allows the unique opportunity for Parties to track their needs for new technologies, capacity building, skills, and equipment necessary to reduce the vulnerability of sectors and livelihoods attributed to climate change as well as to mitigate GHG emissions. The assessment facilitates the implementation of prioritised climate technologies as well as sustainable development through a portfolio of environmentally sustainable technology (EST) projects and programmes.

Cognisant of these benefits as well as the support provided through the process to implement a Party's commitment to the Paris Agreement and revision of NDCs (Phase IV), the Government of The Bahamas submitted its endorsement letter to the GEF in October 2019 for inclusion in the latest project phase.

As highlighted in its first NDC, The Bahamas has identified potential adaptation actions in the sectors of agriculture, tourism, health and water resource management as well as the commitment through mitigation actions to reduce its GHG emissions by 30% when compared to its Business as Usual (BAU) scenario by 2030.

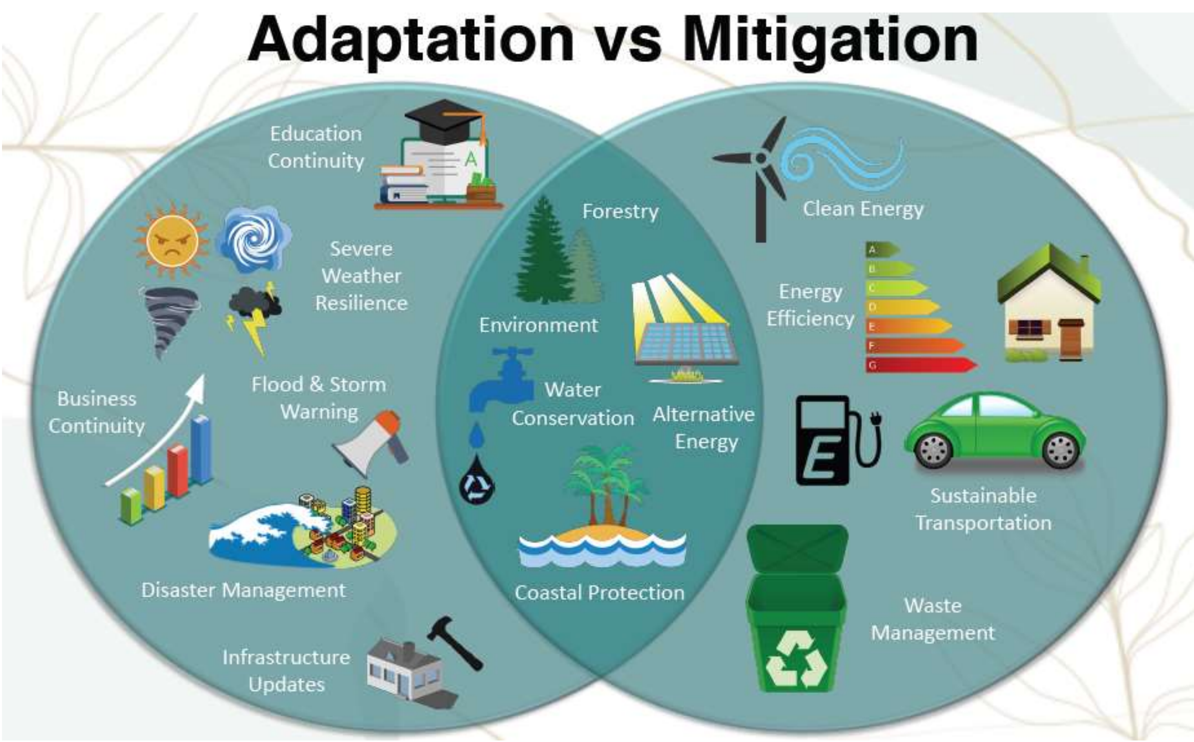
To achieve these goals, The Bahamas will require external support I the forms of investment, finance, capacity building and technology development and transfer in its efforts to prioritise greater implementation of renewable energy sources and to adapt to the negative impacts of climate change. The Bahamas TNA process started in October 2020 and is scheduled to be completed by 2023 with activities being conducted simultaneously with the TNC/BUR1 reporting process.

During the initial activities of the assessment, The Bahamas conducted multi-criteria analysis, reviewed existing planning documents, and engaged stakeholders to prioritise specific sectors to identify technologies for market analysis and eventual inclusion in the National Technology Action Plan (output). Rationale for the chosen sectors as presented by the Bahamas are highlighted in Table 144 and displayed within Figure 56 as an illustration of the integrated nature of intended adaptation and mitigation measures.

Table 144: Rationale for chosen priority areas (as presented during TNA inception workshop)

Identified Priority Area	Rationale
Waste (Mitigation)	One of the largest sources of GHG emissions in the country, probability to increase after climate disasters, need to upscale interventions (especially in an island context)
Forestry (Mitigation)	Significant GHG sink, under threat from climate change and destructive human activities
Meteorology (Adaptation)	Need for accurate forecasting for protection of population and adaptation planning
Education (Adaptation)	Climate change (including disasters) have significantly interrupted the formal education sector, public education and outreach required to enhance climate action

Figure 56: Integrated nature of adaptation and mitigation measures



Through the inception workshop and accompanying stakeholder surveys, The Bahamas formed both adaptation and mitigation working groups that include government public entities, private entities, and academia (gender balanced). Based on SNC submissions, and other key national climate documents, Table 145 through Table 148 are the initial list of technologies under consideration for analysis and review by conducting country interviews and utilizing expert judgement by the aforementioned working groups. It should be noted that due to the stage reached in the assessment process and at the time of writing, the initial lists presented are not exhaustive and may be revised or adapted in future reporting cycles according to the final outputs of the completed TNA process.

Table 145: Initial working group technologies list for Meteorology (Adaptation)

Identified Technology	Specific Name of Technology (If known)	Orgware/Software/Hardware
Coastal Mapping	Lidar Survey	Hardware
Storm Surge Mapping	Lidar Survey	Hardware
Land Survey	Lidar Survey	Hardware
Flood Hazard Mapping	Lidar Survey SLOSH: Sea Lake and Overland Surges from Hurricanes	Hardware
Flood Warning System	-	Orgware
Forecasting and early warning systems	-	Hardware/Orgware
Climate Modelling with Machine Learning/Deep Learning	Python	Software
Climate Forecasting with Machine Learning/Deep Learning	Python	Software
Severe Weather Monitoring and Data Collection	Lightening detector	Hardware/Software
Open water weather monitoring	Fixed weather buoys and drifting weather buoys	Hardware
Air Quality Monitoring	Air pollution Sensor	Hardware
Automatic Weather Stations	-	Hardware/Software
Precipitation Monitoring	Optical and acoustic rain gauge	Hardware
Tide Monitoring	Tide Gauge	Hardware

Table 146: Initial working group technologies list for Education (Adaptation)

Identified Technology	Orgware/Software/Hardware
Trauma Support Programmes	Orgware/Software

Infrastructure Assessment and Upgrades	Orgware/Software
Wireless Network	Orgware/Software
Alternative Energy- Solar	Orgware/Software/Hardware
Rainwater Harvesting and Distribution Systems	Orgware/Software/Hardware
Solar Water Heating	Orgware/Software/Hardware
Curriculum: National adoption of swimming programme	Orgware
Curriculum: Assessment, enhancement of Disaster Preparedness Programme	Orgware/Software
Curriculum: Inclusion of Meteorology, Oceanography, Environmental Studies at undergrad and graduate level	Orgware/Software
Curriculum: Assessment and expansion/enhancement of climate change programmes at the primary and secondary school level	Orgware/Software

Table 147: Initial working group technologies list for waste (Mitigation)

Identified Technology	Orgware/Software/Hardware
Sargassum Seaweed Reuse/Disposal - sustainable Livelihood project	Hardware/Software
Conch Shell Reuse/Disposal - sustainable livelihood project	Hardware/Software
Landfill disposal	Hardware
Waste-energy Technology	Hardware
Waste Incineration	Hardware
Waste Biological Treatment bio-digestor	Hardware
Effluent disposal methods - deep disposal well regulations	Hardware/Software
Alternatives to Cultural Waste Burial/ Open Burn Methods	Software/Orgware
Composting of Organic Waste	Hardware

Table 148: Initial working group technologies list for forestry and other land use (Mitigation)

Identified Technology	Orgware/Software/Hardware
Develop Protection and conservation methods	Orgware/Software
Sustainable Management of the Resources	Software
Forest Restoration Efforts	Hardware/Software
Wood based bio-energy technology	Hardware
Alternative land/property development clearing	Hardware/Software
Tree ordinance/ Replant Initiatives	Orgware/Software
Programme of work relating to ecosystem management	Orgware/Software
National Forestry Estate- Forest Reserves, Protected Forests, and conservation of forests	Software
Sustainable Livelihoods Pilot Projects - indigenous craft industry on Andros and Cascarilla Bark Cultivation/ Processing of Cascarilla Oil in Acklins/ Crooked Islands	Hardware/Software
Management Regime for ecologically important watersheds	Orgware/Software

5.3. Support needed

An assessment and quantification of support needed has not yet been conducted for the prioritized needs identified during the TNC/BUR1 reporting cycle for The Bahamas. Across all areas of climate MRV in The Bahamas, technology transfer, capacity-building, and financial support is needed as soon as possible.

5.4. Support received

As highlighted in the climate finance section of the domestic MRV chapter, The Bahamas through the GCF Readiness and Preparatory Support Programme, engaged in a project to develop a national database system for the MRV of financial investments with specific emphasis on identified actions in the Party’s NDC.

Previous reporting and analysis of relevant climate change documents in The Bahamas indicated that there was no clear indication of climate finance inflows as this data was previously collected on a project-by-project basis in an ad-hoc manner. Priority was given to the following tasks in an effort to track historical data flows and provide a baseline for future climate finance reporting improvements in adherence to the TACCC principles:

- Clear overview of NDC related financial flows, sources, and purposes
- Indication of the recipients of the financial support and identification of data gaps

After extensive analysis of readily available documentation and a data collection mission in-country (inclusive of stakeholder interviews), The Bahamas was able to provide an initial mapping of climate finance recipients, mobilising entities and support received values (USD) for the time period 2010-2020. It should be noted that due to data gaps from stakeholders as well as the need to improve on the outputs of the project, that the information provided in Table 149 **through** Table 152 has not yet been validated and will be improved upon in future reporting cycles. Financial information by year was also not readily available and the project team was not able to disaggregate the total figures for the timeseries on a year-by-year basis.

Table 149 provides the sources of climate funds disaggregated by global and regional support as well as multilateral, bilateral, international NGO, and private sector funding.

Table 149: Sources of climate funding disaggregated by region and type (2010-2020)

Type		Name of Institution
Global	Multilateral	United Nations Development Programme (UNDP) (own funds and GEF funds) United Nations Environment (own funds and GEF and GCF funds) Food and Agriculture Organisation of the United Nations (FAO) International Fund for Agricultural Development (IFAD) World Health Organisation (WHO) through the Pan-American Health Organisation (PAHO) United Nations Industrial Development Organization (UNIDO) World Bank (WB) International Finance Corporation (IFC) World Meteorological Organisation (WMO) Global Environment Facility (GEF) Small Grants Programme (SGP) Bahamas Green Climate Fund (GCF) European Investment Bank (EIB)
		Japanese International Cooperation Agency (JICA)

Type		Name of Institution
Global	Bilateral	German Development Bank (KfW) German Development Agency (GIZ) United Kingdom's Department for International Development (DFID) United States Agency for International Development (USAID) Government of Italy Government of the United Arab Emirates
Global	International NGO	International Union for the Conservation of Nature (IUCN)
Global	Private Sector	US-based foundations Bahamas Chamber of Commerce and Employers' Confederation (BCCEC) Bahamas Hotel and Tourism Association (BHTA) Grand Bahama Power Company St. Georges Cay Power Company Ltd. Bahama Solar Sustainable Energy Ltd. Green Revolution Green Bahamas Company Ltd. Bahamas Energy Solutions Enviro Technologies Ltd.
Regional	Multilateral	Inter-American Development Bank (IDB) Caribbean Development Bank (CDB) Caribbean Community Climate Change Centre (5Cs) (own funds and GCF funds) Caribbean Community (CARICOM) Organization of American States (OAS) Economic Commission for Latin America and the Caribbean (ECLAC)
Regional	International NGO	Inter-American Institute for Cooperation on Agriculture (IICA)

Table 150 provides a summary of the financial inflows based on the disaggregated information available in Table 149. Values for private-sector financing have been removed from global support as there was insufficient information to include in the global support totals with GEF and GCF funds currently accounted for under UNDP and UNEP categorisations.

Table 150: Summary of The Bahamas climate finance inflows (2010-2020)

Sources				
Scale	**Type**	**Sum of Total**	**Sum of Adaptation**	**Sum of Mitigation**
Global	Bilateral	$ -	$ -	$ -
	International NGO	$ 50,000	$ 25,000	$ 25,000
	Multilateral	$ 96,136,919	$ 1,615,311	$ 94,521,609
Global Total		**$ 96,186,919**	**$ 1,640,311**	**$ 94,546,609**
Regional	International NGO	$ 247,911	$ 92,842	$ 155,069
	Multilateral	$ 7,348,754	$ 2,074,655	$ 5,274,100
Regional Total		**$ 7,596,665**	**$ 2,167,496**	**$ 5,429,169**
Domestic	Private sector	**$ 51,249,999**	**$ 10,400,000**	**$ 40,849,999**
Overall Total		**$ 155,033,583**	**$ 14,207,807**	**$ 140,825,777**

Table 151 and Table 152 provide the institutions that mobilise resources from international climate change funds in The Bahamas.

Table 151: Mobilising entities in The Bahamas (2010-2020)

Type of Institution	Name of Institution
Global / Multilateral / United Nations	United Nations Development Programme (UNDP) United Nations Environment Food and Agriculture Organisation of the United Nations (FAO) International Fund for Agricultural Development (IFAD) World Health Organisation (WHO) through the Pan-American Health Organisation (PAHO) United Nations Industrial Development Organization (UNIDO)
Regional	Caribbean Community Climate Change Centre
National	Ministry Of Environment and Housing

Table 152: Financial flows disaggregated by mobilising entity (2010-2020)

Entity Mobilising Funds			
Name of Institution	**Total**	**Adaptation**	**Mitigation**
United Nations Development Programme (UNDP)	$ 9,999,999.00	$ -	$ 9,999,999.00
United Nations Environment	$ 85,296,321.00	$ 800,000.00	$ 84,496,321.00
Food and Agriculture Organisation of the United Nations (FAO)	$ -	$ -	$ -
International Fund for Agricultural Development (IFAD)	$ 1,355.00	$ 1,355.00	$ -
World Health Organisation (WHO) through the Pan-American Health Organisation (PAHO)			$ -
United Nations Industrial Development Organization (UNIDO)	$ -	$ -	$ -
World Meteorological Organisation (WMO)	$ 789,222.00	$ 789,222.00	$ -
Caribbean Community Climate Change Centre (5Cs)	$ 1,163,677.20	$ 1,020,335.80	$ 143,341.40
Ministry of Environment and Housing	$ 56,558,325.00	$ 11,679,162.50	$ 44,879,162.50
Total	$ 153,808,899.20	$ 14,290,075.30	$ 139,518,823.90

5.4.1. Support received for the preparation of BUR1

The Bahamas received multilateral financial support from the GEF in 2019 in the amount of 852,0000 (USD) to develop its first BUR (in addition to its Third National Communication). The funding was administered through the Global Environment Facility (GEF) with the United Nations Environment Programme (UNEP) having the responsibility as the implementing agency, and the Department of Environmental Planning and Protection (formerly known as The Bahamas Environment, Science and Technology (BEST) Commission) serving on behalf of the Government of The Bahamas, as the executing agency. The funding was used to contract the Caribbean Cooperative MRV Hub, Greenhouse Gas Management Institute, SEV Consulting Group, University College London, Factor Integral Services Limited, and two independent consultants. Moreover, the National Project Coordinator and external auditor would have also been contracted with this funding to ensure successful implementation and fiscal management of the BUR1 project.

5.5. Data and information gaps and needs for improvement of reporting

The Government of The Bahamas has prioritised improvements in its climate finance MRV for the next reporting cycle. The financial flow tables presented in this chapter have been presented in an effort to improve transparency in reporting, though the Party is cognisant that more efforts need to be made to comprehensively mapping and validating financial flows to The Bahamas. Furthermore, a list of climate change projects and allocation of support across these projects remains a prioritised improvement for The Bahamas. Improvements in charting public, domestic, international, and private financial flows in The Bahamas is an on-going exercise, noting that understanding these flows facilitates financial planning and resource mobilization to meet The Bahamas' international commitments on climate mitigation and adaptation.

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Annex I - GHG emission tables

Table 153: Total GHG emissions 2001-2010

Categories	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total National Emissions and Removals	5077.85	5157.60	4852.38	4901.25	3640.68	3744.15	3765.39	3832.61	3738.27	5926.03
1 - Energy	2435.21	2512.78	2207.71	2243.39	2407.76	2501.62	2517.49	2583.99	2485.98	2583.91
1.A - Fuel Combustion Activities	2435.20	2512.78	2207.70	2243.38	2407.75	2501.61	2517.48	2583.98	2485.97	2583.90
1.A.1 - Energy Industries	1532.51	1593.82	1217.35	1159.20	1177.49	1223.71	1234.82	1291.91	1200.84	1327.57
1.A.1.a - Main Activity Electricity and Heat Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.a.i - Electricity Generation	1532.51	1593.82	1217.35	1159.20	1177.49	1223.71	1234.82	1291.91	1200.84	1327.57
1.A.1.a.ii - Combined Heat and Power Generation (CHP)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.a.iii - Heat Plants	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.b - Petroleum Refining	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

1.A.1.c.i - Manufacture of Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.c.ii - Other Energy Industries	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2 - Manufacturing Industries and Construction	177.18	188.55	187.28	245.98	290.65	279.34	304.83	283.12	288.83	239.32
1.A.2.a - Iron and Steel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.b - Non-Ferrous Metals	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.c - Chemicals	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.d - Pulp, Paper and Print	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.e - Food Processing, Beverages and Tobacco	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.f - Non-Metallic Minerals	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.g - Transport Equipment	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.h - Machinery	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.i - Mining (excluding fuels) and Quarrying	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.j - Wood and wood products	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.k - Construction	33.42	35.57	35.52	46.65	55.13	52.99	57.82	53.70	54.80	45.41
1.A.2.l - Textile and Leather	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.m - Non-specified Industry	143.76	152.98	151.76	199.33	235.52	226.35	247.01	229.43	234.04	193.91
1.A.3 - Transport	494.45	504.45	562.57	585.06	621.10	634.05	620.64	627.34	641.82	658.85
1.A.3.a - Civil Aviation	75.79	67.53	75.51	81.90	85.55	90.82	80.99	79.90	67.87	69.87

1.A.3.a.ii - Domestic Aviation	75.79	67.53	75.51	81.90	85.55	90.82	80.99	79.90	67.87	69.87
1.A.3.b - Road Transportation	402.93	420.56	479.88	493.39	524.42	532.94	528.10	536.45	563.54	580.58
1.A.3.b.i - Cars	278.29	285.02	345.83	313.91	309.67	326.41	301.26	327.72	349.22	406.55
1.A.3.b.i.1 - Passenger cars with 3-way catalysts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.i.2 - Passenger cars without 3-way catalysts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.ii - Light-duty trucks	83.90	87.60	99.83	102.89	109.50	111.21	110.33	111.95	117.57	120.85
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.iii - Heavy-duty trucks and buses	40.52	47.72	33.93	76.34	105.00	95.05	116.26	96.52	96.47	52.85
1.A.3.b.iv - Motorcycles	0.22	0.23	0.28	0.25	0.25	0.26	0.24	0.26	0.28	0.32
1.A.3.b.v - Evaporative emissions from vehicles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.b.vi - Urea-based catalysts	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.c - Railways	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.d - Water-borne Navigation	15.72	16.35	7.18	9.77	11.13	10.29	11.55	10.99	10.41	8.40

1.A.3.d.i - International water-borne navigation (International bunkers) (1)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.d.ii - Domestic Water-borne Navigation	15.72	16.35	7.18	9.77	11.13	10.29	11.55	10.99	10.41	8.40
1.A.3.e - Other Transportation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.e.i - Pipeline Transport	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.e.ii - Off-road	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
1.A.4 - Other Sectors	231.07	225.96	240.50	253.15	318.51	364.50	357.19	381.60	354.47	358.16
1.A.4.a - Commercial/Institutional	184.82	184.85	198.20	197.87	258.36	305.49	293.81	320.30	297.46	304.43
1.A.4.b - Residential	30.17	23.72	24.98	32.53	33.10	33.05	35.02	35.04	30.03	31.58
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	16.08	17.39	17.32	22.75	27.05	25.97	28.36	26.26	26.98	22.15
1.A.5 - Non-Specified	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B - Fugitive emissions from fuels	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1.B.1 - Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 - Oil and Natural Gas	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1.B.2.a - Oil	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1.B.2.a.iii.3 - Transport	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1.B.2.b - Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

1.B.3 - Other emissions from Energy Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2 - Industrial Processes and Product Use	3.75	8.43	2.84	2.84	3.42	4.17	3.25	3.59	3.09	3.17
2.A - Mineral Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use (6)	3.75	8.43	2.84	2.84	3.42	4.17	3.25	3.59	3.09	3.17
2.D.1 - Lubricant Use	3.75	8.43	2.84	2.84	3.42	4.17	3.25	3.59	3.09	3.17
2.D.2 - Paraffin Wax Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.D.3 - Solvent Use (7)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D.4 - Other (please specify) (3), (8)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E - Electronics Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.G - Other Product Manufacture and Use	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE
2.G.1 - Electrical Equipment	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE

2.G.1.a - Manufacture of Electrical Equipment	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.G.1.b - Use of Electrical Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.G.1.c - Disposal of Electrical Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.G.2 - SF6 and PFCs from Other Product Uses	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.G.3 - N2O from Product Uses	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.G.4 - Other (Please specify) (3)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.H - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	2393.69	2387.17	2388.73	2397.80	967.73	971.70	973.12	968.57	967.69	3052.16
3.A - Livestock	1.93	3.43	2.82	2.94	2.94	2.82	2.89	2.91	2.91	2.96
3.A.1 - Enteric Fermentation	1.36	2.06	1.51	1.59	1.60	1.48	1.53	1.55	1.56	1.60
3.A.2 - Manure Management	0.58	1.37	1.31	1.34	1.34	1.34	1.35	1.35	1.35	1.36
3.B - Land	2377.60	2377.60	2377.60	2377.60	955.66	955.66	955.66	955.66	955.66	3042.82
3.B.1 - Forest land	-930.54	-930.54	-930.54	-930.54	-1341.03	-1341.03	-1341.03	-1341.03	-1341.03	-1059.49
3.B.1.a - Forest land Remaining Forest land	-361.60	-361.60	-361.60	-361.60	-434.70	-434.70	-434.70	-434.70	-434.70	-527.69

3.B.1.b - Land Converted to Forest land	-568.94	-568.94	-568.94	-568.94	-906.32	-906.32	-906.32	-906.32	-906.32	-531.80
3.B.1.b.i - Cropland converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.ii - Grassland converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.iii - Wetlands converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.iv - Settlements converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.v - Other Land converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2 - Cropland	380.16	380.16	380.16	380.16	318.55	318.55	318.55	318.55	318.55	146.16
3.B.2.a - Cropland Remaining Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b - Land Converted to Cropland	380.16	380.16	380.16	380.16	318.55	318.55	318.55	318.55	318.55	146.16
3.B.2.b.i - Forest Land converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.ii - Grassland converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.B.2.b.iii - Wetlands converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.iv - Settlements converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.v - Other Land converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3 - Grassland	1750.81	1750.81	1750.81	1750.81	1053.48	1053.48	1053.48	1053.48	1053.48	2599.54
3.B.3.a - Grassland Remaining Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b - Land Converted to Grassland	1750.81	1750.81	1750.81	1750.81	1053.48	1053.48	1053.48	1053.48	1053.48	2599.54
3.B.3.b.i - Forest Land converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.ii - Cropland converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.iii - Wetlands converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.iv - Settlements converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.v - Other Land converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4 - Wetlands	324.78	324.78	324.78	324.78	302.22	302.22	302.22	302.22	302.22	1103.24

3.B.4.a - Wetlands Remaining Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.a.i - Peatlands remaining peatlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.a.ii - Flooded land remaining flooded land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.b - Land Converted to Wetlands	324.78	324.78	324.78	324.78	302.22	302.22	302.22	302.22	302.22	1103.24
3.B.4.b.i - Land converted for peat extraction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.b.ii - Land converted to flooded land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.b.iii - Land converted to other wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5 - Settlements	819.38	819.38	819.38	819.38	598.61	598.61	598.61	598.61	598.61	217.44
3.B.5.a - Settlements Remaining Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b - Land Converted to Settlements	819.38	819.38	819.38	819.38	598.61	598.61	598.61	598.61	598.61	217.44
3.B.5.b.i - Forest Land converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.B.5.b.ii - Cropland converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.iii - Grassland converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.iv - Wetlands converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.v - Other Land converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6 - Other Land	33.01	33.01	33.01	33.01	23.83	23.83	23.83	23.83	23.83	35.94
3.B.6.a - Other land Remaining Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b - Land Converted to Other land	33.01	33.01	33.01	33.01	23.83	23.83	23.83	23.83	23.83	35.94
3.B.6.b.i - Forest Land converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.ii - Cropland converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.iii - Grassland converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.iv - Wetlands converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.B.6.b.v - Settlements converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C - Aggregate sources and non-CO2 emissions sources on land (2)	14.15	6.14	8.30	17.26	9.13	13.21	14.58	10.01	9.12	6.38
3.C.1 - Emissions from biomass burning	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3.C.2 - Liming	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.3 - Urea application	0.05	0.19	0.15	0.23	0.00	1.68	0.04	0.31	1.15	0.69
3.C.4 - Direct N2O Emissions from managed soils (3)	10.51	4.12	5.79	12.49	6.53	8.33	10.61	6.96	5.65	3.93
3.C.5 - Indirect N2O Emissions from managed soils	3.45	1.40	1.92	4.10	2.16	2.75	3.49	2.31	1.88	1.32
3.C.6 - Indirect N2O Emissions from manure management	0.14	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
3.C.7 - Rice cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.8 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D.1 - Harvested Wood Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D.2 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 - Waste	245.20	249.22	253.11	257.22	261.77	266.67	271.52	276.46	281.51	286.79
4.A - Solid Waste Disposal	205.78	209.13	212.62	216.27	220.07	224.02	228.10	232.32	236.62	240.94

4.B - Biological Treatment of Solid Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.C - Incineration and Open Burning of Waste	1.32	1.34	1.37	1.39	1.42	1.45	1.47	1.50	1.53	1.55
4.C.1 - Waste Incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.C.2 - Open Burning of Waste	1.32	1.34	1.37	1.39	1.42	1.45	1.47	1.50	1.53	1.55
4.D - Wastewater Treatment and Discharge	38.09	38.74	39.12	39.56	40.28	41.20	41.95	42.64	43.37	44.29
4.D.1 - Domestic Wastewaster Treatment and Discharge	38.09	38.74	39.12	39.56	40.28	41.20	41.95	42.64	43.37	44.29
4.D.2 - Industrial Wastewater Treatment and Discharge	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.E - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo Items										
1.A.3.a.i - International aviation (International bunkers)	1080.62	1083.8	519.225	626.017	571.601	755.03	915.785	752.082	615.814	609.6922
1.A.3.d.i - International water-borne navigation (International bunkers)	976.426	979.294	469.16	565.655	516.485	682.228	827.483	679.565	556.436	550.9042

Table 154: Total GHG emissions 2011-2018

Categories	2011	2012	2013	2014	2015	2016	2017	2018
Total National Emissions and Removals	5771.82	5902.51	5941.44	6045.44	6053.83	6063.13	6115.05	6264.31
1 - Energy	2427.07	2553.17	2588.42	2686.94	2752.86	2759.77	2805.72	2949.58
1.A - Fuel Combustion Activities	2427.06	2553.16	2588.41	2686.93	2752.85	2759.76	2805.71	2949.56
1.A.1 - Energy Industries	1300.38	1165.09	1156.89	1291.53	1334.40	1383.86	1363.47	1430.77
1.A.1.a - Main Activity Electricity and Heat Production	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.a.i - Electricity Generation	1300.38	1165.09	1156.89	1291.53	1334.40	1383.86	1363.47	1430.77
1.A.1.a.ii - Combined Heat and Power Generation (CHP)	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.a.iii - Heat Plants	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.b - Petroleum Refining	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	NO	NO	NO	NO	NO	NO	NO	NO

Categories	2011	2012	2013	2014	2015	2016	2017	2018
1.A.1.c.i - Manufacture of Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.c.ii - Other Energy Industries	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2 - Manufacturing Industries and Construction	253.17	365.38	335.03	320.99	327.69	309.69	339.29	350.19
1.A.2.a - Iron and Steel	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.b - Non-Ferrous Metals	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.c - Chemicals	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.d - Pulp, Paper and Print	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.e - Food Processing, Beverages and Tobacco	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.f - Non-Metallic Minerals	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.g - Transport Equipment	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.h - Machinery	NO	NO	NO	NO	NO	NO	NO	NO

Categories	2011	2012	2013	2014	2015	2016	2017	2018
1.A.2.i - Mining (excluding fuels) and Quarrying	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.j - Wood and wood products	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.k - Construction	48.07	69.40	63.66	60.98	62.27	58.85	64.50	66.58
1.A.2.l - Textile and Leather	IE	IE	IE	IE	IE	IE	IE	IE
1.A.2.m - Non-specified Industry	205.10	295.98	271.38	260.02	265.42	250.84	274.79	283.62
1.A.3 - Transport	567.16	681.13	639.38	650.10	675.76	654.90	704.57	727.65
1.A.3.a - Civil Aviation	63.46	66.46	54.11	68.51	72.64	67.34	72.24	74.29
1.A.3.a.ii - Domestic Aviation	63.46	66.46	54.11	68.51	72.64	67.34	72.24	74.29
1.A.3.b - Road Transportation	496.56	605.42	577.62	573.70	596.06	580.96	626.36	647.33
1.A.3.b.i - Cars	309.81	333.26	329.69	337.32	355.73	352.70	375.15	390.52
1.A.3.b.i.1 - Passenger cars with 3-way catalysts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.i.2 - Passenger cars without 3-way catalysts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.ii - Light-duty trucks	103.59	126.56	120.68	119.80	124.44	121.25	130.75	135.12

Categories	2011	2012	2013	2014	2015	2016	2017	2018
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.iii - Heavy-duty trucks and buses	82.91	145.34	126.99	116.31	115.62	106.73	120.15	121.38
1.A.3.b.iv - Motorcycles	0.25	0.27	0.26	0.27	0.28	0.28	0.30	0.31
1.A.3.b.v - Evaporative emissions from vehicles	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.b.vi - Urea-based catalysts	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.c - Railways	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.d - Water-borne Navigation	7.14	9.24	7.66	7.89	7.06	6.60	5.97	6.03
1.A.3.d.i - International water-borne navigation (International bunkers) (1)	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.d.ii - Domestic Water-borne Navigation	7.14	9.24	7.66	7.89	7.06	6.60	5.97	6.03

Categories	2011	2012	2013	2014	2015	2016	2017	2018
1.A.3.e - Other Transportation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.e.i - Pipeline Transport	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.e.ii - Off-road	IE	IE	IE	IE	IE	IE	IE	IE
1.A.4 - Other Sectors	306.36	341.57	457.11	424.32	415.00	411.31	398.38	440.95
1.A.4.a - Commercial/Institutional	252.08	267.35	383.92	351.62	336.62	342.79	325.55	356.71
1.A.4.b - Residential	30.74	40.13	42.08	43.00	48.18	39.80	41.27	51.98
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	23.53	34.09	31.10	29.70	30.19	28.73	31.56	32.27
1.A.5 - Non-Specified	NO	NO	NO	NO	NO	NO	NO	NO
1.B - Fugitive emissions from fuels	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
1.B.1 - Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 - Oil and Natural Gas	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
1.B.2.a - Oil	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
1.B.2.a.iii.3 - Transport	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
1.B.2.b - Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO

Categories	2011	2012	2013	2014	2015	2016	2017	2018
1.B.3 - Other emissions from Energy Production	NO	NO	NO	NO	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NO	NO	NO	NO	NO	NO	NO
2 - Industrial Processes and Product Use	1.42	1.08	1.75	1.00	1.00	1.00	1.17	1.08
2.A - Mineral Industry	NO	NO	NO	NO	NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use (6)	1.42	1.08	1.75	1.00	1.00	1.00	1.17	1.08
2.D.1 - Lubricant Use	1.42	1.08	1.75	1.00	1.00	1.00	1.17	1.08
2.D.2 - Paraffin Wax Use	NE	NE	NE	NE	NE	NE	NE	NE
2.D.3 - Solvent Use (7)	NO	NO	NO	NO	NO	NO	NO	NO
2.D.4 - Other (please specify) (3), (8)	NO	NO	NO	NO	NO	NO	NO	NO
2.E - Electronics Industry	NO	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE	NE	NE	NE	NE	NE	NE	NE

Categories	2011	2012	2013	2014	2015	2016	2017	2018
2.G - Other Product Manufacture and Use	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE
2.G.1 - Electrical Equipment	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE
2.G.1.a - Manufacture of Electrical Equipment	NO	NO	NO	NO	NO	NO	NO	NO
2.G.1.b - Use of Electrical Equipment	NE	NE	NE	NE	NE	NE	NE	NE
2.G.1.c - Disposal of Electrical Equipment	NE	NE	NE	NE	NE	NE	NE	NE
2.G.2 - SF6 and PFCs from Other Product Uses	NO	NO	NO	NO	NO	NO	NO	NO
2.G.3 - N2O from Product Uses	NE	NE	NE	NE	NE	NE	NE	NE
2.G.4 - Other (Please specify) (3)	NO	NO	NO	NO	NO	NO	NO	NO
2.H - Other	NO	NO	NO	NO	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	3051.84	3052.31	3050.36	3052.66	2991.21	2989.65	2991.64	2993.34
3.A - Livestock	2.90	2.96	2.94	3.10	3.01	2.95	3.07	3.14

Categories	2011	2012	2013	2014	2015	2016	2017	2018
3.A.1 - Enteric Fermentation	1.53	1.60	1.55	1.66	1.60	1.54	1.64	1.69
3.A.2 - Manure Management	1.37	1.37	1.38	1.44	1.41	1.41	1.43	1.45
3.B - Land	3042.82	3042.82	3042.82	3042.82	2979.11	2979.11	2979.11	2979.11
3.B.1 - Forest land	-1059.49	-1059.49	-1059.49	-1059.49	-1042.62	-1042.62	-1042.62	-1042.62
3.B.1.a - Forest land Remaining Forest land	-527.69	-527.69	-527.69	-527.69	-503.33	-503.33	-503.33	-503.33
3.B.1.b - Land Converted to Forest land	-531.80	-531.80	-531.80	-531.80	-539.28	-539.28	-539.28	-539.28
3.B.1.b.i - Cropland converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.ii - Grassland converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.iii - Wetlands converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.iv - Settlements converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.v - Other Land converted to Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Categories	2011	2012	2013	2014	2015	2016	2017	2018
3.B.2 - Cropland	146.16	146.16	146.16	146.16	138.31	138.31	138.31	138.31
3.B.2.a - Cropland Remaining Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b - Land Converted to Cropland	146.16	146.16	146.16	146.16	138.31	138.31	138.31	138.31
3.B.2.b.i - Forest Land converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.ii - Grassland converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.iii - Wetlands converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.iv - Settlements converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.v - Other Land converted to Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3 - Grassland	2599.54	2599.54	2599.54	2599.54	2986.35	2986.35	2986.35	2986.35
3.B.3.a - Grassland Remaining Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b - Land Converted to Grassland	2599.54	2599.54	2599.54	2599.54	2986.35	2986.35	2986.35	2986.35

Categories	2011	2012	2013	2014	2015	2016	2017	2018
3.B.3.b.i - Forest Land converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.ii - Cropland converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.iii - Wetlands converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.iv - Settlements converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.v - Other Land converted to Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4 - Wetlands	1103.24	1103.24	1103.24	1103.24	550.03	550.03	550.03	550.03
3.B.4.a - Wetlands Remaining Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.a.i - Peatlands remaining peatlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.a.ii - Flooded land remaining flooded land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.b - Land Converted to Wetlands	1103.24	1103.24	1103.24	1103.24	550.03	550.03	550.03	550.03
3.B.4.b.i - Land converted for peat extraction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Categories	2011	2012	2013	2014	2015	2016	2017	2018
3.B.4.b.ii - Land converted to flooded land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.b.iii - Land converted to other wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5 - Settlements	217.44	217.44	217.44	217.44	304.20	304.20	304.20	304.20
3.B.5.a - Settlements Remaining Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b - Land Converted to Settlements	217.44	217.44	217.44	217.44	304.20	304.20	304.20	304.20
3.B.5.b.i - Forest Land converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.ii - Cropland converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.iii - Grassland converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.iv - Wetlands converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.v - Other Land converted to Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6 - Other Land	35.94	35.94	35.94	35.94	42.83	42.83	42.83	42.83

Categories	2011	2012	2013	2014	2015	2016	2017	2018
3.B.6.a - Other land Remaining Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b - Land Converted to Other land	35.94	35.94	35.94	35.94	42.83	42.83	42.83	42.83
3.B.6.b.i - Forest Land converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.ii - Cropland converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.iii - Grassland converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.iv - Wetlands converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.v - Settlements converted to Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C - Aggregate sources and non-CO2 emissions sources on land (2)	6.12	6.53	4.60	6.74	9.10	7.59	9.47	11.09
3.C.1 - Emissions from biomass burning	NE	NE	NE	NE	NE	NE	NE	NE
3.C.2 - Liming	NO	NO	NO	NO	NO	NO	NO	NO

Categories	2011	2012	2013	2014	2015	2016	2017	2018
3.C.3 - Urea application	0.76	0.15	0.09	0.88	0.49	0.06	0.18	0.11
3.C.4 - Direct N2O Emissions from managed soils (3)	3.67	4.44	3.04	4.04	6.12	5.30	6.64	7.99
3.C.5 - Indirect N2O Emissions from managed soils	1.24	1.49	1.03	1.36	2.03	1.77	2.20	2.65
3.C.6 - Indirect N2O Emissions from manure management	0.46	0.44	0.45	0.46	0.45	0.46	0.45	0.35
3.C.7 - Rice cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.8 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D.1 - Harvested Wood Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D.2 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 - Waste	291.49	295.94	300.90	304.83	308.75	312.71	316.51	320.31
4.A - Solid Waste Disposal	245.20	249.32	253.25	256.98	260.56	264.04	267.46	270.85

Categories	2011	2012	2013	2014	2015	2016	2017	2018
4.B - Biological Treatment of Solid Waste	NO	NO	NO	NO	NO	NO	NO	NO
4.C - Incineration and Open Burning of Waste	1.57	1.59	1.60	1.62	1.63	1.65	1.67	1.68
4.C.1 - Waste Incineration	NO	NO	NO	NO	NO	NO	NO	NO
4.C.2 - Open Burning of Waste	1.57	1.59	1.60	1.62	1.63	1.65	1.67	1.68
4.D - Wastewater Treatment and Discharge	44.72	45.03	46.05	46.23	46.55	47.02	47.38	47.77
4.D.1 - Domestic Wastewaster Treatment and Discharge	44.72	45.03	46.05	46.23	46.55	47.02	47.38	47.77
4.D.2 - Industrial Wastewater Treatment and Discharge	NO	NO	NO	NO	NO	NO	NO	NO
4.E - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
Memo Items								
1.A.3.a.i - International aviation (International bunkers)	682.02	918.05	783.60	698.12	556.18	565.48	632.14	682.47

Categories	2011	2012	2013	2014	2015	2016	2017	2018
1.A.3.d.i - International water-borne navigation (International bunkers)	616.26	829.53	708.04	630.80	502.55	510.95	571.19	616.67

Table 155: GHG emissions in 2018

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)					Emissions (Gg)				Total Emissions
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO2	**CO2 Equivalents (Gg)**
Total National Emissions and Removals	5909.26	11.68	0.12	NE	NE	NE	NE	NE	NE	NE	NE	NE	6264.31

1 - Energy	2928.14	0.38	0.05						NE	NE	NE	NE	2949.58
1.A - Fuel Combustion Activities	2928.12	0.38	0.05						NE	NE	NE	NE	2949.56
1.A.1 - Energy Industries	1426.02	0.06	0.01						NE	NE	NE	NE	1430.77
1.A.1.a.i - Electricity Generation	1426.02	0.06	0.01						NE	NE	NE	NE	1430.77
1.A.2 - Manufacturing Industries and Construction	349.02	0.01	0.00						NE	NE	NE	NE	350.19
1.A.2.k - Construction	66.35	0.00	0.00						NE	NE	NE	NE	66.58
1.A.2.m - Non-specified Industry	282.66	0.01	0.00						NE	NE	NE	NE	283.62
1.A.3 - Transport	711.93	0.24	0.03						NE	NE	NE	NE	727.65
1.A.3.a Aviation	73.72	0.00	0.00						NE	NE	NE	NE	74.29
1.A.3.a.ii - Domestic Aviation	73.72	0.00	0.00						NE	NE	NE	NE	74.29
1.A.3.b - Road Transportation	632.24	0.24	0.03						NE	NE	NE	NE	647.33
1.A.3.b.i - Cars	380.43	0.18	0.02						NE	NE	NE	NE	390.52
1.A.3.b.ii - Light-duty trucks	131.97	0.05	0.01						NE	NE	NE	NE	135.12
1.A.3.b.iii - Heavy-duty trucks and buses	119.52	0.01	0.01						NE	NE	NE	NE	121.38
1.A.3.b.iv - Motorcycles	0.31	0.00	0.00						NE	NE	NE	NE	0.31
1.A.3.c Water-borne Navigation	5.97	0.00	0.00						NE	NE	NE	NE	6.03
1.A.3.d.ii - Domestic Water-borne Navigation	5.97	0.00	0.00						NE	NE	NE	NE	6.03
1.A.4 - Other Sectors	441.16	0.07	0.00						NE	NE	NE	NE	440.95
1.A.4.a - Commercial/Institutional	358.25	0.06	0.00						NE	NE	NE	NE	356.71
1.A.4.b - Residential	50.84	0.01	0.00						NE	NE	NE	NE	51.98

1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	32.06	0.00	0.00						NE	NE	NE	NE	32.27
1.B - Fugitive emissions from fuels	0.02	0.00	0.00						NE	NE	NE	NE	0.02
1.B.2 - Oil and Natural Gas	0.00	0.00	0.00						NE	NE	NE	NE	0.02
1.B.2.a.iii.3 - Transport	0.02	0.00	0.00						NE	NE	NE	NE	0.02
2 - Industrial Processes and Product Use	1.17	0.00	0.00						NE	NE	NE	NE	1.08
2.D - Non-Energy Products from Fuels and Solvent Use	1.17	0.00	0.00						NE	NE	NE	NE	1.08
2.D.1 - Lubricant Use	1.17								NE	NE	NE	NE	1.08
3 - Agriculture, Forestry, and Other Land Use	2979.22	0.08	0.04						NO	NO	NO	NO	2993.34
3.A - Livestock	0.00	0.08	0.00						NO	NO	NO	NO	3.14
3.A.1 - Enteric Fermentation		0.06							NO	NO	NO	NO	1.69
3.A.2 - Manure Management		0.02	0.00						NO	NO	NO	NO	1.45
3.B - Land	2979.11	0.00	0.00						NO	NO	NO	NO	2979.11
3.B.1 - Forest land	-1042.62								NO	NO	NO	NO	-1042.62
3.B.1.a - Forest land Remaining Forest land	-503.33								NO	NO	NO	NO	-503.33
3.B.1.b - Land Converted to Forest land	-539.28								NO	NO	NO	NO	-539.28
3.B.2 - Cropland	138.31								NO	NO	NO	NO	138.31
3.B.2.b - Land Converted to Cropland	138.31								NO	NO	NO	NO	138.31
3.B.3 - Grassland	2986.35								NO	NO	NO	NO	2986.35

3.B.3.b - Land Converted to Grassland	2986.35								NO	NO	NO	NO	2986.35
3.B.4 - Wetlands	550.03		0.00						NO	NO	NO	NO	550.03
3.B.4.b - Land Converted to Wetlands	550.03		0.00						NO	NO	NO	NO	550.03
3.B.5 - Settlements	304.20								NO	NO	NO	NO	304.20
3.B.5.b - Land Converted to Settlements	304.20								NO	NO	NO	NO	304.20
3.B.6 - Other Land	42.83								NO	NO	NO	NO	42.83
3.B.6.b - Land Converted to Other land	42.83								NO	NO	NO	NO	42.83
3.C - Aggregate sources and non-CO2 emissions sources on land	0.11	0.00	0.04						NO	NO	NO	NO	11.09
3.C.1 - Emissions from biomass burning	NE	NE	NE						NE	NE	NE	NE	NE
3.C.2 - Liming	0.00								NO	NO	NO	NO	0.00
3.C.3 - Urea application	0.11								NO	NO	NO	NO	0.11
3.C.4 - Direct N2O Emissions from managed soils			0.03						NO	NO	NO	NO	7.99
3.C.5 - Indirect N2O Emissions from managed soils			0.01						NO	NO	NO	NO	2.65
3.C.6 - Indirect N2O Emissions from manure management			0.00						NO	NO	NO	NO	0.35
3.C.7 - Rice cultivation		NO							NO	NO	NO	NO	NO
3.C.8 - Other (please specify)		NO	NO						NO	NO	NO	NO	NO
3.D - Other	NO	NO	NO						NO	NO	NO	NO	NO

3.D.1 - Harvested Wood Products	NO								NO	NO	NO	NO	NO
3.D.2 - Other (please specify)	NO	NO	NO						NO	NO	NO	NO	NO
4 - Waste	0.74	11.22	0.02						NO	NO	NO	NO	320.31
4.A - Solid Waste Disposal	0.00	9.67	0.00						NO	NO	NO	NO	270.85
4.C - Incineration and Open Burning of Waste	0.74	0.03	0.00						NO	NO	NO	NO	1.68
4.C.2 - Open Burning of Waste	0.74	0.03	0.00						NO	NO	NO	NO	1.68
4.D - Wastewater Treatment and Discharge	0.00	1.52	0.02						NO	NO	NO	NO	47.77
4.D.1 - Domestic Wastewater Treatment and Discharge	0.00	1.52	0.02						NO	NO	NO	NO	47.77
Memo Items													
1.A.3.a.i – International aviation (International bunkers)	677.31	0.00	0.02						NE	NE	NE	NE	682.47
1.A.3.d.i - International water-borne navigation (International bunkers)	610.83	0.06	0.02						NE	NE	NE	NE	616.67

Annex II Institutions and Roles of involved in the Preparation of The Bahamas' NIR

Inventory Phase	Sector	Institution and Contacts	Roles
Planning	Crosscutting	• Department of Environmental Planning and Protection	Coordinating and policymaking authority with respect to environment and climate change in the Bahamas. Overseeing the entire national inventory process from the early stages of data collection through processing and reporting. This includes liaising with data providers, and identifying members of the National Inventory Team and coordinating their capacity building
Data Collection	Energy	• Ministry of the Environment and Housing • Central Bank of the Bahamas • National (reports)	Provides information on GHG emissions associated with electricity generation, national fuel consumption data,

Inventory Phase	Sector	Institution and Contacts	Roles
		• Bahamas Power and Light Company Ltd. • Bahamas National Statistical Institute (reports) • Grand Bahama Power Company • Ministry of Transport and Local Government • Port Department • Ministry of Transport and Local Government (Port Department) • Department of Statistics • Road Traffic Department • Road Traffic Department (Family Islands) • Rubis Bahamas Ltd. • Grand Bahama Port Authority • Bahamas Maritime Authority	energy balance, and vehicle registration data.
	Agricultur e	• Department of Agriculture, Ministry of Agriculture and Marine Resources • Bahamas Agricultural Health and Food Safety Authority • Customs Department (Reports) • Caribbean Agriculture and Research Institute	Provides data and technical support when compiling GHG emissions for agriculture Provides technical support when compiling GHG emissions for land Provides maps for the land sector

Inventory Phase	Sector	Institution and Contacts	Roles
		• Forest and Agriculture Organization (FAO) (reports)	
	Forestry	• Forestry Unit • Bahamas National Trust • Bahamas Reef Environment Educational Foundation (BREEF) • The Nature Conservancy • Perry Institute for Marine Science • University of Bahamas, Climate Change and Adaptation Centre • Forest and Agriculture Organization (FAO) (reports)	
	Waste	• Bahamas Waste Limited • New Providence Ecological Park (NPEP) • The Bahamas Water and Sewerage Corporation • Department of Environmental Health Services • UN Statistics (reports)	Provides information on the waste sector Provides statistical parameters that can be applied when estimating GHG emissions from the waste sector Provides information on the country's wastewater treatment works.

Inventory Phase	Sector	Institution and Contacts	Roles
	Industrial Processes and Product Use	• Ozone Unit, Department of Environmental Health Services (DEHS) • Ministry of Works	Provide GHG information for the IPPU sector, particularly on refrigerants
Preparation	Sectors and Crosscutting	• Caribbean Cooperative MRV Hub Greenhouse Gas Management Institute • Support of National Experts and Data Providers	Provide Capacity to National members of the NIT to take on hands on role in preparation of National Greenhouse Gas Inventories Collecting and evaluating data Selection of methodological approaches Estimation of emissions Assessment of uncertainty and analysis of key categories preparation of inventory report
Quality Control	Crosscutting	• External MRV Hub and GHGMI experts	Review of estimations by experts not involved in the compilation of greenhouse gases

Inventory Phase	Sector	Institution and Contacts	Roles

Quality Assurance/ Review	All Sectors	• Sectoral Experts, and Data Providers including
		• Department of Environmental Planning and Protection
		  ○ Nikita Charles Hamilton
		  ○ Larissa Cartwright
		• Department of Meteorology
		  ○ Jeffrey Simmons
		• University of The Bahamas
		  ○ Dr. George Odhiambo
		• Bahamas Power and Light Company Ltd.
		  ○ Rochelle J McKinney
		  ○ Andrew Bastian
		• Grand Bahama Power Company
		  ○ Garelle Hudson
		• Rubis Bahamas Ltd.
		  ○ Kirk Johnson
		• Department of Agriculture
		  ○ Gina Pierre
		• Forestry Unit
		  ○ Danielle Hanek
		• Bahamas National Trust
		  ○ Giselle Deane
		• The Nature Conservancy
		  ○ Shenique Albury
		  ○ Marcia Musgrove
			Review National Circumstances of methods, approaches and assumptions
			
			Formal and informal technical reviews of National Inventory Report

Inventory Phase	Sector	Institution and Contacts	Roles

		• Department of Environmental Health Services
		  ○ Ryan Perpall
		  ○ Launa Williams
		• New Providence Ecological Park (NPEP)
		  ○ Jamie Strachan
		• The Bahamas Water and Sewerage Corporation
		  ○ John Bowleg	

Validate	Sectors and Crosscutting	• National Climate Change Committee	Provide oversight on the compilation of the report, including reviewing and providing inputs on technical information, in order to ensure the reports reflect the national circumstances. Validates the final NIR before submission to the Cabinet
		• Cabinet	Provides final approval of NIR, BURs, etc. before submission to the UNFCCC
Management	Crosscutting	• Department of Environmental Planning and Protection	Documentation, archiving, reviewing, checking and evaluation of planned improvements and data collected

Inventory Phase	Sector	Institution and Contacts	Roles
			Submission of final report to the UNFCCC Review of necessary inventory improvements and archiving

Annex III Details of the improvement plan

N°	CRF code	Identified issues for Improvements	Recommendations for the actions to be taken	Proposed timeline for implementation	Priority level
G1	n.a.	Set up appropriate institutional, procedural, legal arrangements and documentation for the preparation of the national GHG inventory	In order for the GHG inventory to be sustainable appropriate institutional, procedural, legal arrangements and documentation are needed	2022-2023	High
G2	n.a.	Fully establish and implement QA/QC procedures for the national GHG inventory	QA procedures are to be embedded into the MRV system, while the set of QC procedures should ensure the accuracy of the GHG inventory estimates	2022-2023	High
G3	1.A.1	Quality and completeness of CBB data is unclear	Together with CBB staff, understand how data is collected and whether it covers all relevant activities (e.g., all fuel imports)	2022-2023	High
G4	1.	Develop a national energy balances	Create a Task Force with the national actors related to fuel statistics, to assess the steps to define the institutional, procedural	2023-2025	High

			(including the mechanism to collect information) and legal arrangements to build annual energy balances of The Bahamas, including all populated islands, taking into account national circumstances.		
E1	1.A.1	Data could not be obtained from all fuel distributors	Contact fuel distributors and, in close alignment with the assessment of the CBB data, consider obtaining detailed data annually from fuel distributors where appropriate (avoid double effort with existing customs / CBB data collection)	2022-2023	High
E2	1.A	No country-specific emission factors for fuel consumption available	As the categories 1.A.1.a.i, 1.a.2.m, 1.A.3.b.i-iii, and 1.A.4.a are key categories with regards to CO_2, country-specific emission factors should be developed to allow moving to a Tier 2 approach. As a first step, however, we suggest that the a	2023-2025	Low

			thorough data collection approach is established.		
E3	1.A.1	Incomplete BPL fuel consumption and power generation time series	Collect historic fuel and diesel oil consumption as well as power generation from BPL, GBPC and, if possible, from other smaller power generators on the private islands, ideally back to 2001.	2022-2023	High
E4	1.A.2	Unclear, which activities under manufacture and construction take place	Assess company registers, work with business associations	2022-2023	Mediu m
E5	1.A.3. a	No information on whether aviation gas is also used for international flights and if so, what amounts	Obtain information on fuels sold to airports, from airports themselves or fuels distributors	2022-2023	Mediu m
E6	1.A.3. b	Car registration numbers fluctuate strongly over time	Assess registration data from the transport department, understanding reasons for data fluctuations, improve data where necessary	2022-2023	High
E7	1.A.3. b	Limited information on car population	Assess improved registration data to understand fuel to understand shares of	2022-2023	High

			vehicle types and assess to which extent these fit the IPCC vehicle categories. The motor technologies would also be helpful to understand, but are of lower relevance, as 1.A.3.b is not a key category for N_2O and CH_4.		
E8	1.A.3.b	No information on number of car trips and average distances per trip available	Conduct a study to develop estimates for number of car trips and average distances per trip	2023-2024	Medium
E9	1.A.3.c	No information on fuel consumption for domestic waterborne navigation is available	Assess whether information can be obtained from fuel distributors (potentially as share of fuel consumption reported to the CBB)	2023-2024	Medium
E10	1.A.3.a.i and 1.A.3.c.i	Information on consumption of bunker fuels reported by CBB only as total in TJ, not by fuel type and by area of consumption	Work with CBB and fuel distributors to obtain the consumption of bunker fuels in a disaggregated manner	2022-2023	Medium
I1	2.D	There is no activity data available on non-energy products from fuel and solvent use	Work with customs, industry associations to understand import and use of lubricants, paraffin	2023-2024	Low

		from the use of paraffin waxes and solvents use. Also, lubricant use shows a steep decrease in activity data by over 70% between 2001 and 2018. There is also indication that recollected lubricants are used as fuels under category 1.A.2. Where this was the case, the resulting emissions would have to be reallocated from category 2.D.1 to 1.A.2	waxes and solvents. According to experts lubricants are collected, stored at BPL and treated outside of the Bahamas, so they can be reused. This could potentially explain some of the reduction in lubricant consumption. As GHG emissions from these categories are typically low, these improvements are considered less urgent.		
I2	2.F	Information on the import and consumption of HFCs/ PFCs/SF6 is not available	Work with customs to obtain past import data of HFC and PFC species and of equipment already containing HFCs and PFCs. The National Ozone Office will be able to view future imports of ozone depleting substances through a single window system at the customs which is	2022-2023	High

			currently being implemented. Consider, pesticides / insecticides as a potentially large source of HFC emissions (use as propellant).		
I3	2.F	There is no information on the amount of HFCs/PFCs banked in The Bahamas	Conduct a study together with customs, the National Ozone Officer and the importers/distributors of refrigeration and air conditioning equipment.	2023-2024	High
I4	2.G.	There is no information on the amount of N_2O consumed in The Bahamas	Work with customs to obtain data on N_2O imports and uses. Assess whether N_2O is produced in The Bahamas and production amounts.	2023-2024	Low
I5	2.G.	Experts indicated that at least BPL uses electrical equipment containing SF_6, however such data was not available at the time of the assessment.	Work with BPL and GBPC to understand amounts of SF6 banked and consumption of SF_6 during maintenance (where appropriate). Obtain data on SF_6 imports from customs for validation.	2022-2024	Medium
A1	3.A.1	Livestock data is very limited, not readily available on an annual basis	Work with customs import reports and Agriculture Field officers to collect and validate livestock data	2022-2023	Medium

A2	3.B	Satellite images for 2003 onwards suffer from scan-line error due to failure of on-board scanning instrument resulting in strips of data-gaps. and 2010 contains noise and errors which significantly affects the LULUCF emission estimates for the period 200-2005; 2005-2010 and from 2010-2015	Make plans to establish permanent sampling plots in the main land use categories to improve field training points for land classification map	2022-2023	High
A3	3.B	No country specific emission factors available for land use categories	Categories 3.B.1.a-b, 3.B.2.b, 3.b.3.b, 3.B.4.b and 3.b.5.b are key categories with regards to CO_2. Conduct field survey and measurements to develop country specific emission factors will help improve accuracy of GHG emissions. Generating emission factors for forest, grasslands and wetlands with woody should be made priority.	2022-2024	High

A4	3.B	No digital land use maps available with IPCC land use categories	Conduct training with those with ground knowledge of the country and some GIS expertise will help The Bahamas to calculate emissions for future reporting requirements to produce land use information based on 20 years period	2022-2023	High
A5	3.C.1	Data on biomass burning of crop residues is not available, only anecdotally referenced that 30% of farmers practice slash and burn in the absence of mechanization.	Work with Agriculture Department and field officers to get an appropriate sample of areas where biomass burning occurs to improve non CO_2 emissions estimates.	2022-2023	Medium
A6	3.C.2	Agricultural lime application is not estimated as soils are calcareous, however customs report indicates yearly imports.	Verify with Customs on end usage of lime that is imported, and include this category in the next cycle.	2022-2023	High
A7	3.C.6	Manure management practices of different	Conduct a survey of livestock manure	2022-2023	Medium

		types of livestock is not well documented	management practices to improve accuracy of estimates		
W 1	4.A	There is no information on the depth and size of landfills in The Bahamas, no information on solid waste generation and composition.	Conduct a study assessing waste generation (including from tourism) and composition and providing an overview on the depth and size of landfills in The Bahamas allowing to move to a Tier 2 approach over time. Category 4.A is a key category with regards to CH_4.	2022-2023	High
W 2	4.D	There is no information on industrial wastewater from companies in The Bahamas, no information on solid waste generation and composition.	Map industries, and engage stakeholders early on to provide data, and secure buy-in for wastewater discharge.	2022-2023	High
W 3	4.C	There is anecdotal evidence that open burning of waste takes place in smaller islands of The Bahamas, but no information amounts	Conduct a study assessing open burning practices	2023/2024	Medium

		burned and type of waste burned			
W 4	4.B	There is no information on whether incineration of waste takes place (e.g. in industrial facilities or hospitals)	Approach Bahamas Waste and industry associations about incineration of hazardous and other wastes. Late in the GHG inventory compilation process an expert indicated that Pharmachem in Grand Bahama burn hazardous liquid chemical waste and that other industrial facilities operate smaller incinerators. Conduct a study assessing waste management practices at hospitals	2023/2024	Medium

Annex IV Matching fuels and activities in the energy balance with the IPCC categories

OLADE has prepared an energy balance for the years 2010-2012. The energy balance (EB) presents fuel consumption by activity. These activities mostly show good alignment with the categories of the IPCC 2006 Guidelines. Table 156 shows how the fuels and activities in the energy balance were mapped against the categories in the IPCC 2006 Guidelines. Empty cells in the table indicate that the specific fuel/activity combination did not occur, e.g. there was no firewood consumption in industry.

Table 156: Matching of fuels and activities in the energy balance to the categories in the IPCC 2006 Guidelines

Activity	Fuel consumption							
	Firewood	LPG	Gasoline Alcohol	Jet Fuel Kerosene	Diesel Oil	Fuel Oil	Charcoal	Non-Energy
Power plants	-	-	-	-	1.A.1.a Main electricity and heat production	1.A.1.a Main electricity and heat production	-	-
Self-producers	-	-	-	-	1.A.1.a Main	-	-	-

					electricity and heat production			
Transportation	-	-	1A3b - Road transportation	1A3aii - domestic aviation	1A3b - Road transportation	1A3dii - Domestic water borne navigation	-	-
Industry	-	1A2m - Non-specified industry	1A2m - Non-specified industry	-	1A2m - Non-specified industry	1A2m - Non-specified industry	-	-
Residential	1A4b - residential	1A4b - residential	1A4b - residential	1A4b - residential	1A4b - residential	-	1A4b - residential	-
Commercial, services, public sector	-	1A4A - commercial/institutional	1A4A - commercial/institutional	-	1A4A - commercial/institutional	-	1A4a - commercial/institutional	-

Agriculture, fishing, mining	-	-	1A4c Agriculture/Fishing	-	1A4c Agriculture/Fishing	-	-	-
Construction	-	1A2k - construction	1A2k - construction	-	1A2k - construction	-	-	-

Annex V Land use Change Matrices - 2000 to 2020

The following tables demonstrate the breakdown of land use between individual land use categories for each 5 year interval from 2000-2020.

Table 157: Land use Change Matrix between 2000 and 2005

2000-2005	Area change in ha						Total
	Forestland	**Grassland**	**Cropland**	**Wetland**	**Settlement**	**Other land**	**Area (ha)**
Forestland	174,695	8,047	8,733	6,793	19,478	568	218,313
Grassland	47,850	40,822	30,428	22,554	37,250	1,412	180,315
Cropland	6,885	4,758	16,657	3,040	23,188	1,053	55,581
Wetland	5,075	9,313	2,262	15,502	5,838	11,476	49,465
Settlement	16,586	5,114	15,139	5,311	63,590	7,984	113,724
Other land	355	1,772	470	9,725	6,011	54,111	72,444

Total Area (ha)	251,446	69,826	73,687	62,925	155,354	76,605	689,841

Table 158: Land use Change Matrix between 2005 and 2010

2005-2010	**Area change in ha**						**Total**
	Forestland	**Grassland**	**Cropland**	**Wetland**	**Settlement**	**Other land**	**Area (ha)**
Forestland	210,014	12,259	14,920	8,423	23,650	398	269,664
Grassland	30,242	15,692	19,480	10,124	20,354	7,979	103,871
Cropland	5,230	4,448	16,832	2,244	16,511	547	45,813
Wetland	5,050	31,002	2,201	17,064	4,149	11,787	71,254
Settlement	11,374	4,720	18,796	3,871	59,560	5,424	103,745
Other land	379	667	495	4,841	5,080	43,985	55,447
Total Area (ha)	262,289	68,789	72,723	46,566	129,304	70,121	649,792

Table 159: Land use Change Matrix between 2010 and 2015

2010-2015	**Area change in ha**						**Total**
	Forestland	**Grassland**	**Cropland**	**Wetland**	**Settlement**	**Other land**	**Area (ha)**
Forestland	254,936	6,369	8,558	5,937	21,088	231	297,119

Grassland	71,619	42,578	46,592	30,598	64,678	7,016	263,081
Cropland	2,830	1,227	3,333	1,039	4,948	86	13,463
Wetland	21,927	8,604	1,882	13,051	3,229	4,113	52,805
Settlement	4,391	2,118	7,430	1,271	25,517	2,484	43,212
Other land	373	2,733	744	7,774	7,242	28,451	47,317
Total Area (ha)	356,076	63,629	68,539	59,669	126,702	42,380	716,996

Table 160: Land use Change Matrix between 2015 and 2020

2015-2020	**Area change in ha**						**Total**
	Forestland	**Grassland**	**Cropland**	**Wetland**	**Settlement**	**Other land**	**Area (ha)**
Forestland	243,171	2,424	2,191	14,061	7,288	216	269,351
Grassland	74,795	50,329	7,903	29,760	17,266	10,085	190,138
Cropland	2,506	1,789	2,976	2,569	2,333	33	12,206
Wetland	10,046	11,571	2,445	27,961	824	2,860	55,706
Settlement	5,786	1,516	2,701	749	17,702	1,586	30,040
Other land	372	1,764	65	5,286	2,228	32,929	42,643
Total Area (ha)	336,675	69,393	18,281	80,385	47,641	47,709	600,085

Annex 3

The Second National Communication Report Of

The Commonwealth Of The Bahamas

Under The United Nations Framework Convention On

Climate Change

(UNFCCC)

SEPTEMBER 2014

In numerous statements, speeches, and public pronouncements since becoming a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), The Bahamas has repeated the simple truth that's a small island developing state, our lives, livelihood, and way of life are all threatened by our vulnerability to climate change. The consequences of extreme weather and more frequent tropical processes are evident across the entire archipelago. None of our islands has been spared flooding, a more variable climate, coastal erosion, and the invasion of the alien lionfish (linked to Hurricane Andrew that devastated The Bahamas in 1992).

The Bahamas, surrounded by shallow seas, is indeed a unique ecosystem with more than 80% of its land within one meter of mean sea level. Geologically, the evidence found in our many blue holes and in stalactites and stalagmites chronicles the historic and dynamic rise and fall in mean sea levels. In fact, conditions that we now experience, including one-foot rise in the mean sea level since the beginning of this century, is unprecedented in human history.

The Bahamas has responded to the adverse impacts of climate change and extreme events. We have been constrained to relocate a Family Island community from the shoreline. Further to that, we have built new and strengthened existing coastal defenses; made our tbuilding codes more robust to mitigate against increase wind loadings; and adapted to a loss of freshwater by employing reverse osmosis facilities throughout our islands to provide access to potable water.

All of our achievements have derived from the use of national resources. Adaptation, of course, has come at an additional cost to the economy. For example, reverse osmosis technologies have increased dependence on technologies not available nationally while increasing our carbon emissions.

The Second National Communication of The Bahamas sets out our efforts to meet obligations to the UNFCCC. This report fulfills our commitment under Article 12 of the Convention; however, we have taken considerable action to reduce Climate Change. These actions include:

- Formalising a National Energy Policy that sets a target to achieve a minimum of 30% renewables in the country's energy mix by 2033;
- Joining the Carbon War Room "Ten Island Challenge" to deploy 20 MW of utility scale PV installations;
- Amending legislation to promote the use of alternative sources of energy and grid-tie connected systems;
- Adjusting our tax regime to encourage the deployment of energy efficient appliances, solar water heaters and photovoltaic systems;
- Phasing out the importation of incandescent light bulbs and increased the adoption of CFL and LED lights;
- Increasing fiscal incentives to foster the rapid deployment of fuel efficient and hybrid vehicles;
- Expanding the Marine Protected Area network to 10% of nearshore and marine environment; and
- Improving the fuel efficiency of our national airline.

Notwithstanding present strides and realities, with forty years of Public Service and a genuine love for our environment, I am not satisfied that I have witnessed an urgent enough global response to climate change. We must keep the global rise in temperature below 1.5C for our very survival...literally! I look forward to our collective and individual actions to ensure that no Small Island Developing State (SIDS) is left behind in accordance with Sustainable Development Goals (SDGs) and the SAMOA Pathway for SIDS.

Rt. Hon. Perry Gladstone Christie, M.P.
Prime Minister
The Commonwealth of The Bahamas

THE SECOND NATIONAL COMMUNICATION OF THE COMMONWEALTH OF THE BAHAMAS UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

SEPTEMBER 2014

The Bahamas Second National Communication to the UNFCCC dated September 2014 is presented in accordance with the UNFCCC Guidelines for the preparation of national communications from Parties not included in annex 1 to the Convention as contained in decision 17/CP.8. The time lines for various sections of the report are based on those guidelines and projections for example used in BahamasSimClim use time scales to the year 2050 for illustrative purposes. All other data and information is presented in the time periods specified in the guidelines. “

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EXECUTIVE SUMMARY

NATIONAL CIRCUMSTANCES

The Commonwealth of The Bahamas is an archipelago of 700 islands and more than 200 cays, islets and rocks in the western Atlantic Ocean (lat. 21° and 27° N and long. 72° and 79° W) covering over 100,000 square miles (mi^2) or 260,000 square kilometres (km^2) of ocean between. Thirty islands and cays are permanently inhabited.

The total land area is 5,382 mi^2 (13,943 km^2) stretching from the northwest tip of Grand Bahama Island to the southeast coast of Inagua Island (approx. 550 miles (mi) / 880 kilometres (km)). The Bahamas Platform extends from the coast of Florida to the island of Hispaniola (840 miles (1,335 km)). Table 1 summarizes key information relating to the national circumstances of The Bahamas.

Daily maximum temperatures may reach 96°F (36°C) and night time temperatures may fall as low as 41°F (5°C) during winter in northern islands. Mean daily temperatures generally lie between 60°F and 90°F (17°C and 32°C). In the summer temperatures usually fall to 78°F (25°C) or less at night and seldom rise above 90°F (32°C) during the day (Fig. 1).

Average Monthly Maximum and Minimum Termperatures for New Providence

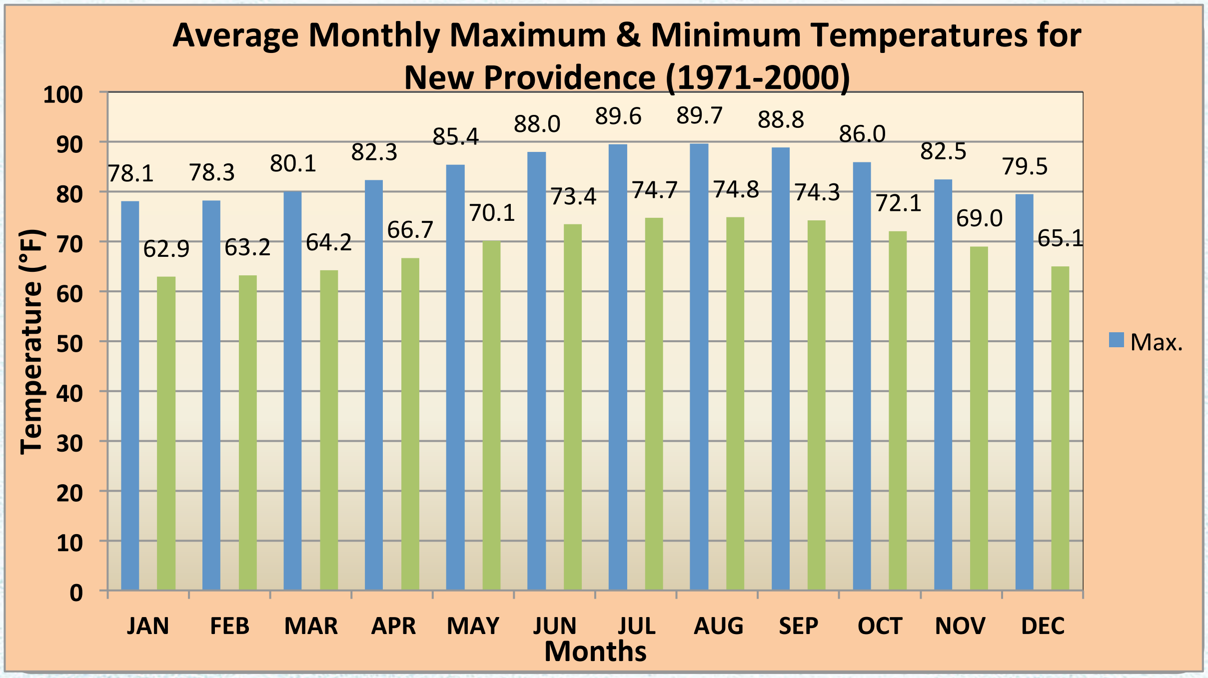


Fig. 1: Average monthly maximum and minimum termperatures for New Providence (1971 – 2000)

Rainy months are May to October. In New Providence, rainfall averages 2 inches (5.1 cm) a month from November to April and 6 inches (15 cm) a month from May to October. The northern islands of The Bahamas receive 20% or more rainfall than New Providence. On the other hand, the southern islands receive half of the total rainfall in New Providence.

Summary of National Circumstances

CRITERIA	2010
Population (2010 Census)	351,461
Relevant area Total (km^2)	13,943
Land area (km^2)	10,070
GDP at current market price	US$ 8.552 billion (2010 estimate)
GDP per capita at current market price (2010)	USD24,279
Share of industry in GDP (%)	14.7
Share of services in GDP (%)	84.1 (2001)
Share of agriculture in GDP (%)	1.2
Urban population as % of total population	83.9 (2009)
Total labour force (2009)	184,000
Percentage of workforce unemployed (%)	7.6
Population in absolute poverty (% 2004)	9.3
Life Expectancy at birth (years)	73 (2007)

Table 1: Summary of state of the nation. *Source: Central Bank of The Bahamas*

Tropical Storms and Hurricanes

The Atlantic Hurricane Season (June 1 to November 30) produces several hurricanes each year to necessitate warnings and alerts in The Bahamas. Since 2000, six major hurricanes have made landfall in The Bahamas or significantly impacted the islands. Tropical storms and hurricanes[1] most frequently occur in the months of September, October, August and November. Abaco and Grand Bahama had the greatest number of hurricanes with a frequency of 40 in every 4 years during 1944 and 2010 period. The island of Abaco is considered “Hurricane Capital of the Caribbean” based on the number of hurricanes between 1851 and 2010.

[1] Based on storms and hurricanes whose centre passed within 100 mi (160 km) of The Bahamas from 1871 to 1999 (129 seasons).

HISTORY, GOVERNMENT AND POPULATION

The Bahamas gained independence from England on July 10, 1973, and is now considered a small island state within the Commonwealth of Nations (formerly the British Empire).

Head of State (Queen of England) is represented by the Governor-General and the Government comprises the Executive with the Prime Minister, the Attorney-General and at least seven other members. The other Cabinet Ministers and Ministers of State are responsible for running their Government ministries. The Legislature is a two-chamber system based on the Westminster model, with a House of Assembly and a Senate. There are currently 25 constituencies in Nassau and 16 in the Family Islands totalling 41 House seats. Local Government is made up of 23 Local Government districts.

The population of The Bahamas was 351,461 in 2010. 246,329 (70%) live on the Island of New Providence while Grand Bahama has a population of 51,368 (14.6%). Data from the past three censuses indicate that the national population had an average growth rate of 2.2% per year over 30 years (1980 – 2010) and 1.9% between 1990 and 2010. In 2010 the highest percentage of the population in The Bahamas was less than 40 years old. A significant proportion of the population was20 years or less making The Bahamas a large young population.

There were 306 deaths in The Bahamas during 2013. The ten leading causes of death in The Bahamas during the 2006-2009 period include hypertension (688), ischemic heart disease (605), HIV (566), cerebrovascular disease (517), diabetes (399) and assault (homicide). (Bahamas 2013 http://www.paho.org/saludenlasamericas/).

ECONOMY

Tourism is the mainstay of the Bahamian economy and the financial services sector is the second largest contributor to the gross domestic product (GDP). The GDP in Current Prices for 2012 had a positive growth of 3.5%, while GDP in Constant Prices grew at 1.83%. The hotel and restaurant expenditure in 2012 was $983.11 million. Tourism employs directly or indirectly approximately 50% of the Bahamian population. Dependence on the tourism sector makes The Bahamas vulnerable to changes in the global economy. For example the global economic crisis of 2008-2009 resulted in thousands of lay-offs from hotels, resorts and guest service businesses throughout The Bahamas. The national per capita income for the year 2008 was $ 24,279 (2008 estimate). Banking and financial services include numerous offshore banks, which make gains through foreign exchange. Game and sport fish include amberjack, bonefish, dolphin, blue marlin (the national fish), white marlin, sailfish, swordfish, tuna, and wahoo. The total fisheries catch for the year 2007 was valued at B$80.3 million dollars. Coral reefs protect the island coastlines against erosion and storm action and studies by Burke and Maidens (2004) indicate that about 30% of the 4,000 mi^2 (10,300 km^2) of coral reef is under threat from overfishing and coastal impacts.

Agriculture is often focused on a small number of native and introduced fruit species. Approximately 90% of food consumed is imported, and includes all sugar, virtually all dairy products and most carbohydrate foods. Waste management is often carried out through an area designated (officially or unofficially) as a dumpsite. The Environmental Health Services Act of 1987 provides regulations, penalties and provisions for remediation of pollution emission into the environment. The primary source of energy for electricity generation, transportation and domestic use is the combustion of imported fossil fuels. Gasoline and diesel oil are used for transportation while liquefied petroleum gas (LPG) is used for cooking. Brewing, distillation and furniture production represent the growing industries in New Providence while chemical and pharmaceutical manufacture is currently present in Grand Bahama. Mining of rock and limestone sand are restricted by the regulations established in the Conservation and Protection of the Physical Landscape of The Bahamas Act of 1997.

The Ministry of Health holds responsibilities in human physical and mental health and manages two major hospitals and numerous public clinics. Vector–borne diseases represent a health and an economic threat to The Bahamas through incidences of dengue, malaria, and yellow fever. The Bahamas had 365 (1998), 155 (2003) and 3,500 (2011) confirmed cases of dengue fever.

The Bahamas' ship registry is among the three largest ship registry centres in the world. More than 1,600 ships were registered in The Bahamas in 1995.

ENVIRONMENT

The establishment of The Bahamas Environment, Science and Technology (BEST) Commission in 1994 and the Conservation and Protection of the Physical Landscape Act of 1997 made way for increased conservation action and use of scientific data in management decisions relating to the environment. The BEST Commission has been mandated to: advise Government on the environmental implications of development proposals; coordinate policies and programs for environmental protection and responses to the international environmental conventions to which The Bahamas is a party; foster development of science and technology; develop a national conservation strategy and action plan; propose legislation to support the national conservation strategy and plan; prepare an inventory of natural resources; and develop a national system of parks, protected areas and reserves, to provide for in situ conservation of inventoried resources.

The biodiversity of The Bahamas has been described by the BEST Commission in The Bahamas Country Study Report (1995) and other issues pertaining to the prevention of biodiversity loss are contained in the National Biodiversity Strategy and Action Plan (NBSAP). The Government has committed to protecting 20% of all near shore marine resources by the year 2020 through the Caribbean Challenge. In addition to national efforts to wisely manage its environment, the Government of The Bahamas has endorsed and/or ratified 35 International Legal Instruments on the Environment.

The Bahamas has a long history of land use, land use changes and forestry dating back to the 1700s. The country possesses substantial natural forest resources comprising of pine forests, coppice hardwoods and mangrove forests. Approximately 80% of forest resources are found on state lands (Crown land) and the remaining 20% on private lands. Under the Forestry Act 2010, a Forestry Unit, headed by a Director of Forestry, was established within the Ministry of the Environment administer, manage and develop forests.

NATIONAL GREENHOUSE GAS INVENTORY

Greenhouse Gas (GHG) emissions and their removal have been calculated for the year 2000 in accordance with the UNFCCC guidelines on the preparation of national communications from non-Annex I Parties. Accessing and retrieving data collected for statistical purposes was challenging because of the rules of the sector. Moreover, a statistical survey was required to collate and verify existing data.

The Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC) was used to produce the national inventory of greenhouse gases.

GHG emissions were mainly from imported liquid fossil fuels consisting of gasoline, jet, gas and diesel oil and liquefied petroleum products such as liquefied propane gas (LPF) and lubricants. Figure 2 provides a trend for petroleum imports.

Trend of Petroleum Imports from 1990-2000

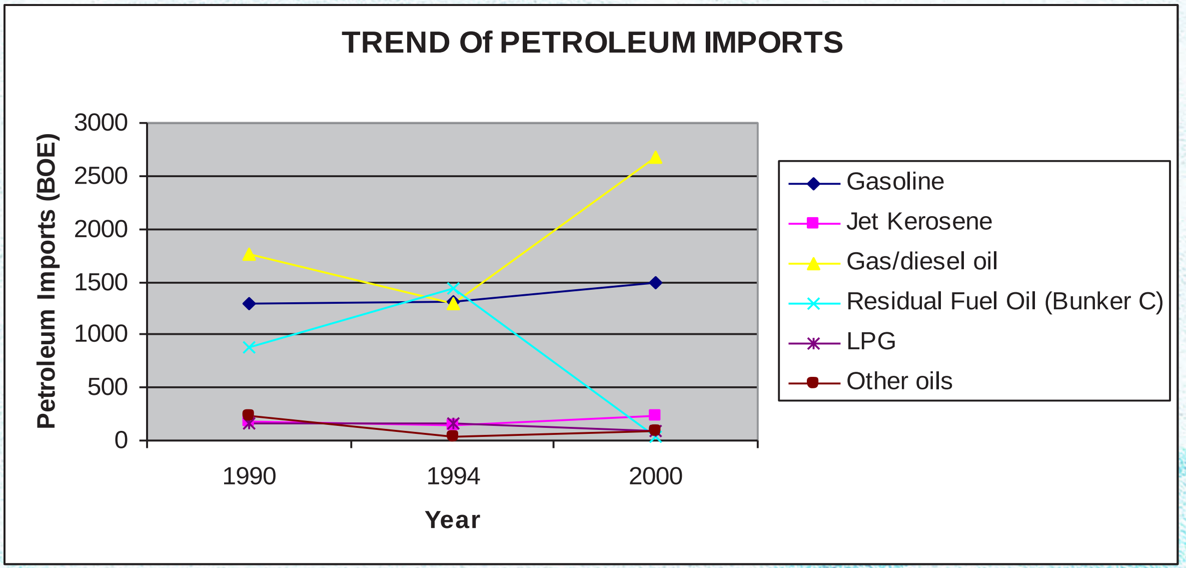


Figure 2: Trend of Petroleum Imports Reported between 1990-2000

The inventory found that electricity generation and the transportation sector are the two most significant sources of greenhouse gas emissions. Fuels exported through The Bahamas are international marine and air bunkering fuels and fossil fuel from storage and transmission. Therefore, bunker fuel totals are not included in the national total.

SUMMARY OF GHG EMISSIONS

A tabular summary of emissions by gas is presented in Table 2 below. From the table, the most significant GHG for The Bahamas is CO_2 emissions.

Summary of Gas Emissions in 2000

Emissions by Gas	**Gg**	**GWP**	**CO_2 Eq.**	**Tonnes CO_2**
CO_2 Emissions				
Energy	660.4448	1	660.4448	660,444.81
LUCF onsite burning of forests	4.35	1	4.3500	4,350.00
Methane Emissions	**Gg Gas**			
Livestock	0.233737	21	4.9085	4,908.49
Solid Waste	0.06940	21	1.4574	1,457.39
Comm/Industrial Wastewater	0.002675	21	0.0562	56.17
Wastewater and Sludge	0.054368	21	1.1417	1,141.73
LUCF on site burning of forests	0.500000	21	10.5000	10,500.00
N2O Emissions	**Gg Gas**			
Animal Waste Mgmt Systems	0.00115	310	0.3573	357.25
Grazing Animals	0.00387	310	1.2008	1,200.81
Agricultural Soils	0.00539	310	1.6705	1,670.46
Leaching	0.03414	310	10.5837	10,583.68
Human Sewage	0.01969	310	6.1054	6,105.39
LUCF	0.00013	310	0.0415	41.54
NO Emissions	**Gg Gas**			
LUCF onsite burning of forests	0.12000			
NMVOC Emissions	**Gg Gas**			
Fugitive Emissions	2.312			
Road Surfacing	0.17349			

Table 2: Summary of Emissions in 2000

Emissions from the Energy sector totaled some 660.48 Gg of CO_2 Equivalent. In 1994, some 85% of all diesel/ gas oil was used in power generation. In 2000, this figure dropped to 52%. This represents a rapidly increasing contribution of the transport sector to the GHG emissions, as well as, a movement away from the more expensive gas/oil for electricity generation. The CO_2 emissions produced from the consumption of fossil fuels for public electricity production totaled some 37.1% of the total CO_2 emissions. Fugitive Emissions were derived from the 3,287 metric tons of fuel stored on an annual basis and transshipped outside The Bahamas. A single facility *(South Riding Point Holding Ltd.)* represents the primary source of fugitive emissions in The Bahamas estimated at 2.3 Gg of non-methane volatile organic compounds (NMVOC). CO_2 emissions from International bunkers indicate that CO_2 emissions from the aviation and marine bunkers accounted for 881.86 Gg CO_2 and 791.15 Gg of CO_2 respectively.

Emissions from Waste contributed 11.1 Gg of CH_4 emissions while solid waste contributed more than 171,270,000 tonnes of municipal solid waste annually. New Providence Island contributed 77% to this total; Grand Bahama 17% and 6% was contributed by the other Family Islands.

The Industrial processes sector is small. It does not contribute significantly to the national emissions with 0.0562 Gg CO_2 equivalent emissions from commercial and industrial wastewater. The LUCF sector records net emissions of 1513.67 Gg of CO_2 and trace gases of 0.12 Gg of CO_2. The sector has recorded removals in the amount of 4159.61 Gg of CO_2.

Emissions from the Agriculture Sector showed 0.23 Gg of CH_4 emissions from Enteric Fermentation. Emissions of N_2O from Domestic Livestock were less than 1/100 of a Gg per year. Direct Emissions of N_2O from Agricultural Fields excluding cultivation of Histosols was estimated at 0.01 Gg per year. Emissions of Nitrous Oxide (N_20) from grazing animals pasture range and paddock was less than 1/100 of a Gg per year. Indirect emissions of Nitrous oxide (N_2O) from atmospheric deposition of NH_3 and NO_x were less than 0.01 Gg. Indirect N_2O emission from leaching was 0.03 Gg.

CLIMATE CHANGE MITIGATION

The Government of The Bahamas is committed to the following National Energy Vision: "The Bahamas will become a world leader in the development and implementation of sustainable energy opportunities, by aggressively re-engineering our legislative, regulatory, and institutional frameworks; retooling our human resources; and implementing a diverse range of well researched and regulated, environmentally sensitive and sustainable energy programmes and initiatives, built upon our geographical (both proximity and diversity), climatic (sun, wind, and sea) and traditional economic strengths (tourism and banking)."[2] Given this commitment the focus of the policies and measures is to target a lower dependence on imported oil, including a reduction in energy demand due to energy efficiency measures of 30% relative to a business-as-usual scenario by 2030 and an increase in share of renewable energies in electricity generation of at least 15% by 2020 and 30% by 2030.

A scenario analysis was conducted using the Long-range Energy Alternatives Planning system (LEAP)[3] for the energy sector to quantify energy demand and supply, greenhouse gas emissions and costs across four specific measures in the energy sector over the time period of

[2] NEPC report p.4 http://www.best.bs/Webdocs/NEPC_2ndReport_FINAL.pdf (exact text).
[3] LEAP, developed by the Stockholm Environment Institute, www.sei-international.org; software distributed through the COMMEND website: www.energycommunity.org.

2010 to 2030. The non-energy sector and transportation measures and the costs associated with each measure were considered outside the scope of this assessment.

The analysis included a historical energy demand and supply in The Bahamas from 2000 to 2009. It also encompassed one baseline scenario of how a particular energy system might evolve over a time period of 2010 to 2030 in the absence of additional policies or measures. The baseline scenario includes demand projections for electricity and petroleum products within five sectors: households, commerce, industry, hotels and transport.

Energy consumption in The Bahamas is dominated by the household, commerce and transport sectors. Measures have been included in the mitigation scenario to target reductions in demand in the household, commerce, industry and hotel sectors (See Figure 3). All data points from 2000-2009 are historical values. Projections begin in 2010.

Energy and Electricity Demands by Sector

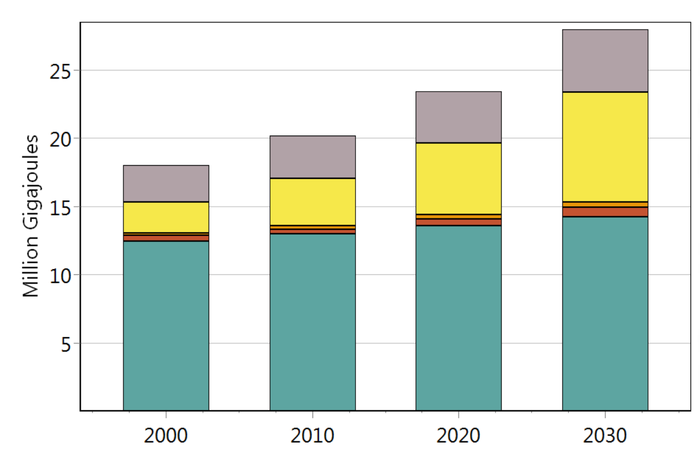


Figure 3: Total energy demand by sector, baseline scenario [Million Gigajoules]

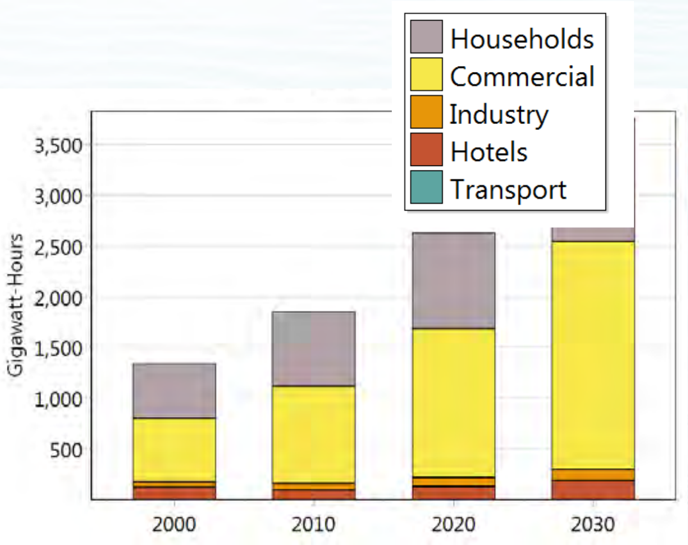


Figure 4: Total electricity demand by sector, baseline scenario [Gigawatt-hours]

The household sector is dominated by electricity consumption (See Figure 4), and that is assumed to increase as electric devices replace the use of kerosene and propane. Total energy consumption was projected forward to the year 2030 using total population projections of a growth rate of about 0.94% per year from 2010 to 2030 and historical trends of per capita consumption by fuel based on an assumption of 0.89% annual growth. In the commercial sector, GDP is expected to grow at a rate of 1.3% per year and energy consumption per unit of GDP is expected to increase at a 3.0% annual rate. As with the commercial sector, industrial sector GDP was assumed to grow 2.7% every year and electricity consumption per unit of GDP was assumed to be constant due to a lack of consistent trend in historical data. The hotel sector was assumed to consume electricity at a rate of 3.6% every year. The electricity consumption per unit of GDP was assumed to be constant due to a lack of consistent historical trends. The transport sector consumes a combination of various petroleum products. Total consumption was projected forward based on trends in transportation GDP, which was assumed to grow at 3.3% per year. Historical fuel consumption is assumed to decrease at 2.8% per year.

Electric Capacity Expansion - Baseline Scenario

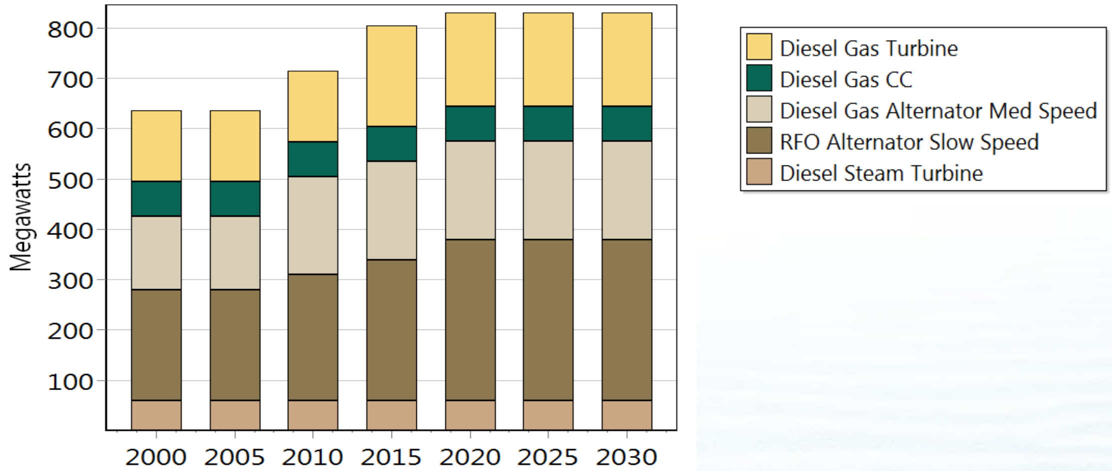


Figure 5: Capacity expansion, baseline scenario [MW]

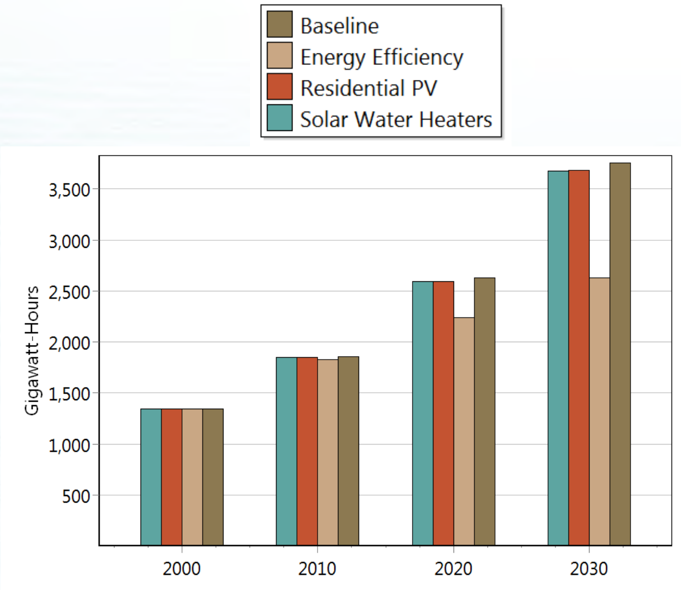
Electricity generation capacity includes all future power plants built according to utility expansion and retirement plans and include mainly diesel and residual fuel oil gas turbines and alternators. [4] Figure 5 shows the plans for the installations of new power plants in MW.

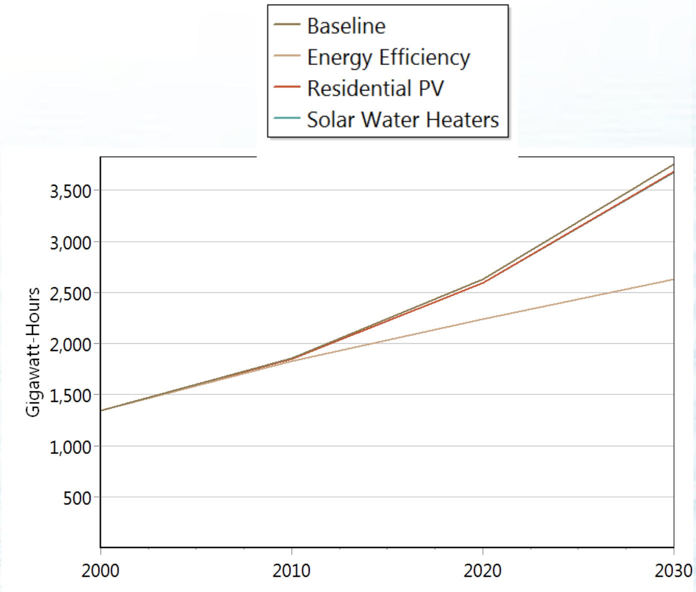
A mitigation scenario follows the same basic approach as the baseline, and includes the same historical data up to the year 2009. It consists of four components: (1) *Rooftop Solar Thermal Hot Water Heaters Replacing Electric Hot Water Heaters In Residential Homes* (assuming that 100% of the hot water demand could be met by solar thermal by 2030); (2) *Distributed PV Generation In Residential Homes* (assuming that 100% of household photovoltaic (PV) potential could be achieved by 2030); (3) *Energy Efficiency Measures (*assuming that all other energy efficiency measures would amount to a 30% reduction in electricity demand compared to the baseline by 2030); and (4) *New Renewable Generation Mix* (assuming that renewable power plants would be introduced to allow for 15% renewable generation by 2020 and 30% renewable generation by 2030). The first three scenarios are demand-side measures and the fourth is a supply-side measure.

[4] CC = combined cycle power plant; RFO = residual fuel oil.

A combination of these measures (and many others) is assumed to collectively be able to reduce electricity consumption in 2030 by 30% compared to the baseline scenario. This measure has the greatest electricity reduction potential of the demand-side policies when compared with the baseline scenario, as can be seen in Figures 6 and 7 below.

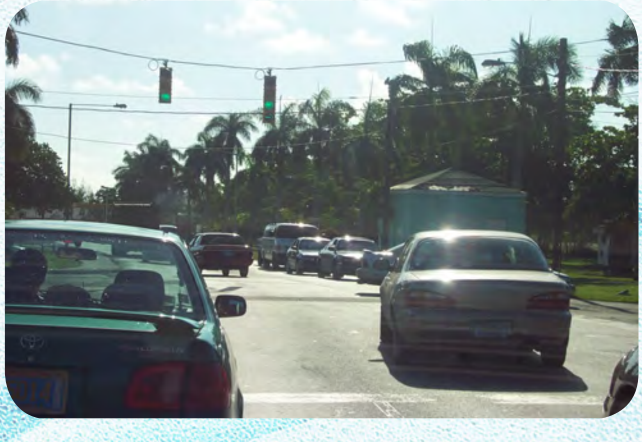
Electricity Consumption For Three Demand-side Policies As Compared With The Baseline Scenario





Figures 6 and 7: Total electricity consumption for three demand-side policies as compared with the baseline scenario [Gigawatt-hours][5]

Of the five technologies (Table 3 below) biomass shows the most promise to provide near-term electricity production potential in The Bahamas. The 15 Megawatt waste to energy power plant is being considered both for electricity generation purposes and also for waste management purposes. The ocean thermal electric conversion (OTEC) systems considered are expected to be a viable technology option for The Bahamas by 2030.



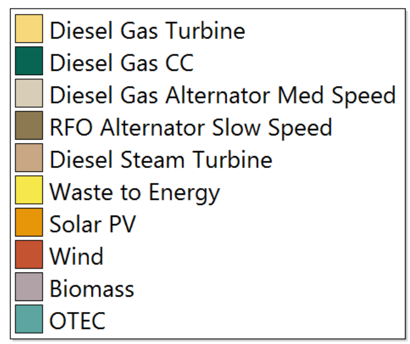
[5] The Residential PV measure and the Solar Water Heater measure have very similar reductions, and therefore the line for solar water heaters cannot be seen in Figure 8.

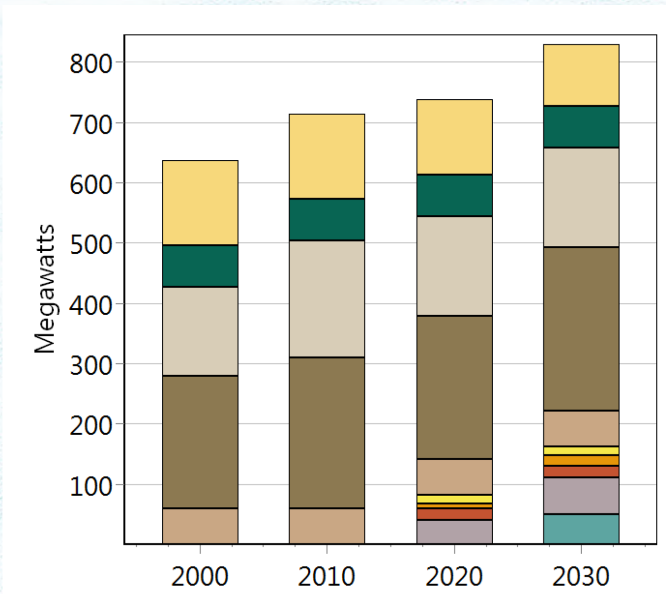
Renewable Electricity Generating Capacity and Generation In 2030, Mitigation Scenario

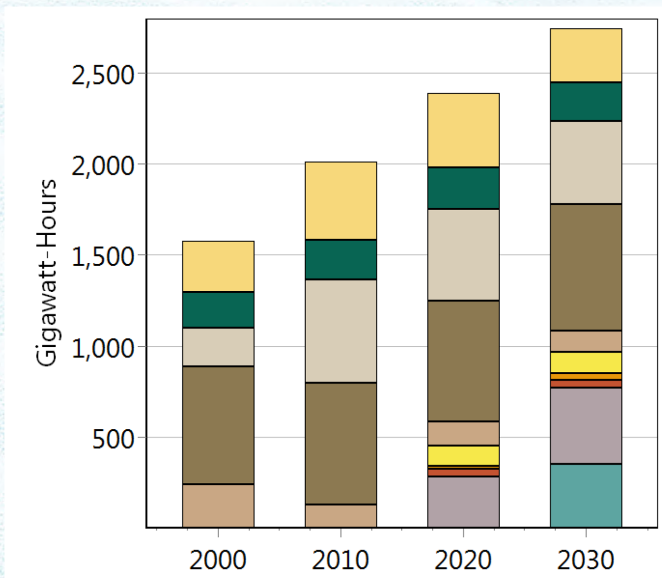
Technology	Capacity [MW]	Generation [GWh]
Biomass	60	1510
Waste to Energy	15	400
Solar PV	17	130
Wind	20	150
OTEC	50	1250

Table 3: Renewable electricity generating capacity and generation in 2030, mitigation

Capacity expansion and electricity output by technology, mitigation scenario







Figures 8 and 9: Capacity expansion [MW] and electricity output [GWh] by technology, mitigation scenario

Figures 8 and 9 show the addition of renewable energy to the national electric grid capacity in an overall electricity generation. Biomass, OTEC and waste to energy are base load plants, and can generate more electricity than wind and solar energy per unit of capacity.

RESULTS

Solar hot water heaters and residential PV policies are able to reduce household electricity demand by 6% and 5%, respectively in 2030. The energy efficiency scenario reduces electricity demand across all sectors by 30% in 2030. Total electricity demand reductions in the mitigation scenario amount to over 1200 Gigawatt-hours, approximately 34% of the baseline electricity consumption in 2030. Table 4 below included overall GHG savings from each policy measure included in the mitigation scenario. The energy efficiency and renewable grid electricity measures provide the majority of the savings. These measures mainly displace residual fuel oil and diesel fuel from electricity generation.

Electricity Demand and GHG Emission Savings in 2030 Based on Explored Policies and Comprehensive Mitigation Scenario

Policy/Measure	Electricity Demand Savings [GWh]	GHG Emission Savings [kT CO_2e]
Solar Hot Water Heaters	75	69
Residential PV	69	64
Energy Efficiency	1125	1032
Renewable Generation	0	843
Mitigation	**1269**	**1988**

Table 4: Electricity demand and GHG emission savings in 2030 based on individual policies explored and the comprehensive mitigation scenario

Figure 10 shows the dynamic reductions in electricity demand over time based on the three demand-side mitigation policies included in the mitigation scenario. The dotted white bar represents the avoided demand.

Avoided Electricity Demand in Mitigation Scenario Compared with Baseline Scenario

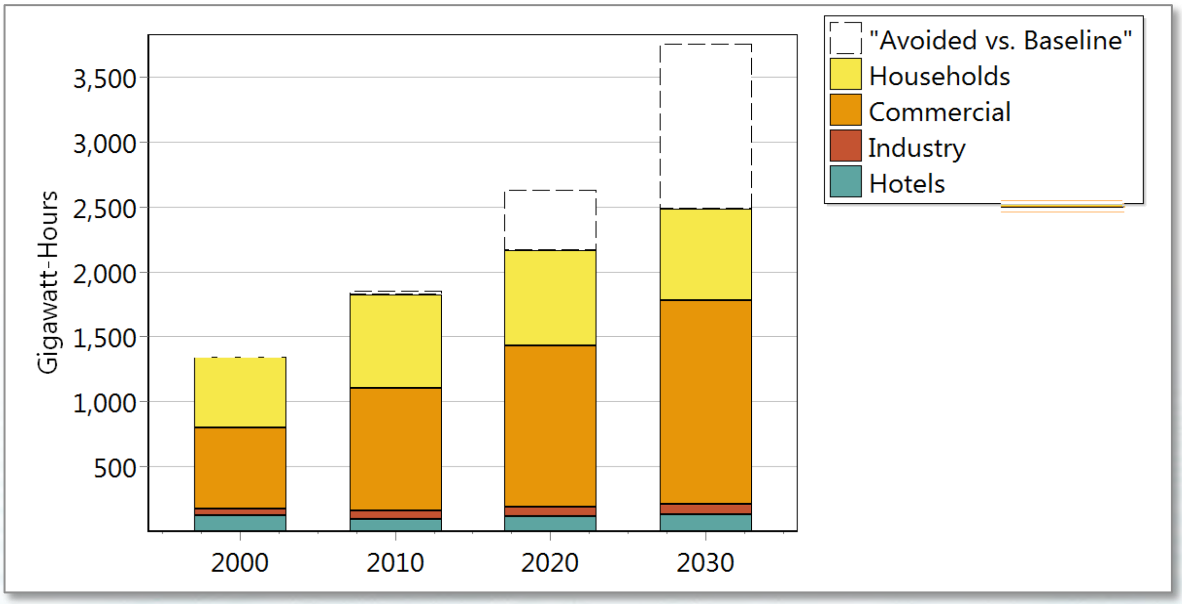


Figure 10: Avoided electricity demand in mitigation scenario as compared with the baseline scenario [Gigawatt-hours]

The electricity demands avoided due to solar PV, solar water heaters and energy efficiency in turn decrease the overall electricity generation required by power plants. Figure 11 shows a comprehensive picture of the electricity supply mix and the avoided electricity generation leading up to 2030.

Avoided Electricity Generation by Technology in the Mitigation Scenario as Compared with Baseline Scenario

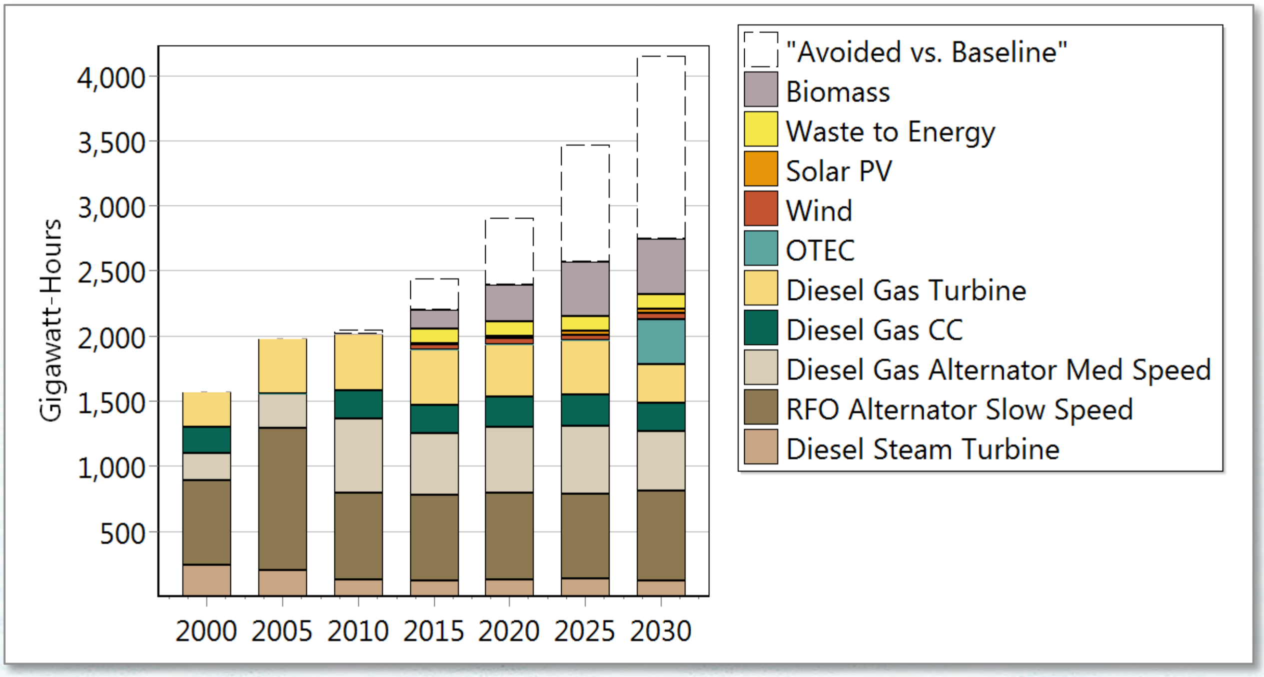


Figure 11: Avoided electricity generation by technology in the mitigation scenario as compared with the baseline scenario [Gigawatt-hours]

Based on the renewable energy potential assumed for the mitigation scenario, The Bahamas could feasibly produce over 30% of their electricity from renewable generation sources by 2030 as shown in Table 5 below.

Renewable Electricity Generation by Technology in Mitigation Scenario

	2010	2015	2020	2025	2030
Biomass	0	140	280	420	420
Waste to Energy	0	112	112	112	112
Solar PV	0	4	15	26	37
Wind	0	44	44	44	44
OTEC	0	0	0	0	350
Total Generation Required	2,014	2,195	2,338	2,568	2,743
% Renewable Generation	**0%**	**13.6%**	**19.3%**	**23.4%**	**35.1%**

Table 5. Renewable electricity generation by technology in the mitigation scenario [GWh]

The Bahamas also has a GHG emission sink from the land use change and forestry sector. If these savings were to be included in an analysis like LEAP, based on the estimates in GHG inventory calculations, net emissions would be negative, as seen in Figure 12.

Avoided Emissions by Sector for the Mitigation Scenario Compared with Baseline scenario

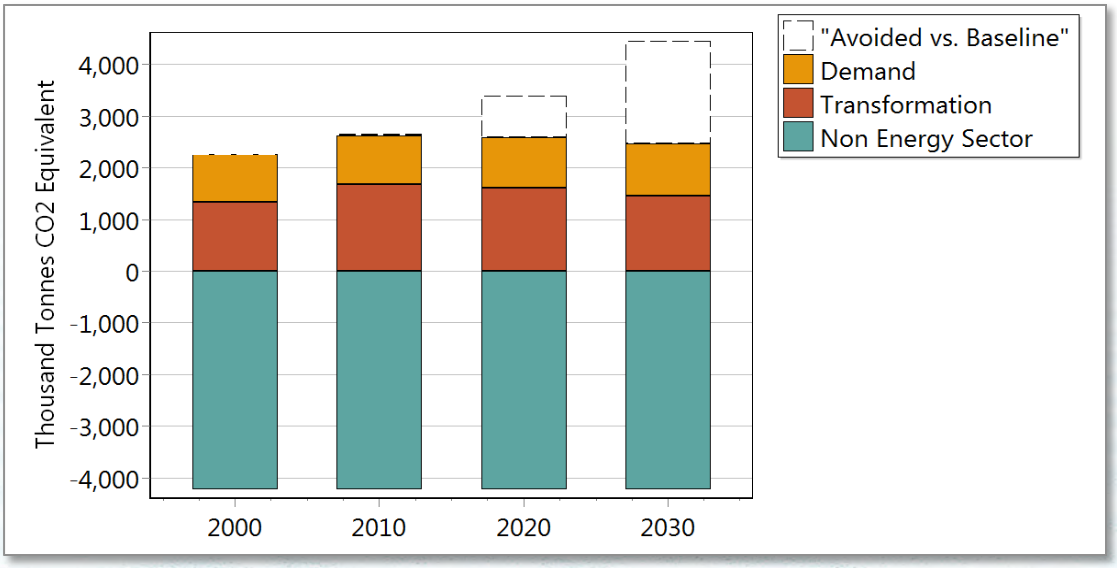


Figure 12: Avoided emissions by sector for the mitigation scenario as compared with the baseline scenario including land use change and forestry [Thousand Tonnes CO_2 equivalent][6]

Barriers to Energy Efficiency include lack of awareness, insufficient knowledge and skills among users, planners, designers and service providers about energy efficient alternatives and opportunities of energy efficiency; high up-front investments; limited availability to highly efficient technologies; landlord-tenant problems regarding the installation of energy efficient measures. Barriers to Renewable Energy Deployment include limiting access to capital; reduced incentives for The Bahamas Electricity Corporation (BEC) to buy electricity from Independent Power Producers; non-transparent technical and commercial grid connection rules; uncompetitive technologies under present conditions, petroleum product shipping, delivery and distribution frequencies and practices. [7]

[6] This assumes no change in GHG emissions or savings from the non-energy sector from the 2000 GHG inventory. Transformation includes emissions from electricity production and transmission and distribution.
[7] Policy report 13/44 (exact text).

CLIMATE CHANGE IMPACTS, VULNERABILITY AND ADAPTATION

The vulnerability and adaptation assessment (V&A) report presented here is in line with the guidelines provided by the UNFCCC guidelines for the preparation of national communications adopted at the eighth session of the Conference of the Parties to the UNFCCC. The information generated for the vulnerability and adaptation assessment (V&A) followed two principal approaches: (i) a consultative process involving key stakeholders and/or sectors and (ii) a modeling approach using climate change and sea-level rise projections for different time horizons in the future.

Approaches and Frameworks for Assessment of Vulnerability and Adaptation

The stakeholder consultations found that while climate change and sea-level rise are recognised as serious threats to relevant sectors of the economy most sectors do not necessarily incorporate climate change issues in their operations. This may be attributed to the lack of information on adverse impacts of climate change except for the most identifiable impacts resulting from hurricanes.

Workshop on climate change vulnerability and adaptation assessment to: (i) brief the stakeholders (thematic working group on V&A/participants) on the V&A assessment in preparation for the second national communication under the new UNFCCC guidelines[8]; (ii) introduce a range of frameworks, approaches, methods, tools, and data sources for conducting V&A; and provide a forum for participants to share knowledge, experience, and difficulties in preparing the V&A and examine ways of overcoming these constraints/gaps.

Learning-by-doing focused on building the capacity of The Bahamas' experts. These experts will conduct V&A and identify, evaluate and prioritise key vulnerabilities, adaptive strategies, policies and measures for implementation. This will improve the adaptive capacity of The Bahamas, its resources and people. The training workshop provided instruction in the use and application of BahamasSimCLIM[9] for examining impacts and adaptations to climate variability and change in The Bahamas.

Modeling of future Climate Change and Sea Level Rise for The Bahamas involved the creation and/or generation of climate change and sea-level rise scenarios, appropriate global circulation models, (from the IPCC Special Report on Emission Scenarios (SRES)) greenhouse gas, other emission scenarios and the interpretation of results. This component also allowed for input of country-specific or site-specific data to The BahamasSimCLIM system.

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[8] The UNFCCC guidelines for the preparation of national communications from Parties not included in annex I to the Convention is contained in decision 17/CP.8 http://unfccc.int/resource/docs/cop8/07a02.pdf#page=2

[9] BahamasSimCLIM is a tool for generating climate change and sea-level rise projections using the various SRES emission scenarios. The tool has an open structure which allows it to be populated with the country-specific data and is linked to the several biophysical models for conducting integrated assessments. BahamasSimCLIM uses ensemble of 21 GCM patterns for generating climate change and sea-level rise projections for The Bahamas. More information on this tool and its applications can be obtained from http://www.climsystems.com/.

Evidence of Climate Change in The Bahamas

Historical record

Recent analysis of the temperature record shows that the average annual temperatures have been steadily increasing over the last 30 years (1971-2000) and this trend is likely to continue in the foreseeable future (McSweeney, et al. 2009). The mean annual temperature has increased by about 0.5^{o}C since 1960, at an average of 0.11^{o}C per decade (McSweeney, et al. 2009). As for rainfall, observational record shows that the mean rainfall has not changed significantly since 1960**.**

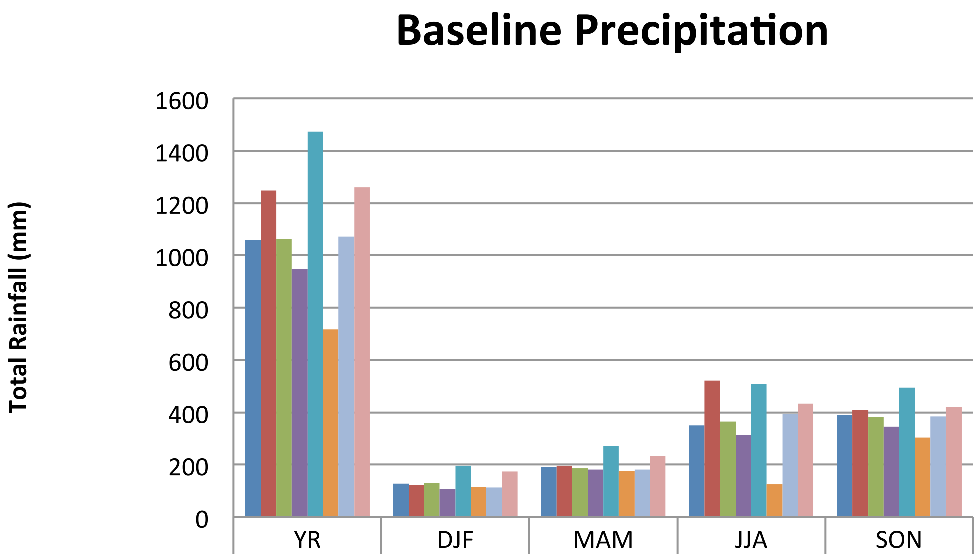
Climate Change and Sea-Level Rise Projections

Projections of future changes in climate are from a baseline, the average over the period 1961-1990. The SimClim software (Warrick 2009) which uses the results of the GCMs in the IPCC intermodal comparison database was used to generate the calculations. Where possible, ensemble results were used.

Precipitation

The baseline precipitation for The Bahamas and seven of the Family Islands is given in the table below (yearly total, as well as seasonal sums, all in millimetres).

Annual Seasonal Rainfall in The Bahamas



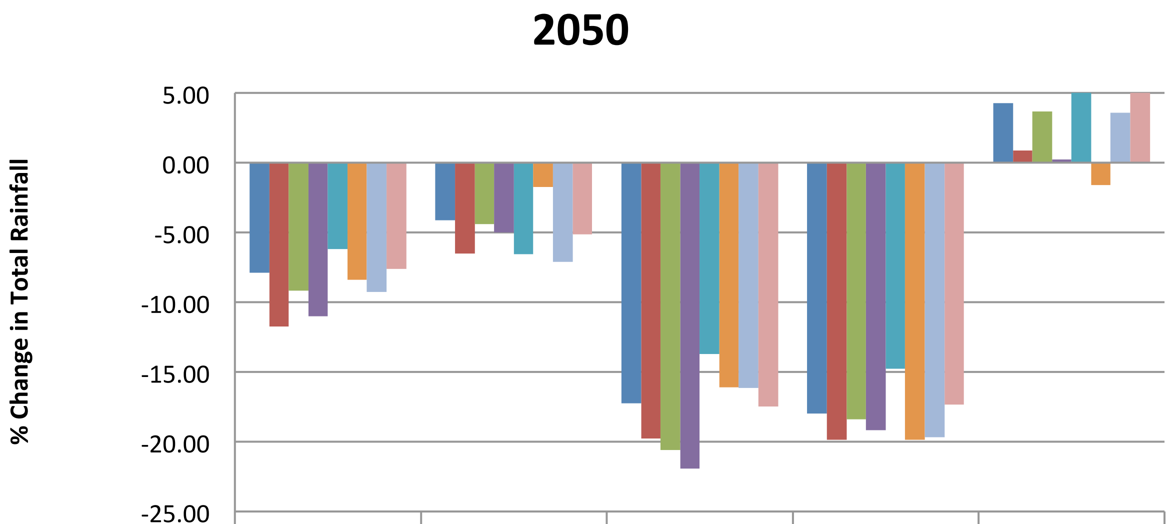
	YR	DJF	MAM	JJA	SON
Bahamas	1059	128	192	351	388
New Providence	1248	123	196	521	408
Eleuthera	1063	129	187	364	383
Exuma	948	109	180	313	346
Grand Bahamas	1472	196	272	510	494
Inagua	717	114	176	124	303
Andros	1072	113	180	394	385
Abaco	1260	174	232	433	421

Table 6: Annual seasonal rainfall in The Bahamas

The “wettest” island (Grand Bahama) gets twice the amount of rainfall (1472 mm) of that of the “driest” island (Inagua, 717 mm) annually. During, the June/July/August season, it is four times more (510 mm vs. 124 mm). Thus more rain falls in the northwest (Grand Bahama, Eleuthera, and Abaco), Central (Andros, New Providence) and less in the southeast (Exuma, Inagua). Decreases in summer rainfall in all islands are expected with significant decreases in Exuma, Eleuthera and New Providence. During the winter, Inagua will remain “driest” while all other islands to the northwest will experience an increase in rainfall by 2050.

Using the median result of a 21-GCM ensemble and the A1FI emission scenario, with high climate sensitivity rainfall changes (%) likely to be expected by 2050 will mean a decrease in rainfall by as much as 10% for annual precipitation, and 20% in some seasons for most islands (Table 6).

21-GCM Ensemble for The Bahamas (2050)



	YR	DJF	MAM	JJA	SON
Bahamas	-7.88	-4.12	-17.26	-17.99	4.25
New Providence	-11.76	-6.50	-19.79	-19.85	0.86
Eleuthera	-9.17	-4.38	-20.60	-18.41	3.67
Exuma	-11.00	-5.02	-21.92	-19.18	0.21
Grand Bahamas	-6.20	-6.58	-13.71	-14.79	6.92
Inagua	-8.38	-1.74	-16.12	-19.85	-1.62
Andros	-9.28	-7.09	-16.15	-19.68	3.57
Abaco	-7.63	-5.12	-17.47	-17.34	6.77

Table 7: Results of the 21-GCM Ensemble for The Bahamas (2050)

New Providence, Eleuthera and Exuma islands would experience up to 20% reduction in rainfall during the dry and wet seasons (March-August) by 2050.

The change in rainfall for The Bahamas would decrease by as much as 5-11% in most islands. Drier regions such as the southeast (e.g. Inagua) will become drier while the wet regions in the northwest will experience decrease in rainfall but not as much as the southeast region. Additionally, the seasonal differences will be greater ranging from 6-20% decrease. Figure 13 shows the spatial distribution of rainfall in the entire Bahamas archipelago.

Change in Precipitation for The Bahamas (2050)

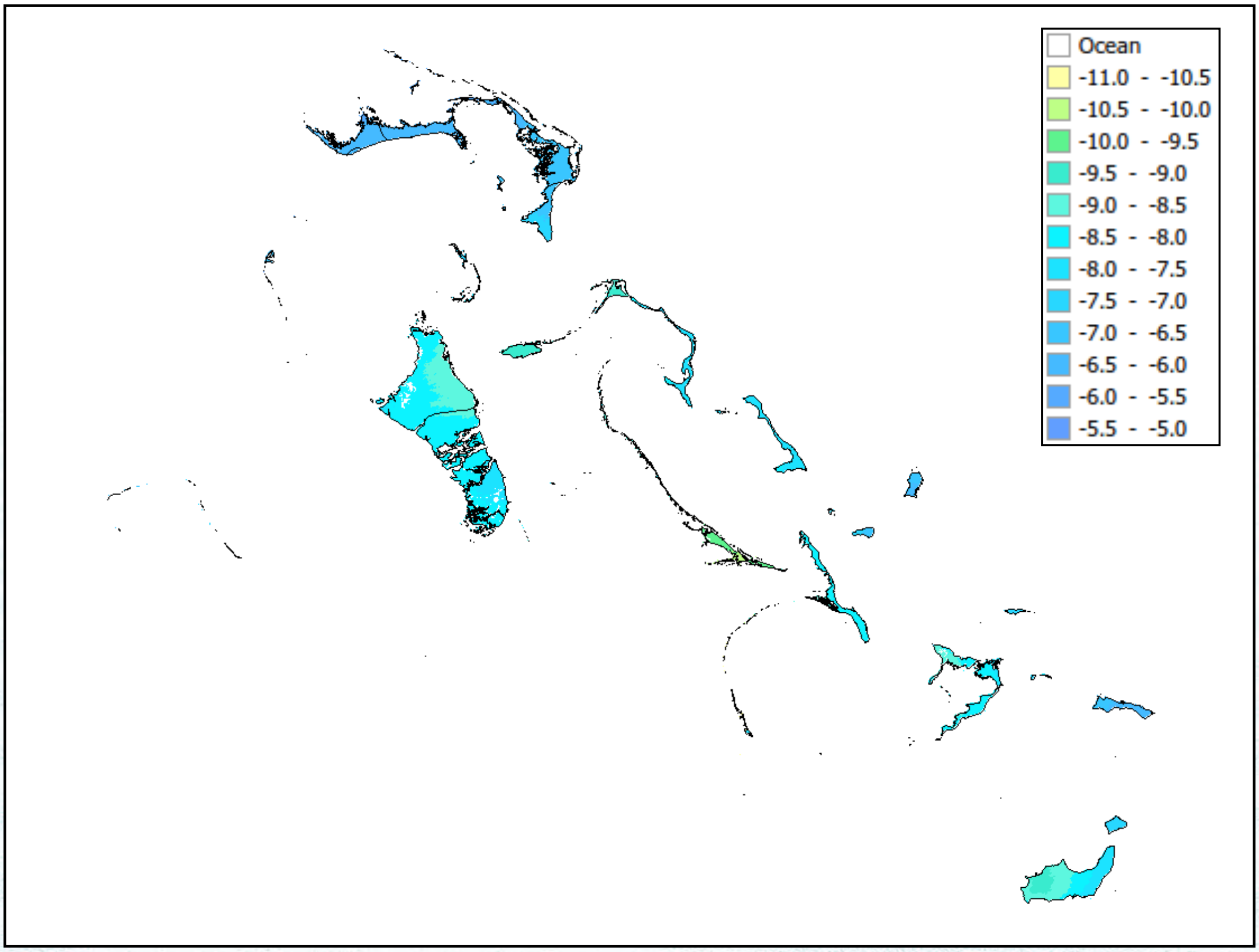


Figure 13: Change in precipitation for The Bahamas (A1FI, high, 2050)

Current climate variability was assessed through historic observations which are available for Nassau Airport (New Providence), with highly variable total annual rainfall ranging from less than 500 mm to 2500 mm per year (based on 1977-2009).

An extreme value analysis tool was used to analyse extreme events for current climate and climate change. It was also used to calculate return periods for certain extreme rainfall events. Figure 14 shows that the most extreme rainfall event at Nassau Airport (481 mm of rain in one day) has a return period[10] of once in almost 60 (58.07) years. A 1:100 year event is almost 560 mm of rain.

[10] A return period, also known as a recurrence interval, is an estimate of the interval of time between events like an extreme rainfall or extreme event of certain intensity or size. It is usually required for risk analysis (i.e. whether a project should be allowed to go forward in a zone of a certain risk and also to design structures so that they are capable of withstanding an event of a certain return period.

High Extreme Precipitation

The extreme event analysis shows that The Bahamas will experience a decrease in precipitation, suggesting future extreme high events would be less severe. However, when daily outputs of 12 GCMs are applied, the analysis shows that by 2050 (with A1FI-high), the return period for the current most extreme event will have dropped to 42 years (from 58), while the 1:100 year event increases to 622 mm (from 560 mm). This would mean that such events would become more severe and more intense.

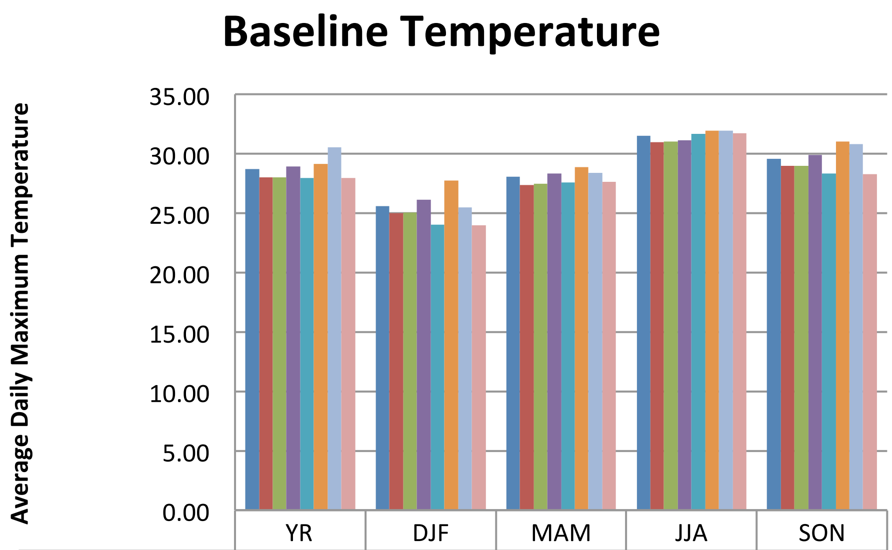
Low Extreme Precipitation

For low extreme rainfall, a low amount of rain in a given period is calculated as the extreme event. In this case a 90-day period (three months) was chosen. Using the example for Nassau Airport, and for every 10 years, at least one three-month period will have less than 24 mm of rain (extreme low rainfall). However, by 2050, under the A1FI-high scenario, and using a 21-GCM ensemble, this will have dropped to 20 mm of rain. While the driest period (DJF) only shows a decrease of up to 7%, this analysis shows that for extreme droughts, the decrease in rainfall is closer to 17%.

Temperature: Extreme (High) Temperature

The baseline for daily maximum temperature for The Bahamas and seven of its islands is shown in Table 8. Maximum daily temperatures range from 27°C to 31°C for most islands with an average maximum temperature of 28.70°C for the entire Bahamas. Analysis of extreme or maximum temperatures shows a 5°C change from winter (DJF) and summer months (JJA).

Average Daily Maximum Temperatures for The Bahamas, 1960-2006



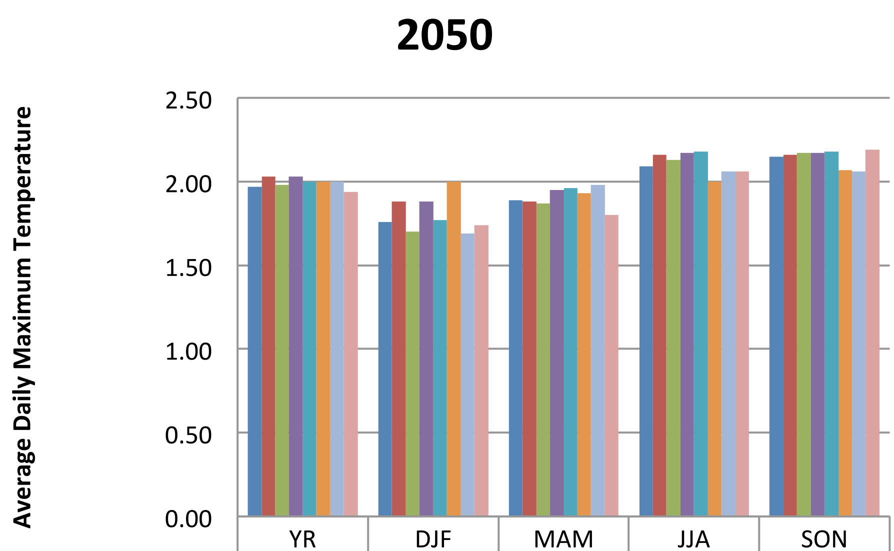
	YR	DJF	MAM	JJA	SON
Bahamas	28.70	25.61	28.08	31.49	29.58
New Providence	28.01	24.97	27.37	30.97	28.97
Eleuthera	28.02	25.05	27.47	31.00	28.99
Exuma	28.91	26.11	28.34	31.15	29.90
Grand Bahamas	27.97	24.02	27.57	31.69	28.31
Inagua	29.11	27.72	28.86	31.93	31.00
Andros	30.54	25.49	28.37	31.93	30.83
Abaco	27.95	23.99	27.61	31.70	28.27

Table 8: Average daily maximum temperatures for The Bahamas, 1960-2006

However, when projecting maximum temperature for 2050 by using a 21-GCM ensemble, and the A1FI emission scenario, with high climate sensitivity, the following changes for the daily maximum temperature are expected: (1) maximum temperature for The Bahamas will increase by 1.97^{o}C while maximum temperature increases for individual islands will range from 1-2^{o}C; (2) the average daily maximum temperature of the winter months will be less than 2^{o}C while the summer months will be just over 2^{o}C; (3) the drier islands in the southeast will experience higher temperatures during the winter months (DFJ) than the central and northwest regions. The range of daily average maximum temperature increase in The Bahamas is expected to be up to 2^{o}C which compares favourably with the expected increase of 2.7^{o}C global average daily temperature. The lower increase in The Bahamas is due to the moderating effect of the surrounding waters (Please see Table 9).

Increase in Average Daily Maximum Temperature Under A1FI, High Sensitivity, 2050

Increase in Average Daily Maximum Temperature Under A1FI, High Sensitivity, 2050



	YR	DJF	MAM	JJA	SON
Bahamas	1.97	1.76	1.89	2.09	2.15
New Providence	2.03	1.88	1.88	2.16	2.16
Eleuthera	1.98	1.70	1.87	2.13	2.17
Exuma	2.03	1.88	1.95	2.17	2.17
Grand Bahamas	2.00	1.77	1.96	2.18	2.18
Inagua	2.00	2.00	1.93	2.00	2.07
Andros	2.00	1.69	1.98	2.06	2.06
Abaco	1.94	1.74	1.80	2.06	2.19

Table 9: Increase in average daily maximum temperature under A1FI, High Sensitivity, 2050

Baseline Average Daily Maximum Temperature, New Providence

Using the example of spatial distribution of average daily maximum temperature in New Providence, it can be seen that there is an increase in temperature for New Providence (range 0.2°C - 0.9°C) from the baseline (1960-2006) temperature, which is consistent with the increase over the entire Bahamas (Figure 15). Depending on the geography of the island and the positioning of the prevailing trade winds, subtle differences can be experienced with respect to temperature and rainfall even under current climate, atmospheric and oceanic conditions. It is likely that these subtle differences could be amplified under future climate change.

Daily Maximum Temperature Projected for New Providence (2050).

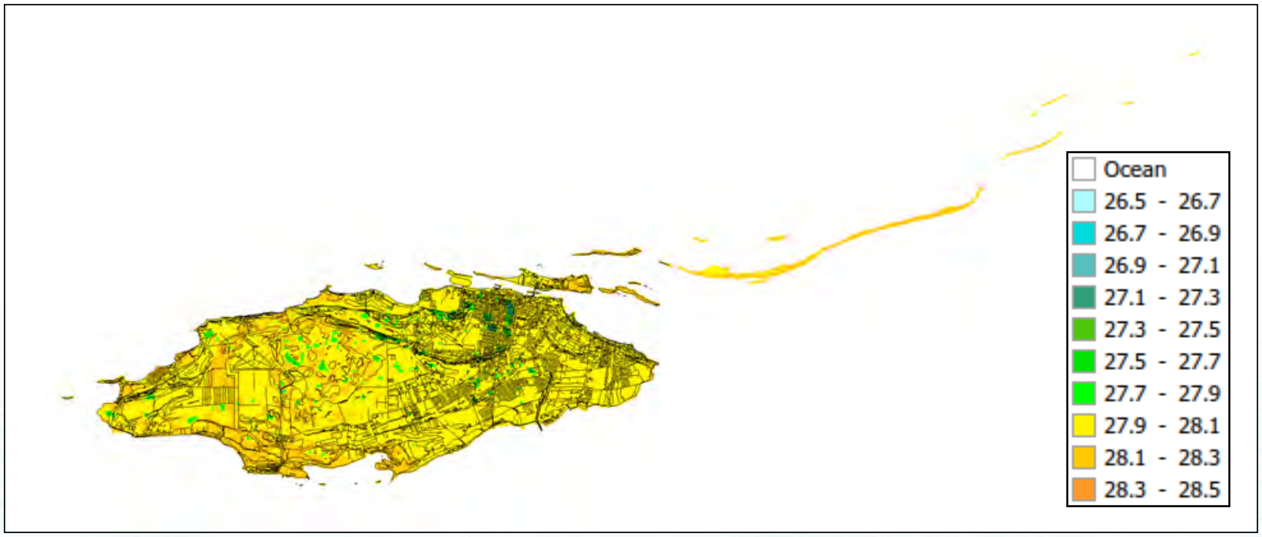


Figure 15: Average daily maximum temperature projected for 2050, New Providence.

Using the 21-GCM ensemble, under the A1FI high scenario by 2050, the projected temperature increase is spatially uniform over the island of New Providence (2.0^{o}C), ranging from 26.50^{o}C to 28.50^{o}C. However, for the entire Bahamas the increase in average daily maximum temperature ranges from 1.91^{o}C to 2.11^{o}C (Figure 16). The daily maximum temperature is highest in the northernmost island of Grand Bahama and in the southernmost island of Inagua (average over 2.0^{o}C). In the central part of The Bahamas the daily maximum temperature increase of 1.93^{o}C to 1.97^{o}C is expected.

Daily Maximum Temperature for The Bahamas Under A1FI for 2050

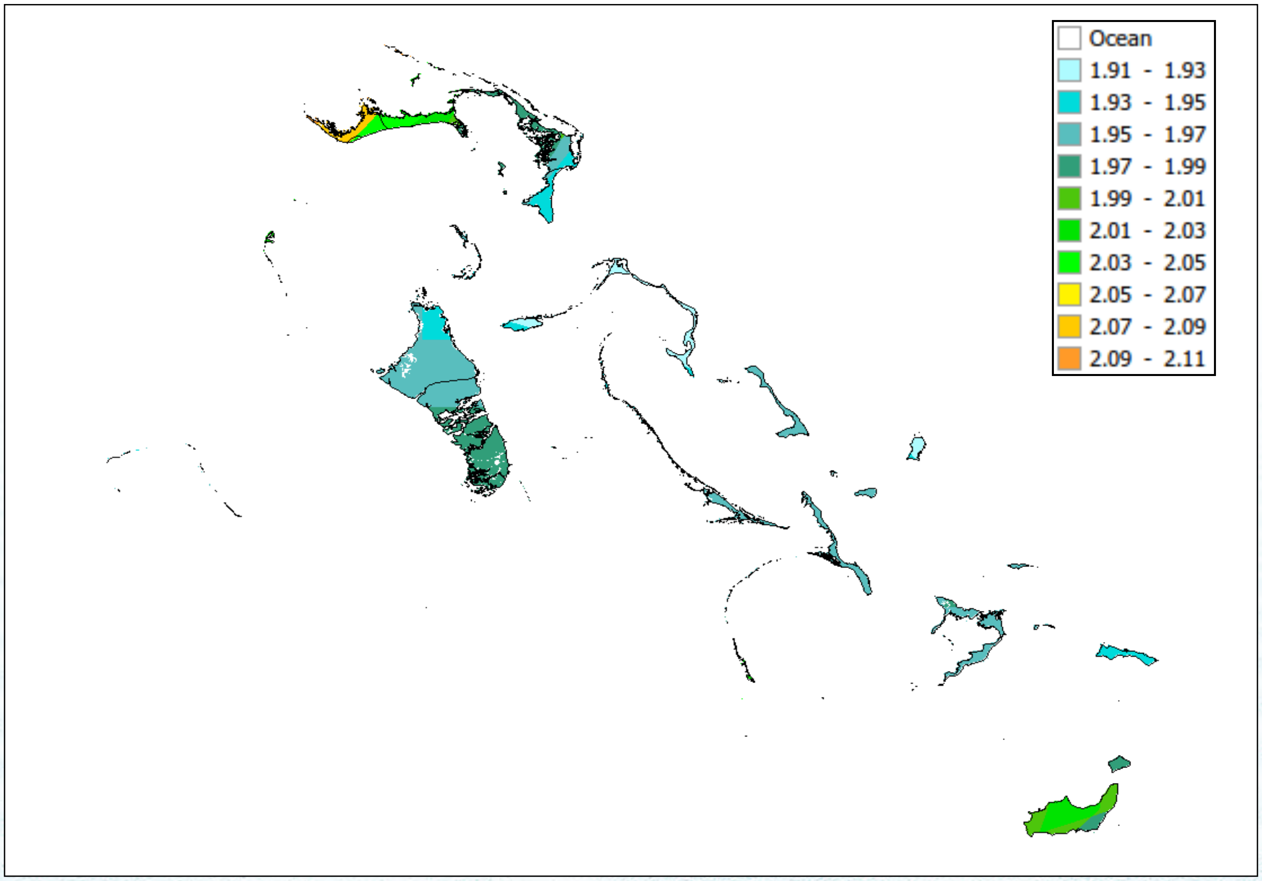


Figure 16: Average daily maximum temperature for The Bahamas under A1FI for 2050

Observational record at Nassau Airport shows a steady increase in average daily maximum temperature between 1974 and 2008 (34 years) (Figure 17).

Daily Maximum Temperature at Nassau International Airport (1974 -2008)

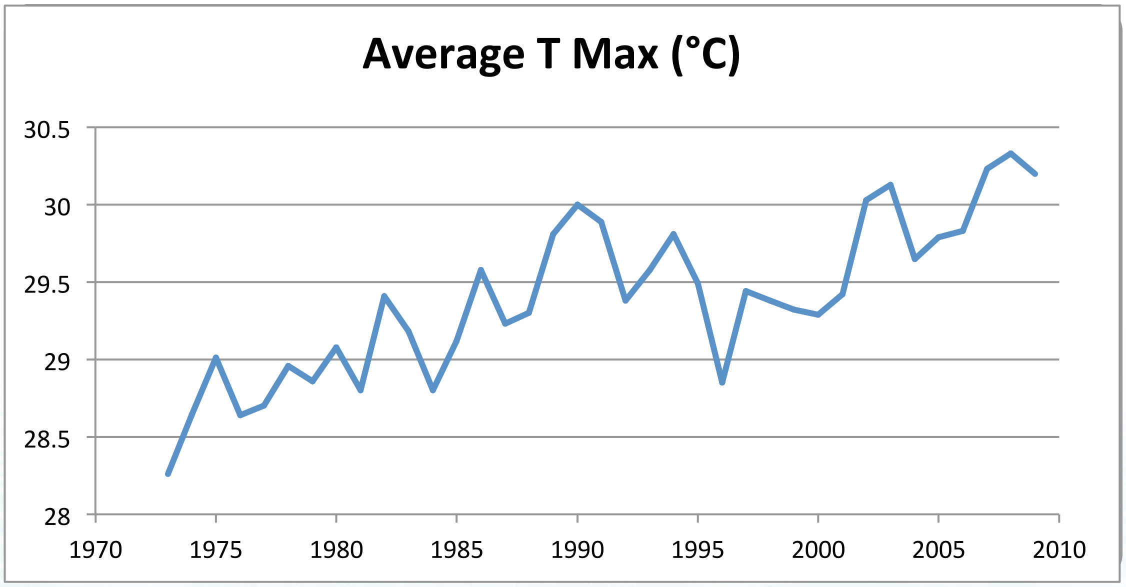


Figure 17: Average daily maximum temp. at Nassau Airport, New Providence (1974 -2008)

The use of extreme value analysis shows that the highest temperature extreme of 39.22°C has a return period of 74.31 years. Under the A1FI-high scenario, using a 21-GCM ensemble, by 2050, the frequency will increase to 9.92 years. Thus, extreme temperatures are likely to occur more frequently by 2050.

As with extreme value analysis, the trends for maximum and minimum temperatures were analysed for Nassau Airport (Figure 18).

Temperatures Trends at Nassau International Airport (1973-2010)

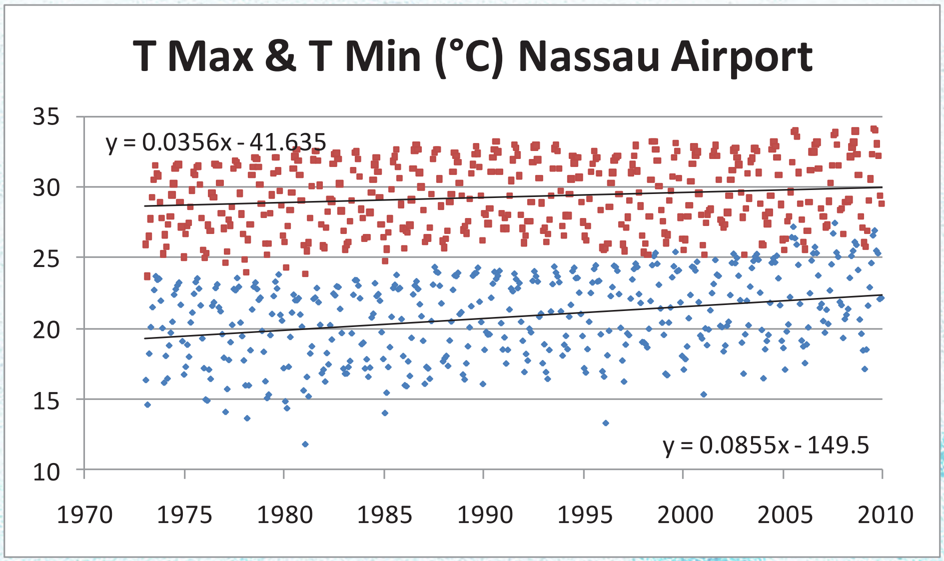


Figure 18: Trends for maximum (red) and minimum (blue) temperatures

Figure 18 shows that minimum temperature (TMin) has risen at a rate of 0.05°C/yr faster than the maximum temperature (TMax). The total increase for TMin was 3.24°C while the total for TMax was 1.35°C over almost 38 years. The increase in TMin is consistent with the faster rate of increases in night time temperatures than day-time temperatures globally (Meehl, et al. 2009).

Sea Level Rise

With respect to sea level rise, the analysis here uses historical hourly data from Settlement Point, Grand Bahama, which has a good data set to uncover a trend. Figure 19 shows that recursively fitting the data-points to a trend line assesses the rate of sea level rise in order to determine if the estimate converges. This analysis shows that relative sea level rise at Settlement Point (Grand Bahama) is between 0 and 0.5 mm/yr. Additionally, from the SONEL database (Santamaria-Gomez and Bouin, 2009) with vertical land movement data, the value of -0.7 mm/yr (land sinking) is estimated. Thus sea-level rise is slower than the vertical land movement (i.e. sinking/subsidence). This indicates that the impact of thermal expansion causing sea-level rise is minimal for Grand Bahama.

Sea Level Rise Recursive Estimate at Settlement Point, Grand Bahama

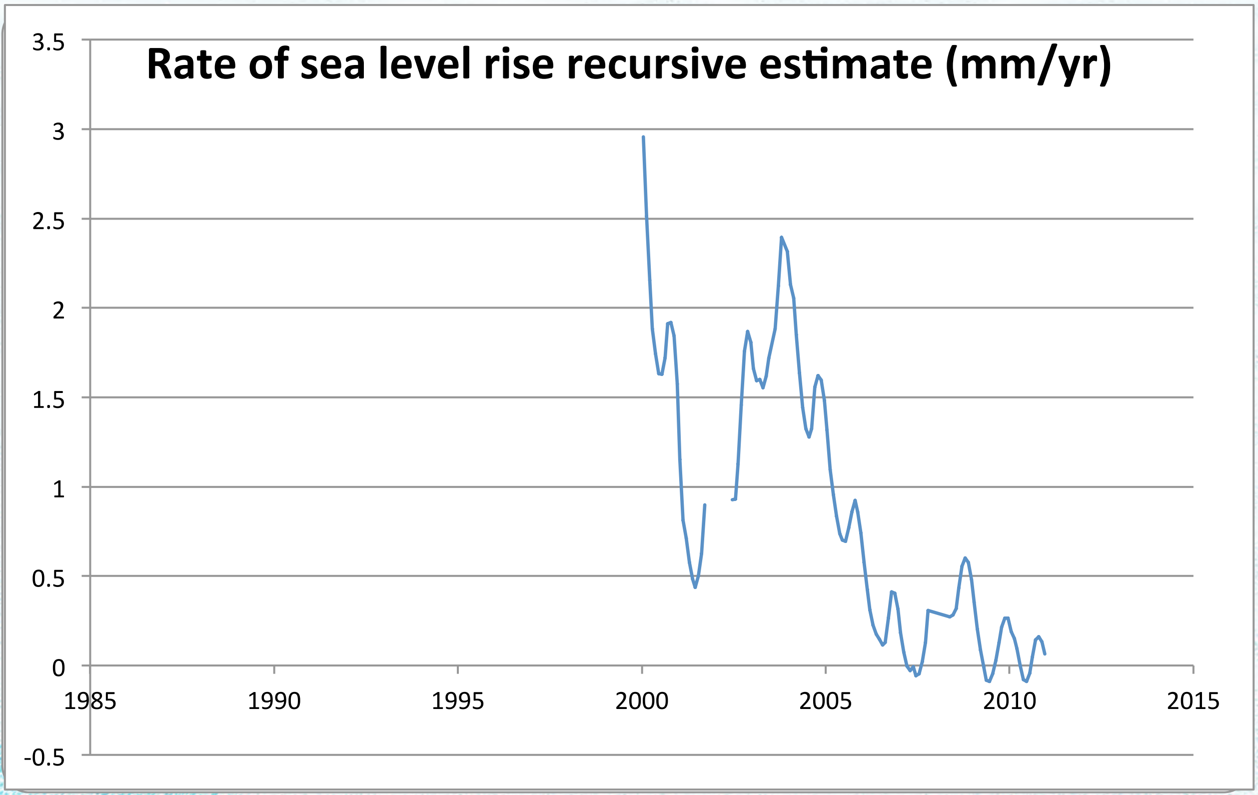


Figure 19: Sea level rise recursive estimate at Settlement Point, Grand Bahama (mm/yr).

While the historical evidence, as presented above, shows that sea-level rise is occurring at a slower rate than vertical land movement, it also indicates that sea level is rising at a rate of 0.2 mm/yr (the difference between vertical land movement and thermal expansion). Based on the

13-GCM Ensemble and using the A1FI scenario, the sea level rise is projected to increase by 2100 in The Bahamas. Figure 19 shows that by 2030 the sea level will have risen by 9.0mm and by 2050 the sea level rise will be 20mm and by 2100 it will be near or at 70mm. The increasing rate of sea level rise in the Grand Bahama is consistent with the global sea level trend.

Sea Level Rise Projections (AIFI), 2100 (local, 13 GCMs)

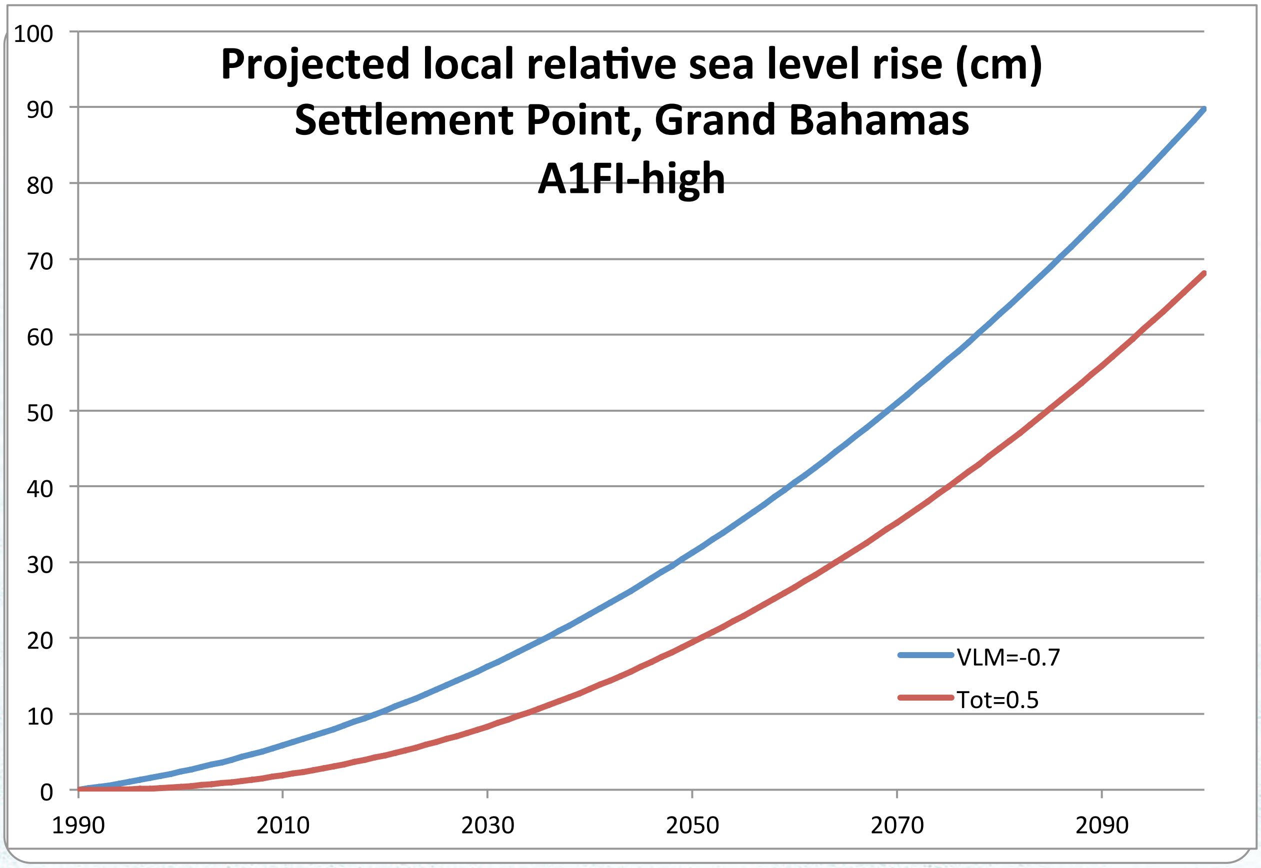


Figure 20: Sea level rise projections (AIFI), 2100 (local, 13 GCMs). The blue line shows vertical land movement (VLM), and the red line shows total sea level rise (Tot). The y-axis is in mm.

Storm Surge Modeling

The vulnerability of The Bahamas is further reinforced by Sea Lake and Overland Surges from Hurricane (SLOSH) modeling. Under the worst-case climate change scenarios and with variable intensity of hurricanes, the surge height overland in many of the islands will be up to 26ft (7m), which would render most parts of the islands under water.

A recent study of a comparative analysis of the impacts of sea level rise and storm surges in developing countries (Dasgupta, et al. 2009) indicates that relative exposure of coastal populations will be high for The Bahamas (73.02%), with most severe losses in coastal GDP (65.7%). The urban extent along the coast will be highly vulnerable to inundation from storm surges in The Bahamas (94.12%) while coastal wetlands will be subject to 71.4% inundation risk from storm surges. Of the top ten countries most at risk to storm surges, The Bahamas is ranked 1 (highly vulnerable) with respect to its coastal population, loss of GDP and coastal urban areas.

The foregoing analysis of climate change in The Bahamas provides a basis for taking action as early and urgently as possible to either cope with and/or adapt to imminent changes that are likely to be expected over the coming decades.

IMPACT ASSESSMENT AND KEY VULNERABILITIES

The key vulnerabilities in The Bahamas are water resources, forests, human health, agriculture, human settlement, disaster management, energy, tourism and coastal zones. These vulnerabilities were identified through consultative processes including expert workshops and synthesis reports[11] prepared by relevant experts.

Water Resources - The Bahamas depends almost entirely on groundwater resources, which are extremely vulnerable, particularly in the low-lying limestone islands. This vulnerability is caused by several factors: overexploitation of the water lens; development of canals and waterways for boat access and to increase the value of lots; seawater inundation in low-lying limestone islands; and pollution of the water resources. Of all the threats to water resources identified and outlined above, the most significant is water table rises, which generally occur in the flatter low-lying areas.

Human Health - Temperature increase of 1.5^{o}C to 2.0^{o}C is evident for all highly populated islands of The Bahamas. This will contribute to increases in vector-borne (e.g. dengue and malaria), water-borne and communicable diseases and increased costs associated with treating these diseases. Elevated temperatures with little rainfall can increase incidences of dengue fever that can put pressure on public health resources. Increased temperatures would also affect the lifestyle of an aging Bahamian population with increased incidences of respiratory and cardiovascular problems.

Human Settlement and Infrastructure - The main challenge of human settlement and infrastructure development is the extensive areas of pine forests that have been cleared and developed for housing and agriculture. Clearance of pine forests will affect water sources and public services. For example, there is no freshwater flowing on the island of New Providence, thus the capital city Nassau relies heavily on reverse osmosis for its water supply. Increasing population, land and infrastructure development makes the preservation of the pine forests and well fields more difficult. As the population continues to increase, groundwater sources are now

[11] Synthesis reports were prepared for water resources, energy, forests, human settlements and infrastructure, agriculture and tourism.

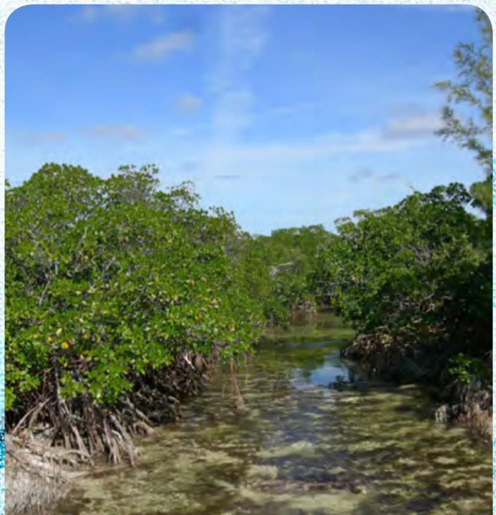
fully developed and no increased quantity from this source can be achieved easily in the near future.

Agriculture - Agricultural production in The Bahamas focuses on four main areas: crops, poultry, livestock, and dairy. Climate change will exacerbate the problems associated with food production in The Bahamas, as it currently experiences a limited capacity to grow food. Thus, climate-related extremes such as storm surge and sea-level rise would result in loss of arable land which can limit the capacity to produce crops. The expected changes in mean annual temperature are unlikely to have a major impact on Bahamian agriculture until the latter part of the century. However, warming of the magnitude that has been projected, coupled with CO_2 fertilization, may increase plant growth in the short term. Extreme high temperatures and an increase in global average temperature can damage food crops thus affecting food production and yield.

Coastal Zones - Much of the coastline of The Bahamas, particularly in the built-up areas, are protected by seawalls. However, infrastructure and investment is under serious threat from climate change, sea level rise and extreme events like storm surge associated with hurricanes. Construction of harbour facilities, such as at Gunpoint, Ragged Island, is necessary for quickly getting supplies safely to the island after a hurricane or other storm event.

Tourism - The Bahamas is the third most popular destination for the 43 million US dive market, 30% share. The industry supports the jobs of approximately 900 divers and contributes, on an annual basis, 49,000 room nights to the accommodation sector (Bahama Dive Association). Tourism contributed an estimated $365M to the economy in 2009. In fact, The Bahamas lost 10% of its GDP due to two hurricanes (Frances and Jeanne) at a cost of USD 551m. Additionally, destinations that are frequently hit by hurricanes or severe weather events suffer from the perception in the market that they are unsafe.

Forests - Presently, there is no information available on the potential impacts of climate change on Bahamian forests. It had been documented in other countries that the climatic variables directly influence plants and trees as a result of the increasing concentration of CO_2 in the atmosphere. Research will have to be conducted to determine the physiological effects as well as the correlation of forest health, fires, storm surges, hurricanes impacts, sea-level rise and soil salinisation levels. With the expected increase in temperature coupled with CO_2 fertilization effect may increase forest growth but this is likely to be compromised by the effects of intense hurricanes, which usually destroy large tracts of forests in The Bahamas.



Biodiversity - Impacts of climate change on biodiversity includes sea level rise, saltwater intrusion, coastal erosion; ocean acidification, and coral bleaching. The results of coral bleaching are far reaching. It reduces the ability of coral reefs to act as a natural defence system that will protect our beaches from storm surge and erosion. Beach erosion negatively affects the Tourism industry. Other impacts of climate change on biodiversity are droughts, floods, fires, storm surge, hurricanes, ENSO, vector and water-borne diseases and invasive species.

Energy - Direct impacts are those that directly influence processes related to energy production and power generation, including transportation, energy resource availability (effects of weather on shipment of energy sources), electricity generation, and transmission and distribution systems. Erosion of the coast impacts the maintenance and safe handling of fuel. Hurricanes, droughts, floods, fires and storm surge also pose a serious threat to infrastructure of the energy sector.

ADAPTATION MEASURES, STRATEGIES AND OPTIONS

The vulnerability analysis suggests that many of the issues, constraints, gaps and difficulties relating to climate change are not necessarily new. Rather they will become worse if no actions are taken to address them. From the foregoing, the evidence of climate change in The Bahamas will be seen by temperature increases by of at least 2^{o}C in the coming decades (by 2050). This will place additional pressure on the population, human systems and natural ecosystems that provide goods and services to sustain livelihoods. Some islands will become wetter and others will become drier with more frequent extreme events in The Bahamas.

In recognition of problems associated with sustainable development and the greater potential for worse problems under climate change, the Government of The Bahamas developed a National Policy for the Adaptation to Climate Change (NPACC) in 2005. This policy identifies the key vulnerable sectors to which resources would be directed to address climate change issues and concerns. The analysis of available information, on each of the key vulnerable sectors identified, indicates that only a handful of actions have been implemented including the development of policy actions for energy and forestry.

The adaptation measures, strategies and options identified were aided by information generated through vulnerability assessments, sectoral reports produced by national experts, stakeholder consultations and the several expert and training workshops.

Water Resources - Policies and measures that need to be adopted to protect the nation's freshwater resources and related environmental concerns are as follows:

a) Enactment of laws and regulations, where needed. (The Water Management Consultants 2003 report outlines these needs in detail):
b) Prevention of further development in low-lying areas proned to flooding, now, or in the future;
c) Non-excavation of canals, waterways and areas below the water table;
d) Control of rock and sand mining activities that are restricted to approved locations only;

e) Protection of beach ridge and coastal dune formations;
f) Protection of mangroves and similar coastal features;
g) Adoption of appropriate physical planning policies that will protect infrastructure from storm surges and rising water tables;
h) Promotion of careers in Environmental Engineering and Hydrology.
i) Provision of local courses and training programmes for young Bahamians.

With accurate sea level projections and more knowledge of future changes in climate, it is anticipated that there will be a better understanding of how groundwater conditions will change. It should become feasible to plan how long a specific water resource area can be used as a supply; when it should be abandoned; and when plans will commence for the development of future alternate supply options. Alternative sources must be considered and the most obvious of these must be desalination. This accepted technology involves high energy usage and is costly. More attention has to be given to devise ways to produce alterative energy options that provide potable water at acceptable prices. Two other research areas of particular relevance to The Bahamas are Ocean Thermal Energy Conversion (OTEC), and current power. The Bahamas has a reverse geothermal energy profile that may permit the necessary cold water for OTEC use to be directly retrieved from deep wells.

Forests

Presently, there is no information to access the potential impacts of climate change on Bahamian forests. Research will have to be conducted to determine the physiological effects as well as the correlation of forest health, fires, storm surges, hurricanes impacts, sea-level rise and soil salinisation levels.

In order to meaningfully address the present state of affairs in the public forestry sector, the following realistic and fundamental mechanisms are prescribed for adoption;

a) Enact comprehensive forestry legislation, ensuring congruency with international standards and protocols;
b) Establish institutional arrangements for forestry (Forestry Unit) to effectively and efficiently undertake the mandate for sustainable forest resource management. This institution should be adequately resourced with qualified staff, and a sustained budget. It should be guided by the provisions of the National Forest Policy, Forestry Law and Regulations;
c) Review and evaluate the existing forest management plans for the sustainable management of all types of forests, on Crown Lands;
d) Plan and implement a comprehensive public education and awareness program on all aspects of forestry development and conservation in partnership and concert with relevant stakeholder agencies in The Bahamas;
e) Institute a program to allow for the sustainable utilization of the natural pine forest resources;
f) Actively participate on the Committee on Forestry (COFO) of the FAO, the Latin American and Caribbean Forestry Committee (LACFC) of the FAO, the Standing

Committee on Commonwealth Forestry, the Commonwealth Forestry Association and the Caribbean Foresters Association;

g) Develop a program to recruit and train Bahamian students from high schools, who show a keen interest in forestry and conservation; and
h) Provide In–Service Training Awards or Scholarships for training in forestry sciences & conservation.

Tourism

In response to the impact of climate change, variability and extreme events on the tourism sector, the Ministry of Tourism will engage in the following activities:

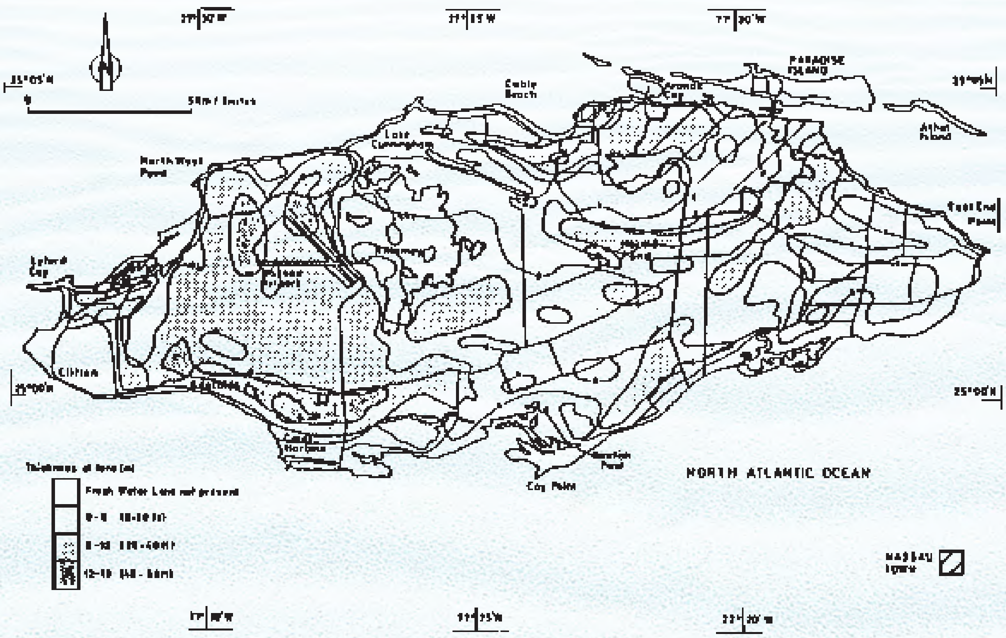
a) Awareness-raising of policy makers and other relevant stakeholders through workshops and symposiums to understandings of the impact of climate change on tourism and related sectors;
b) Introduction of the Foundation for Environmental Education Blue Flag certification program to marinas to encourage the development of programs that will protect the marine ecosystem;
c) Development of a hurricane preparedness and evacuation plan that will permit the tourism sector to respond and recover from any hurricane or extreme weather events in cooperation and collaboration with its public and private partners;
d) Assist communities to develop funding mechanisms and technical know-how in protecting their beaches and shoreline in conjunction with the Coastal Awareness Committee;
e) Educate the general public on the role of wetlands play in the protection of our coast from storm surges and as an important habitat for fisheries and wildlife;
f) Solicit the support and buy-in from local stakeholders and the travel public to educate persons on climate change and its impact; and
g) Establish an Integrated Coastal Zone Management Unit to manage our coastal assets.

Financial, technical and human resources are required to train additional Department of Meteorology technicians in the use of the SLOSH modeling to forecast hurricane landfall, and provide equipment to assist in mapping coastal areas vulnerable to sea level rise.

OTHER INFORMATION CONSIDERED RELEVANT FOR THE ACHIEVEMENT OF THE OBJECTIVES OF THE CONVENTION

The Bahamas has taken the following initiatives to implement the Convention:

Integration of Climate Change into National Policies - The Bahamas has a National Policy for the Adaptation to Climate Change. The policy outlines a framework for advancing the capacity and capability of The Bahamas to effectively adapt to climate change impacts and contribute significantly to the conservation and preservation of The Bahamas' natural resources for present and future generations. Integration of this policy and other aspects of climate change vary across agencies:



FRESHWATER LENS THICKNESS MAP OF NEW PROVIDENCE

- **Department of Meteorology** has no existing policies. They operate with based on the National Emergency Management Agency (NEMA) Plan of Action. The Department is involved in the Global Climate System (GCOS) program, and is looking at being involved in Global Earth Systems Observing System.

- **Bahamas Electricity Corporation's (BEC)** priorities include the reduction of electrical power produced from fossil fuels (this will lead to reduction in fuel costs). A draft national energy policy encourages BEC to look at solar, wind, waste-to-energy, Ocean Thermal Energy Conversion and plasma energy generation as alternatives.

- **Water and Sewerage Corporation's (WSC)** priorities include developing adequate service standards throughout the country, providing the populace with potable water and collecting their waste effluents.

- **Ministry of Education's** policies include educating young children about climate change. Climate change is incorporated in the national secondary school curriculum with more detail provided at Grades 10 through 12 levels.

- **The College of The Bahamas (COB)** has educational policies and programs for science, science majors and teachers. COB has a Small Island Sustainability programme that includes a curriculum related to climate change.

- **Port Department** contributes to statistics and GHG issues.

- **Department of Lands and Surveys** LUPAP (land use policy and administration project) is an attempt to create a base map of all the islands of The Bahamas starting with Grand Bahama, New Providence and Abaco. GIS maps or statistics would be the best format for relaying information.

- **Department of Agriculture** is looking at policies on land use and tenure, water use and management, pesticide use, animal and plant health, food security and production, wildlife conservation and research, import control, and rural planning. The Department is encouraging farmers to use greenhouses to start seedlings and grow crops. They are also fostering the use of improved seed varieties and drip irrigation instead of rain fed agriculture.

- **Department of Environmental Health Services (DEHS)** speaks to the issue of burning, and may make it illegal to emit any pollutant into the environment.

- **Ministry of Finance's** policies include a reduction in duty on solar panel and other equipment related to solar energy.

- **Bahamas National Trust (BNT)** does not include climate change, but is planning to review them to see how they can include this issue. Its priorities are biodiversity and wetlands conservation.

- **Ministry of Tourism** has no existing climate change policies, but it supports the national climate change policy. Priorities include conserving the natural resources of The Bahamas and making tourism thrive. Sustainable tourism guidelines exist that are provided to developers when new projects are presented to the Ministry for comment.

Other areas considered relevant for the achievement of the objectives of the Convention include the mechanisms for transfer and access of Environmentally Sound Technologies for adaptation and mitigation in agriculture, energy (including renewable), health, transportation, water conservation, land use, forestry and tourism. The Bahamas contributes and participates in Climate Change Research and Systematic Observations as a member of the World Meteorological Observations (WMO) and the Global Climate Observing System (GCOS). Systematic observations are made from a network of 21 automatic weather observing stations on 15 inhabited islands. Hydrological Observations include a data well wave rider buoy study of waves for use in marine forecasting for coastal management and planning. Sea level is monitored by three tidal gauges installed in Nassau Harbour, Lee Stocking Island and Inagua. A tidal gauge has been maintained and operated since 1978 by the National Oceanographic and Atmospheric Administration (of the United States) as part of the GLOSS (Global Sea Level Observing System) network, at Settlement Point, Grand Bahama. Research Programmes range widely. They encompass regional and international initiatives, meteorological and socio-economic elements. A study on El Nino-Southern Oscillation is to design feasible regional early warning systems to ameliorate the impacts of the El Nino Southern Oscillation (ENSO).

Education, Training and Public Awareness carried out by The National Climate Change Committee (or NCCC), under the auspices of the BEST Commission, has tasked a public education and outreach subcommittee (or PEO subcommittee) with drafting and implementing a public education and outreach strategy on climate change in The Bahamas. Education on climate change includes general environmental education components, but no specific content on climate change. The national secondary school level curriculum currently includes specific components on climate change. Media has no specialist environmental journals or newspapers, and there is limited national scholarship on the issue.

Non-governmental organizations such as The Bahamas National Trust (BNT) have developed many educational programs and collateral material that aid in teaching the effects of climate change in the ecosystems of The Bahamas. Programmes include Treasures in the Sea Teacher Resource Manual, the Wondrous Wetland Workshop and teacher's resource that highlights the importance of mangroves in acting as barriers for hurricanes and storm surges. The Bahamas Reef Environmental Education Foundation (BREEF) conducts an annual summer Marine Conservation Teacher Training Workshop at the Gerace Research Center on San Salvador. The objective of the workshop is to provide Bahamian primary and secondary level educators with hands-on experiences in the marine environment that they could subsequently share with their students.

Public Sector participation in climate change issues has been encouraged through presentations by senior government officials, efforts to build capacity and report on the national involvement in the UNFCCC process. Public Participation and Access will be promoted with plans to enact a

Freedom of Information Act and the enacted Planning and Sub-division Act 2010. Sub-regional, Regional and International Cooperation is being developed through partnerships on climate change with the University of South Florida.

CONSTRAINTS, GAPS AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

Gaps, Needs and Priorities include a lack of national data collection and distribution initiatives; policy interactions; and prioritization of climate change at the institutional and executive level which further reduces the efficacy of any educational and outreach impetus. In order to address these gaps and needs, further funding will be required to implement the public education and outreach strategy. Capacity building is required for better management of the impacts of climate change and sea level rise on coastal resources, human settlements, and infrastructure. The Caribbean Planning for Adaptation to Climate Change (CPACC) seeks to strengthen regional cooperation and institutions to provide a cost-effective means for adaptation planning, data collection, sharing of information and skills and project benefits.

The 2005 National Capacity Needs Self-Assessment (NCSA) Report confirmed that “current levels of government funding are insufficient to adequately support the implementation of the four international environmental Conventions” with the UNFCCC being one of the four. A lack of financial resources at the systemic and institutional levels was identified as a key obstacle to staff training.

Technology Needs Assessment is scheduled to occur within the next 3 years, and will provide the basis for technology transfer to The Bahamas. Other Capacity Building Needs include the need for regulations related to climate change. Legislation is also required for environmental impact assessment guidelines to adequately address extractive processing, energy industries, industrial operations and manufacturing in the context of climate change. Funding is also required for a fully staffed Ministry of the Environment of 274 persons with necessary infrastructure and equipment.

CHAPTER 1: NATIONAL CIRCUMSTANCES

1.1 GEOGRAPHICAL CHARACTERISTICS

1.1.1 Location

The archipelago of The Bahamas contains the largest tropical shallow water area in the Western Atlantic. It is located on the northern and eastern margins of two large submerged banks. The Bahamas has over 700 islands that are low-lying and composed of limestone. The sub-tropical climate and a geographic position between two major warm ocean currents affect the region with seasonal variability. This variability of the seasons influences the biological communities inhabiting the ocean and coastal areas.

The Bahama Banks are separated from the North American continent by the Florida Straits and deep channels in excess of 6,561ft/2000m (see Figure 1). Two deep water channels cut into the larger Great Bahama Bank. Most of the marine area is shallow (65ft/20 m), and contributes to marine resources with both important ecological and economic value. The northern and central islands are located on two vast carbonate platforms averaging 33ft/10 meters in depth. Little Bahama Bank is located in the northern Bahamas while the Great Bahama Bank begins about 62mi/100km south, extending to the south and southeast. These two banks are separated by North-east-North-west Providence Channels and the Great Bahama Bank is split by two deep water channels: the Tongue of the Ocean (49,000-59,000ft/1500-1800m in depth), which separates Andros from New Providence and the Exuma; and the Exuma Sound forming a deep area to the east of the Exumas (Buchan 2000).

Thus, the Commonwealth of The Bahamas consists of an archipelago of 700 islands and more than 200 cays, islets and rocks in the western Atlantic Ocean. The islands cover approximately 100,000 square miles (mi^2) or 260,000 square kilometres (km^2) of ocean between latitudes 21° and 27° North and longitudes 72° and 79° West. The total land area is only 5,382 mi^2 (13,940 km^2). The archipelago stretches approximately 550 miles (mi) / 880 kilometres (km) from the northwest tip of Grand Bahama Island to the southeast coast of Inagua Island.. The Bahamas Platform, a distance of more than 840 miles (1,335 km), extends from the coast of Florida to the island of Hispaniola.

Thirty islands and cays are permanently inhabited. The economy, standard of living and population size among these islands are widely varied. All populated islands have basic infrastructure such as schools, roads, electricity and running water. Amenities such as cellular telephone, cable television and internet access are less accessible in more remote areas or less populated islands. Nassau, the capital city, is located on New Providence Island, which measures just 21 miles (34km) long by 7 miles (10km) wide. Andros Island is the largest island in the archipelago, and is a conglomerate of smaller islands separated by shallow creeks and waterways. Approximately 80% of Andros is within 3.3 ft (1m) above mean sea level. Harbour Island, with an area of 1.5 mi^2 (3.9 km^2) and Spanish Wells, with an area of 0.5 mi^2 (1.3 km^2), are the two smallest permanently inhabited islands. These islands are connected to Eleuthera and Long Island respectively by regular ferry service to the larger islands.

Map of the Commonwealth of The Bahamas

Figure 1: Location of The Bahamas archipelago showing Little Bahama Bank in the northwest, the Tongue of Ocean between Andros and New Providence Islands on the Great Bahama Bank, and the Exuma Sound to the east of the Exumas.

The island of Bimini, in the west, lies within 50 miles (80km) of the east coast of Florida and Inagua Island lies within 50 miles (80km) of the coast of Cuba and about sixty miles (96km) north of Haiti. The Turks and Caicos Islands are geographically and geologically part of the archipelago and share many plant and animal species. The Turks and Caicos Islands were under Bahamian Administration until about 1848 when they were placed under colonial administration from Jamaica.

1.1.2 Geology

The name, Bahamas, is a derivative of *baja mar*, which means shallow seas in Spanish and accurately describes the morphology of the archipelago. The islands of The Bahamas have generally low relief; around 80% of the land surface is within 3ft/1 meter of mean sea level. The

Bahama platform is partially covered by lithified Aeolian ridges, beach ridges, and areas of unconsolidated or partially consolidated sand. These formations contribute to the development of the islands, which form primarily on the eastern edges of the Little and Great Bahama Banks. The islands generally run northwest to southeast throughout the chain along the windward margins of the plateaus. Central ridges rising up to 100 ft (31m) may be found on most islands, including New Providence, with a maximum height of 127 ft (39 m) above sea level on the island. Cat Island boasts of the highest point in the archipelago at 206 ft (63 m). The highest point in Andros Island, the largest island in The Bahamas, is only 71 ft (21.6 m), and most of that island lies less than 20 ft (6m) above sea level. Throughout The Bahamas many rocks and sand banks are submerged at high tide and some connect larger islands at low tide. This low relief is evidence of sea level fluctuations, during the Pleistocene Epoch, which caused dune formation and the development of recessional beach ridge systems. These features then lithified due to the high level of calcium carbonate in the sands. Hearty and Kindler (1995) and Kindler and Hearty (1996) describe the carbonates of The Bahamas and the sea level changes that contributed to the islands' formation.

Geophysical data indicate that the carbonate deposits that comprise the Little and Great Bahama Banks range from 3.2 mi (5.4 km) and 6 mi (10km) thick. Sea level fluctuations during the Pleistocene Epoch exposed and inundated the upper portions of the islands at various times in the geological past. Radiocarbon dating has shown the rocks to be between 5,000 and 1,000,000 years old. Little et al. (1971 to 1976) compiled detailed reports on the geology, landforms, soils, water resources, vegetation and land use for the larger islands of The Bahamas. The studies were conducted by the Ministry of Overseas Development of the United Kingdom, under the auspices of The Bahamas Ministry of Agriculture.

1.1.3 Hydrogeology

The limestone rock, of which the islands are comprised, were formed due to wave action deposition of oolitic and skeletal sands from marine sources and cementation of these particles with calcium carbonate. Rainwater dissolves the calcium carbonate and penetrates even the microscopic pores between particles. The calcium carbonate may then precipitate out and cement nearby particles together. Conversely, rainwater may carve pathways through the rock as it dissolves away previous calcium carbonate deposits. The movement of water through the limestone rock may create holes and channels eventually carving subterranean tunnels, caves and chambers below the surface.

Housed below the land's surface are thin layers of fresh water. These thin destructible lenses float above the saline and brackish water below the islands' surfaces. Some of these lenses may be within a few feet of the island's surface and extend down to as much as 110 ft (40 m). The lens includes water enclosed or trapped in chambers, minute pores and cracks in the rock. These lenses may be exposed to the surface in some areas and are called blue holes. Well drilling on residential properties and within developments exploits this resource throughout the islands. Some settlements in the Bahama Islands are after the historically important wells that occur in the area such as Warderick Wells, Exuma and Spanish Wells, Eleuthera are two examples (Little et al. 1971-1976). The delicate nature of the freshwater lenses makes them prone to overexploitation or damage by salt intrusion in residential areas or within larger developments. Storm events and natural erosion within the limestone rock may also cause changes in the orientation, size or shape of the freshwater lenses in a given area (Cant 1986, Little et al 1971-1976). These factors provide for limited access to freshwater resources throughout The Bahamas. As the population of The Bahamas increases, access to potable freshwater resources is becoming increasingly important. Pollution of near surface lenses is highly probable since septic tanks are used on most properties (Cant, 1996, 1997). Freshwater supplies for the island of New Providence, where the vast majority of Bahamians live, is shipped from Andros Island by barge.

Groundwater resources also include fresh, brackish, saline and hypersaline waters found in the near and deep subsurface of the islands and in permanent and ephemeral water bodies. These bodies are affected by rainfall, geology, orientation and shape of surface and subsurface limestone.

1.2 CLIMATE

1.2.1 Weather Conditions

The Bahamas Archipelago spans 6° latitude and 9° longitude, across the Tropic of Cancer, so there are regional variations in weather patterns and a mix of climatic conditions throughout the island chain. The climate of The Bahamas is sub-tropical. It also has distinct winter and summer regimes (Halkitis et al., 1982). The Sub-tropical climate of The Bahamas lends itself to two distinct seasons. During the dry season from November to April, the islands experience less than 10 rainy days per month (Sealey et seq, 1994). Hurricane activity in any given year may increase rainfall in the month of November. Rain may fall 10 to 20 days per month during the wet season from May to October. The rainy months are considered the summer months in The Bahamas, when mean daily temperatures exceed 77°F (25°C).

There are no summits higher than 206 ft (63m). Therefore, mountain-induced rainfall or rain shadow zones are non-existent. Rain clouds that develop over the islands due to transpiration from vegetation may be displaced by the dominant Northeast trade winds. The rain subsequently falls on the western side of the narrow islands or out to sea (Little et al. 1971-1976). A distinct decrease in rainfall during the month of July creates a bi-modal rainfall distribution over the rainy season in southern islands. Rainfall is seen as highly localized and varies greatly even within small areas. The variation among rainfall gauges throughout The Bahamas would appear extremely high on a daily, weekly or monthly basis. Thus averages are generally calculated based on decades of data to determine trends (Department of Meteorology, 2009). Chenoweth (1998) provides an in-depth account and comparison of historical weather data for the islands from the 19th and 20th centuries.

The average maximum temperatures is approximately 88°F (31°C), but a temperature of 96°F (36°C) has been reached. The average minimum temperature is approximately 66°F (19°C),. However, a night time temperature as low as 41°F (5°C) has been recorded on January 19th, 1977 in New Providence. Mean daily temperatures generally lie between 60°F and 90°F (17°C and 32°C). Cool arctic air passing through the islands during the winter months may cause temporary drops in temperature called cold fronts from December to March and sometimes into April.

The climate in The Bahamas is described as tropical maritime wet and dry type climate with winter incursions of modified polar air. Generally, The Bahamas experiences neither frost, snow, sleet, hail nor extremes of temperatures. A unique exception to that occurred on January 19, 1977, when parts of the northern Bahamas experienced a brief flurry of light snow. The following climatological data (following) covers the 30-year period between 1971 and 2000. The lowest recorded temperature was 41.4°F (7^{o}C) on January 20th, 1981.

In New Providence, winter temperatures seldom fall much below 60°F (15.5^{o}C) and usually reach about 75°F (24^{o}C) during the afternoon. In the summer, temperatures usually fall to 78°F (25^{o}C) or less at night and seldom rise above 90°F (32^{o}C) during the day (Fig. 2). In the more northerly islands, winter temperatures are lower than New Providence and some 5°F (-15^{o}C) higher in the southern islands in summer months. Sea surface temperatures vary between 74°F (23^{o}C) in February and 83°F (28^{o}C) in August. Figure 2 shows the average maximum and minimum temperatures for New Providence.

Monthly Maximum and Minimum Temperatures for New Providence

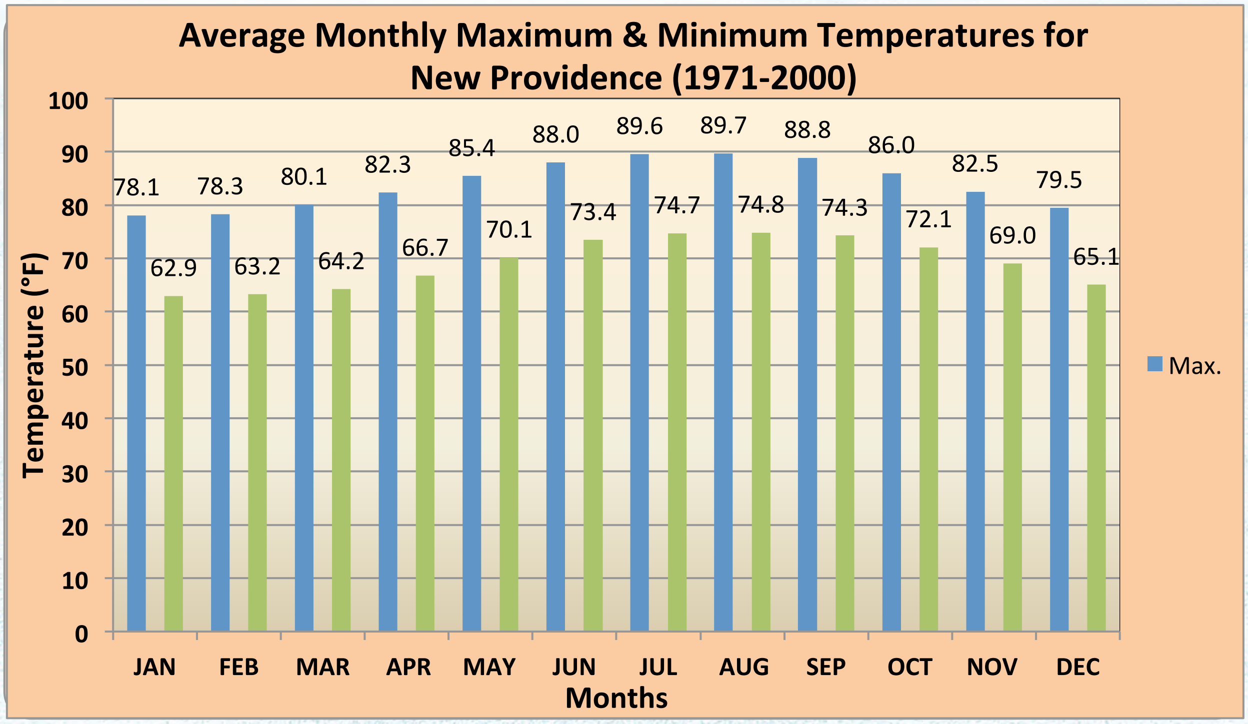


Figure 2: Average monthly maximum and minimum temperatures for New Providence

Humidity is fairly high, especially in the summer months. Winds are predominantly easterly throughout the year, but with a tendency to become northeasterly from October to April and southeasterly from May to September. Wind speeds are, on average, below 10 knots (18 km/hr); and in winter months, periods of a day to two of north and northeast winds of about 25 knots (42 km/hr) may occur.

On average, there is more than seven hours of bright sunshine per day in Nassau with periods of a day or two of cloudy weather at any time of year. The length of day (the interval between sunrise and sunset) varies from 10 hours and 35 minutes in late December to 13 hours and 41 minutes in late June.

Rain showers occur any time of the year, but the rainy months are May to October. For example, in Nassau, rainfall averages 2 inches (5.1 cm) a month from November to April and 6 inches (15 cm) a month from May to October. In the northern islands, rainfall averages are20% more. The southern islands normally receive half of the total rainfall in New Providence. Rainfall is mainly in the form of heavy showers or thundershowers, which clear quickly. Figure 3 shows the average (1971-2000) monthly rainfall for New Providence, indicating that more rain falls in the period June to October (summer). This period also coincides with the Atlantic Hurricane Season.

Monthly Rainfall for New Providence (1971-2000)

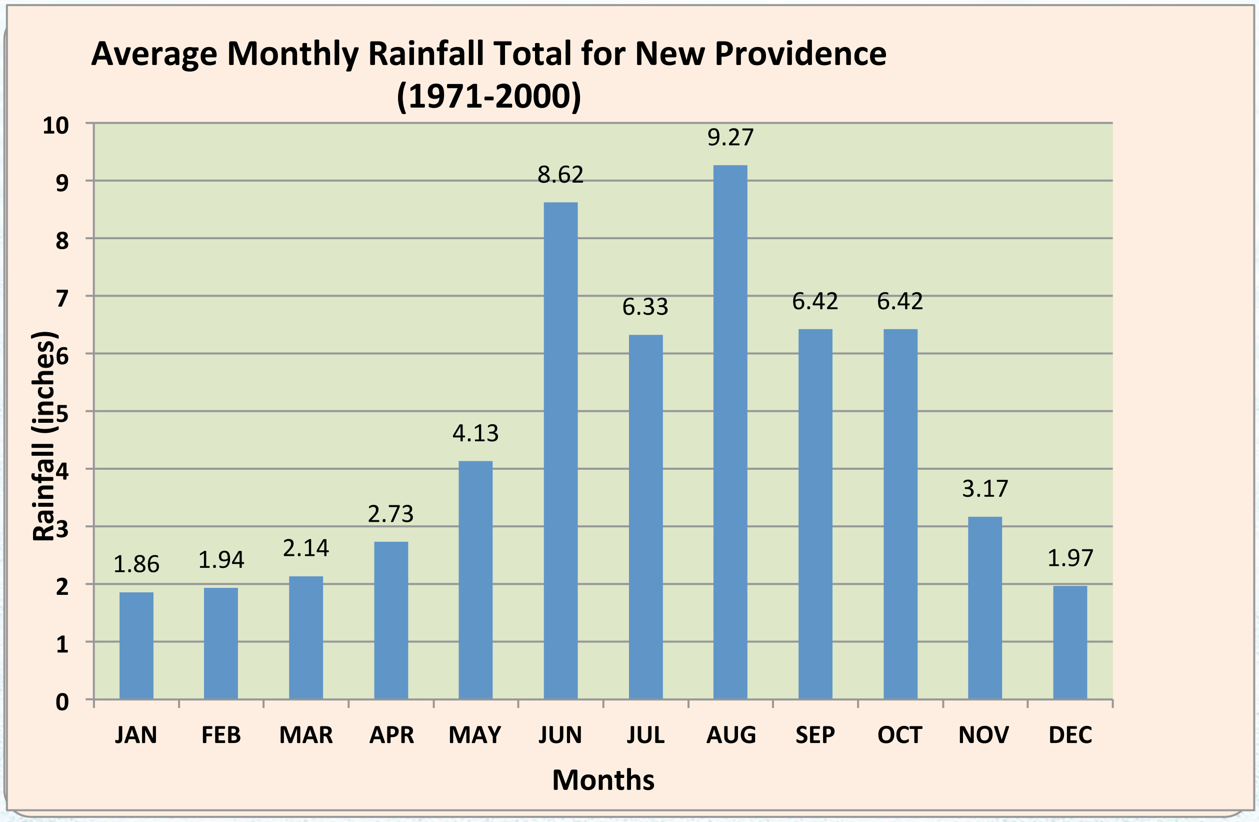


Figure 3: Average monthly rainfall for New Providence (1971-2000).

The Figure 3 above shows that the summer months in The Bahamas bring more rain than the winter months. This would have implications for agriculture where summer crops are suitable for good harvests. It is not known which of the summer crops would grow better under these conditions. However, the Department of Agriculture has conducted some studies relating to the impacts of climate change (especially on changes in temperature and rainfall) on crop growth.

The duration of daylight varies from 10 hours 35 minutes in late-December to 13 hours 41 minutes in late-June. There are at least seven (7) hours of bright sunshine per day year round, although it is not uncommon to get a spell of cloudy weather for two or three consecutive days at any time of the year.

1.2.1 Tropical Storms and Hurricanes and Non-tropical Processes

The Atlantic Hurricane Season (June 1 to November 30) produces several hurricanes each year to necessitate hurricane warnings and alerts in The Bahamas. Before sophisticated technology allowed the detection, tracking and monitoring of hurricanes, it is likely that many hurricanes went unreported. Customarily, hurricanes were reported when unless they were seen by ships or made landfall on inhabited islands. Hurricanes have been recorded in The Bahamas from the earliest settlers. Shaklee (1998) compiled 18th century hurricane data for the islands. There is little information given regarding the strength of these hurricanes beyond the amount of damage caused. The absence of rapid communication and early detection resulted in severe property damage because inhabitants had very little time to prepare for approaching hurricanes. It is unlikely that hurricanes affecting remote or uninhabited Family Islands (once called Out Islands) would have been reported. Based on the historic record, there were fewer hurricanes in the early twentieth century than in later years. This observation may be inaccurate if hurricanes were significantly under-reported. Forty-three hurricanes were reported in The Bahamas between the years 1900 and 1999. The mean of 4.3 storms per decade was exceeded in the first half of the century during the 1900s, 1920s, 1930s and 1940s. Four hurricanes occurred in 1933 making it the most active year for hurricanes affecting The Bahamas. The strongest hurricane recorded during that century was the category 5 (Saffir Simpson Scale) hurricane of 1947, which crossed Abaco and Grand Bahama before hitting Florida. However, this hurricane does not have a name like hurricanes of recent times, because it occurred before hurricanes were named.

Hurricanes are considered “major” when sustained winds exceed 111 miles per hour (mph) (178km/hr), which is a category 3 storm on the Saffir Simpson Scale. Since 2000, six major hurricanes have made landfall in The Bahamas or significantly impacted the islands.

Hurricanes that were notoriously destructive in The Bahamas include Hurricane Andrew (1992) and Hurricane Floyd (1999). The large separation between islands allows some islands to escape damage almost entirely, while others may be devastated.

Hurricane Andrew swept across North Eleuthera, Harbour Island, Spanish Wells, Current Island and the Berry Islands, while the Islands of New Providence and Andros were not so badly affected. The Disaster Preparedness and Response Act of 2006 established and published a network of emergency shelters throughout The Bahamas. Twenty-eight shelters are registered on the island of New Providence and 171 are distributed throughout the Family Islands.

Paths of all North Atlantic tropical storms and hurricanes from 1871 to present are provided in the United States Weather Bureau Technical Papers (Tropical Cyclones of the North Atlantic Ocean) and are updated every five years. The hurricanes and tropical storms passing within 100 miles (160km) of The Bahamas (distance to centre) are tallied in tables that follow.

Data on the number of tropical storms and hurricanes whose centre passed within 100 mi (160 km) of The Bahamas from 1871 to 1999 (129 seasons) are summarised in Table 1A. The data indicate that tropical storms and hurricanes most frequently occur in the months of September, October, August and November respectively.

Probability is calculated as the number recorded for any one month divided by the number of Atlantic hurricane seasons.

Hurricanes and Tropical Storms Between 1871-1999

1A: Number of hurricanes and tropical storms over the period 1871-1999 (129 hurricane seasons) by months								
Hurricanes & Tropical Storms	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**Total**
Number per month	**3**	**5**	**11**	**43**	**52**	**50**	**22**	**186**
Probability per month	**0.02**	**0.04**	**0.09**	**0.33**	**0.40**	**0.39**	**0.17**	**----**
1B: Number of hurricanes over the period 1886-1999 (115 hurricane seasons) by months								
Hurricanes	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**Total**
Number per month	**3**	**5**	**11**	**43**	**52**	**50**	**22**	**186**
Probability per month	**0.02**	**0.04**	**0.09**	**0.33**	**0.40**	**0.39**	**0.17**	**----**
1C: Number of tropical storms over the period 1886-1999 (114 hurricane seasons) by months								
Tropical Storms	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**Total**
Number per month	**2**	**4**	**7**	**14**	**19**	**28**	**12**	**86**
Probability per month	**0.02**	**0.04**	**0.06**	**0.12**	**0.17**	**0.25**	**0.11**	**----**

Table 1A: Hurricanes and tropical storms recorded over the period 1871-1999 (129 hurricane seasons) by months. Table 1B: Hurricanes recorded over the period 1886-2000 (115 hurricane seasons) by months. Table 1C: Tropical storms recorded over the period 1886-1999 (114 hurricane seasons) by months

From 1886 onward, hurricanes were distinguished from tropical storms, and data on the numbers of hurricanes and the number of tropical storms, are summarized in Tables 1B and 2C, respectively. The data indicate that in August and September, more than half of all tropical cyclones (storms plus hurricanes) affecting The Bahamas become hurricanes, whereas in other months, the proportion is about one-third. The information above indicates the total number of storms affecting any part of The Bahamas. Due to the variations in paths travelled by individual storms, these numbers may be significantly different for individual islands. As an example, Tropical Storm Chris passed south of Inagua in 2006 and its effects were not felt in the northern Bahamas. Storms of this nature may be reflected in national totals, though they may not affect some islands.

Between 1944 and 2010 the number of severe hurricanes (category 3-5) passing by within 69mi (111km) of The Bahamas was higher than in eastern and western Caribbean. Abaco and Grand Bahama had the most number of hurricanes in that period with a frequency of 40 in every 4 years. Thus, The Bahamas is more active than the eastern and western Caribbean (Caribbean Hurricane Network 2013). The island of Abaco in The Bahamas is considered the “Hurricane Capital of the Caribbean” based on the number of hurricanes between 1851 and 2010.

Storm surges are often associated with the movement of hurricanes across land, where the central low-pressure core of the storm pushes a wall of water ahead of it. Non-tropical processes also generate storm surges, with waves travelling long distances over the open ocean, and interacting with the ocean-facing side of the islands. The surge of water often lasts for several days due to the the height of the waves, the strength of the non-tropical process and the ocean wind dynamics at the site. Typical non-tropical processes create the “rages” of Abaco and North Eleuthera, as they face the open Atlantic Ocean. These rages often occur in the winter months as intense low-pressure systems move eastward into the North Atlantic Ocean. Rolle (1990) has produced an atlas of storm surge scenarios for the central and northern Bahamas. Geological evidence suggests that storm surges in the past have changed the coastline in certain areas of The Bahamas. On North Eleuthera, for example, huge boulders up to 1,000 cubic meters (m3) in volume are thought to have been moved onshore by storms approximately one hundred thousand years ago (Hearty, 1998). The presence of chevron-shaped coastlines, and evidence of inland flood levels, supports this theory. More recently, in 1991, the “Halloween storm”, struck at the Glass Window in North Eleuthera. A newly constructed reinforced bridge deck, weighing several hundred tons, was moved off its abutments by an Atlantic Ocean surge and caused coastal flooding across the northern region of the archipelago.

1.2 HISTORY AND GOVERNMENT OF THE BAHAMAS

1.3.1 History

San Salvador is generally accepted as the island where Cristóbal Colón (Christopher Columbus) landed on October 12, 1492. There has however been recent debate by some persons who claim that Cat Island is the true landing site. The Europeans encountered Taino Amerindians called the Lucayans inhabiting the islands during this time. These aboriginal people were taken into slavery by the Europeans. The Lucayans died out soon thereafter because of the European diseases and slavery. Therefore, the islands remained uninhabited until around 1648 when English pilgrims from Bermuda, seeking religious freedom, came to the island now called Eleuthera (freedom). Piracy developed as the norm for The Bahamas by the early 1700's. The British government appointed Woodes Rogers as the first Royal Governor of the Islands of The Bahamas in 1718 with the intent to put an end to piracy in the islands.

The colony, which then included the Turks and Caicos Islands (until 1848), saw little growth. Most commercial agricultural ventures were unsuccessful and persons lived primarily through subsistence fishing and farming. After the American Revolutionary War, Loyalists and their slaves settled in The Bahamas. Many of them attempted to establish cotton plantations, which soon failed due to poor conditions and crop pests.

An economic boom developed during the American Civil War (1861-1865) when The Bahamas was used as a gateway for the exchange of goods and materials between Europe and the Confederacy. During this time, the Royal Victoria Hotel was built on the island of New Providence in the capital city of Nassau. Prohibition of alcohol in the United States (US) between 1919 and 1933 encouraged the return of smuggling operations between The Bahamas and the US. After the end of the prohibition era, The Bahamas began to establish itself as a tourist destination and the tourism industry experienced continued growth.

Party politics in The Bahamas began in 1953. The extension of voting rights to non-property owners and women came soon after. A new Constitution was adopted in 1964 along with internal self-government. The Progressive Liberal Party heralded in the beginning of majority rule in The Bahamas by defeating the United Bahamian Party in 1967 and retained power until 1992. The Bahamas gained independence from England on July 10, 1973 and now is considered a small island state within the Commonwealth of Nations (formerly the British Empire).

1.3.2 National Government

Head of State

Her Majesty Queen Elizabeth II is Head of State and is represented by the Governor-General. Her Majesty appoints the Governor General on the advice of the Prime Minister and the Governor General can be legally removed by the Prime Minister. His Excellency, the Honourable Arthur Foulkes is the tenth Governor General appointed to The Bahamas since Independence Day, July 10th 1973. The Governor General signs bills into law after they are passed by the House of Assembly and the Senate.

Executive Branch

The Executive branch of the government includes the Prime Minister, the Attorney-General and at least seven other members. The Prime Minister and Minister of Finance must be members of the House of Assembly. The other Cabinet Ministers and Ministers of State are appointed from the House of Assembly and up to three senators may be appointed as Ministers. The appointed Ministers and Ministers of State are responsible for running their Government ministries. Each ministry has a Permanent Secretary, a designated public officer, who is responsible for the organization and control of the work of the ministry on a day-to-day basis.

Legislative Branch

The Bahamas legislature is a two-chamber system based on the Westminster model, with a House of Assembly and a Senate. First convened in 1972, The Bahamas House of Assembly is the fourth oldest parliament in the English-speaking world. The House of Assembly is comprised of at least 38 elected representatives of the Bahamian citizenry. There 41 seats in the House of Assembly - 25 constituencies in Nassau and 16 in the Family Islands. The 16 members of the Senate are appointed as follows: nine members appointed by the Governor General on the advice of the Prime Minister, four on the advice of the Leader of the Opposition, and three on the advice of the Prime Minister after consultation with the Leader of the Opposition. This means that the Opposition will have at least four representatives in the Senate and may influence directly as many as seven Senate seats.

Laws in The Bahamas begin as “bills” introduced in the House of Assembly. Each bill must be read three times, debated and passed. If passed, the bills then enter the Senate to be read three times and debated. If passed after debate by the Senate, the bill is then sent to the Governor General. Once signed, the bill becomes law.

Judicial System

English Common Law is the basis of the judicial system, although there is a large volume of Bahamian statute law. The highest tribunal in the country is the Court of Appeal, which sits on a full-time basis througout the five year. Five Judges are appointed by the Governor General, inlcuding the residing president, three resident judges and one non-resident judge. Generally, three judges sit to conduct hearings. In practice, they are usually leading judges of Commonwealth countries, and they need have no former ties with The Bahamas.

The Chief Justice as well as the 11 justices who are appointed by the Governor General presides in the Supreme Court, which has general, civil and criminal jurisdiction. In addition there are two Supreme Courts. And one resident Justice in Freeport, Grand Bahamas, presiding over the northern region of The Bahamas, which includes Bimini, Abaco, and Grand Bahama. New Providence has 13 magistrates’ courts. Grand Bahama has four magistrates’ courts.

In addition, all Family Island administrators exercise summary jurisdiction in crimininal matters of a less serious nature and in civil matters. An appeal from a decision of a Family Island administrator acting in his capacity as a magistrate goes to the stipendary and circuit magistrate, and an appeal from a decision by a stipendary and circuit magistrate excercising origianal jurisdiction goes to the Supreme Court and in some instances directly to the Court of Appeal. An appeal from a Supreme Court decision goes to The Bahamas Court of Appeal, and an appeal from The Bahamas Court of Appeal goes to the judicial committee of the Privy Council in England.[12]

[12] Bahamas Handbook (2008), Judicial System, p. 425

Majority Rule

Elections in The Bahamas are held every five years. Voting is open to all Bahamian adults over 18 years of age and residing in The Bahamas. The major political parties are the ruling Free National Movement (FNM) and the Progressive Liberal Party (PLP). The party winning the majority of seats (constituencies) in the election forms the government. The last general election was held May 2, 2007. The next general election must be held within 5 years, but may be held before if the Governor General, on advice of the Prime Minister chooses to dissolve Parliament.

Local Government

In July 1996, the Local Government Act of that year allowed twenty-three Family Island districts to hold elections. In the following month, elected officials assumed responsibility for their communities. Local Government allows greater autonomy in Family Island communities and makes Central Government more accountable to those communities. Local Government elections are held every 3 years and positions are open to certain public servants who can campaign without jeopardizing their current jobs, tenure or eligibility for promotion in the public service. New Providence is not included in the Local Government system though provisions in the Act allow for any part of the island to be added to the system by the responsible Minister. The 23 Local Government districts are listed below. Some Family Islands are divided into multiple districts while other Family Islands are grouped together to form one district. Having Local Government offices and officials allow the government to better oversee and account for the regular operations of each district.

The Local Government Districts are as follows:

- North Abaco
- Central Abaco
- South Abaco
- Acklins, Crooked Island and Long Cay
- North Andros
- Central Andros
- South Andros
- Berry Islands
- Bimini and Cat Cay
- Cat Island
- North Eleuthera
- Central Eleuthera
- South Eleuthera
- East Grand Bahama
- Exuma and Exuma Cays
- The City of Freeport
- West Grand Bahama
- Inagua
- Long Island
- Mayaguana
- Ragged Island
- Rum Cay
- San Salvador

1.4 POPULATION

The Statistics Act of 1973 established the foundation of the authority of the Department of Statistics to collect, compile, analyze and publish census data. The Act makes provisions for failure to furnish information and penalties for breaches in the confidentiality of the information by agents of the Department. A major task of the Department is to conduct a census every ten years.

The population of The Bahamas was determined to be 255,049 in 1990, 303,611 in 2000, and 351,461 in 2010 which is an average increase of 1.9% per year. The projected population for 2008 was 338,300. At the time of the 2010 census, 26.8% of the population was under the age of 15, 68.8% were aged 15 to 64 years and 6.2% of the population was over 65 years of age. The vast majority of Bahamians, 246,329 (70%) live on the Island of New Providence while Grand Bahama has a population of 51,368 (14.6%). The capital city of Nassau is located on New Providence and the second city, Freeport is located on Grand Bahama. Increased development, urbanization, and job availability on these islands account for relatively high population densities when compared to other islands. The population density for New Providence, which is only 21 miles long by 7 miles wide at its furthest points, was determined by the 2010 census as 2,635 persons per square mile (mi^2) or 6,825 square kilometres (**km^2**). Andros, Abaco and Inagua, are the first, second and third largest islands in the nation respectively. These islands have significantly lower population densities.

The national population density average of 65.3 per mi^2 was dwarfed by the population density on New Providence of 3,079 per mi^2 (7,974.5 km^2) in 2010. Grand Bahama with an area of 530 mi^2 (1373 km^2) had a population density of 96.9 per mi^2 (248.6 km^2). Andros the largest island in the country (2300 mi^2) has a population density of only 3.3 per mi^2 (2.58 km^2). The increase in tourism, banking and other jobs in New Providence has caused a dramatic population decline in some Family Islands as citizens' move to New Providence in search of better opportunities. These opportunities may include employment and education, which are not available on other islands. This emigration from Family Islands has served to slow development in each of the affected islands, which already have lower population densities.

Population growth in New Providence is rapidly approaching its space limits for homes, recreation and the availability of freshwater and other resources. New Providence saw a 14.4% population increase in the years 2000 to 2010. Fishing is a stable source of income or sustenance in most islands and ecotourism-related development is on the rise. The island of Andros saw a population decrease from 8,307 in 1980 to 8,177 in 1990 and at the last census in 2010, the population was 7,490.

Land Area, Population and Density of the Principal islands of The Bahamas

Island	Area(mi^2)	Population (2000 census)	Density (per mi^2) 2000	Population (2010 census)
New Providence & Paradise Island	80	210,832	2,635	246,329
Grand Bahama	530	46,994	89	51,368
Abaco	649	13,170	20	17,224
Acklins	192	428	2	560
Andros	2,300	7,686	3	7,490
Berry Islands	12	709	59	807
Bimini Islands	9	1,717	190	1,988
Cat Island	150	1,647	11	1,522
Crooked Island & Long Cay	93	350	4	368
Eleuthera, Spanish Wells & Harbour Island	187	11,165	60	11,515
Exuma & Cays	112	3,571	32	6,928
Inagua	599	969	2	913
Long Island	230	2,992	13	3,094
Mayaguana	110	259	2	277
Ragged Island	14	72	5	72
San Salvador & Rum Cay	63	1,050	17	1039
All Bahamas	5,382	303,611	56	351,461

Table 2: Land area, population and density of the principal islands of The Bahamas. *Source: Department of Statistics*

1.4.1 Growth Rates

Data from the past three censuses indicate that the national population experienced an average growth rate of 2.2% per year over 30 years (1980 – 2010) and 1.9% between 1990 and 2010. Table 3 below shows birth and death rates and the rate of increase between 1990 and 2010. Death rates remain fairly stable, but birth rates (per 1000) show a steady decline. This creates a decrease in the natural rate of increase throughout the population.

Vital Events, Rates and Natural Increase for Bahamas (1990 - 2010)

Year	Birth Rate (per 1000)	Death Rate (per 1000)	Rate of Increase	Rate of Infant Mortality (per 1000 births)
1990	24.0	5.3	18.7	24.4
1991	23.9	5.2	18.8	22.3
1992	25.6	5.5	20.1	24.9
1993	24.8	5.6	19.2	19.2
1994	22.3	5.6	16.7	19.7
1995	22.4	5.9	16.5	19.0
1996	20.8	5.5	15.4	18.3
1997	20.9	5.9	15.0	16.4
1998	20.1	6.1	13.9	13.9
1999	18.0	5.5	12.5	15.8
2000	17.4	5.4	12.0	14.8
2001	17.3	5.6	11.7	12.7
2010	14.4	5.8	14.4	8.1

Table 3: Vital events, rates and natural increase for Bahamas, 1990 to 2010

1.4.2 Demographics

As of the year 2010, the population of The Bahamas totalled 351,461 with 181,204 persons registered as females and 170,257 males. The following figure and table shows the number of persons registered in The Bahamas by age and gender at the time of the 2000 census. In 2010 the highest number of persons in The Bahamas was less than 40 years old. So, with a significant number of persons 20 years or less, The Bahamas is considered a large young population.

Population Demographics for The Bahamas – 2005

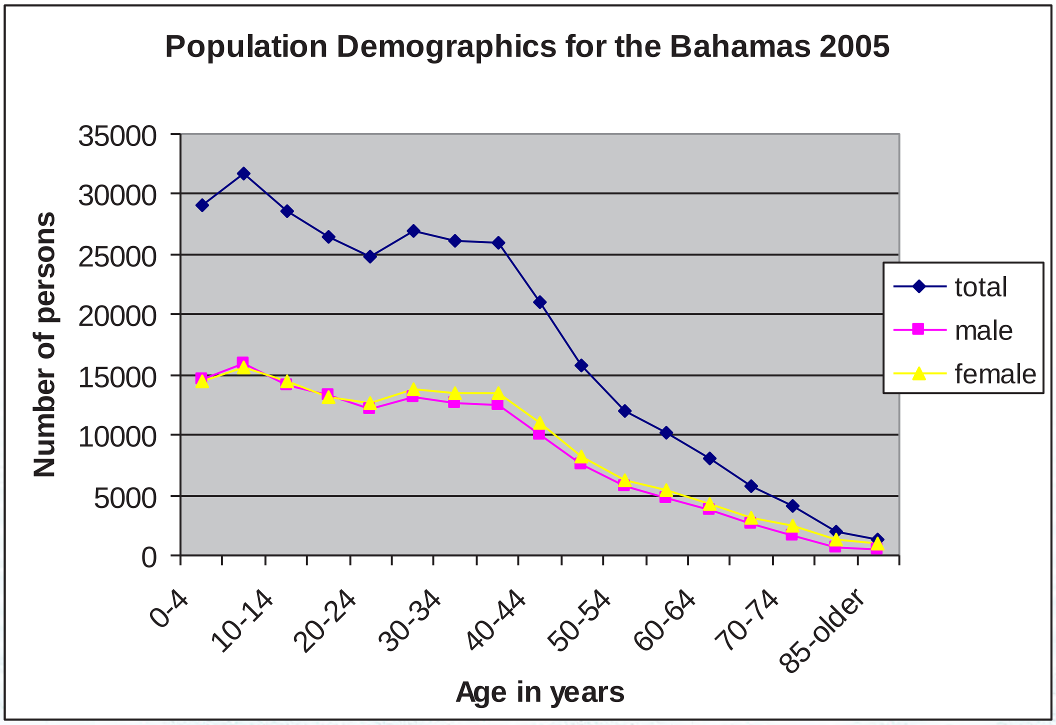


Figure 4: Population demographics for The Bahamas – 2005

1.4.3 Family Islands Population Trends

Excluding the islands of New Providence, Grand Bahama, Abaco, Exuma and Eleuthera, the total population of The Bahamas is 20,702 people. The >15 years of age group of these islands account for 73% of the population whilst the <15 years of age group accounts for the remaining 37%. Using this data, we can surmise that the total population of these islands are dominated by the >15 years of age group.

1.4.4 Causes of Death

Preliminary projections from the 2010 population and housing count estimated a total population of 353,658, a 16.48% increase over the 2000 population. There was a resultant increase in the population density per square mile (2.6 sq. km) from 56.7 in 2000 to 66.9 in 2010. The population distribution changed little over that period, with the exception of Exuma and the Cays, where the population more than doubled, from 3,571 to 7,314 persons. Most of the country's population (85%) resides in the most urbanized islands of New Providence and Grand Bahama.

The ten leading causes of death in The Bahamas during 2006-2009 period include hypertension (688) ischemic heart disease (605), HIV (566), cerebrovascular disease (517), diabetes (399) and assault (homicide) with 306 deaths (Bahamas 2013 http://www.paho.org/saludenlasamericas/.

1.3 ECONOMY

Tourism is the mainstay of the Bahamian economy, and the financial services sector is the second largest contributor to the gross domestic product (GDP). The 2012 annual preliminary results of gross domestic product are based on early estimates from major data sources such as the Central Bank, Ministry of Tourism, and the Foreign Trade Section of the Department of Statistics, etc. They are also based on indicators which normally mimic movements of particular industries such as Hotel Room Rates, Megawatt Sales, Building Permits, Chargeable Telephone Minutes, Consumer Price Index, etc. The 2012 GDP figures are preliminary and will be revised as more data becomes available. GDP is measured in both Current Market Prices and Constant 2006 Prices. The current measure utilizes current price levels and currency values, without factoring in inflation and determines the total value of the products and services produced in a particular year. The Constant Prices measures the effects of inflation and is more useful for studying trends in economic growth. According to the preliminary results, the GDP in Current Prices for 2012 had a positive growth of 3.5%, while GDP in Constant Prices grew at 1.83%. The hotel and restaurant expenditure in 2012 was $983.11 million.

Agriculture and fisheries make a much smaller contribution to GDP on the national level, but are very important in Family Island communities. The industrial sector is small, but growing. It stands to make increasing contributions to GDP in years to come as development continues. Government (utility) corporations and the public service currently employ more Bahamians than any other single employer. Government utilities include The Bahamas Electricity Corporation (BEC), The Bahamas Telecommunications Company Limited (BTC, formerly Batelco), The Bahamas Hotel Corporation, the Broadcasting Corporation of The Bahamas, Bahamasair Holdings (the national airline) and The Bahamas Water and Sewerage Corporation. The Government has begun privatization of the utilities by offering share sale of BTC in 2002. This sale will transfer management control and 49% stake in BTC to a "strategic partner".

The Bahamas national per capita income for the year 2001 was approximately $15,925. The national per capita GDP has increased to $ 24,279 (2008 estimate). Income distribution varies widely between the urban New Providence and Grand Bahama and the Family Island rural communities. Subsistence fishing and farming is still widely practised. Commercial efforts to exploit the marine resources and large scale farming on select islands mainly in the Northern and Central Bahamas, continues.

1.5.1 Tourism

Tourism continues to serve as the core of the Bahamian economy. In 2008, 3.9 million visitors to The Bahamas spent approximately 2 billion dollars (Central Bank of The Bahamas). Growth in the tourism sector is being encouraged by the Ministry of Tourism through increased offerings. These offerings include ecotourism opportunities, increased access to Family Islands and mooring sites throughout the islands for sailing visitors. This diversification is essential to the future growth and stability of the tourism industry.

Tourism in The Bahamas includes cruise ship visitors, stopover visitors and sailing guests. Tourism directly or indirectly employs approximately 50% of the Bahamian population. These persons may be employed in hotels, resorts, or restaurants, which cater to foreign visitors or provide services and entertainment geared toward the foreign guest. Dependence on the tourism sector makes The Bahamas vulnerable to changes in the global economy. This means that while tourism may remain relatively lucrative when compared to other industries, individuals employed in this sector may experience pay cuts, lay-offs, or loss of pay as tourist behaviour changes from year to year. The global economic crisis of 2008-2009 resulted in thousands of lay-offs from hotels, resorts and guest service businesses throughout The Bahamas.

Aside from economic contributions, tourism has a broad range of impacts on the environment and resources. Hotel and resort construction has resulted in damage to both marine and terrestrial environments. Developments, such as golf courses, may pose threats to water quality and coral reefs due to leaching of fertilizers and chemical for lawns. Along with increased tourism, there are concerns for the generation of electricity, potable water, and waste disposal for guests that visit The Bahamas in addition to services required for the Bahamian population.

The primary destination for tourists to The Bahamas is Nassau, where the international airport serves as a hub to most other islands and bridges connect to Paradise Island.

A recent renaissance of sorts in the tourism sector has diversified tourism income and increased the number of visitors to Family Island destinations such as Abaco, Andros, the Exumas and Harbour Island. These islands are marketed as prime ecotourism destinations. Environmentally friendly offerings include sustainable catch and release bonefishing on the west side of Andros, bird watching of the ground-nesting Bahama parrots in Abaco or sailing and kayaking through the Exuma Cays Land and Sea Park. This designation as an ecotourism destination allows many Bahamians to benefit from tourism revenues with minimal impact on the environment, and encourages lasting sustainable use of the resources available.

1.5.2 Banking and Finance

Banking and financial services in The Bahamas include numerous offshore banks. Many of these banks generate no Bahamian dollar earnings, but make gains through foreign exchange. The Bahamas is in the process of developing Tax Information Exchange Agreements with countries including the US and Canada. This is in an effort to prevent The Bahamas from being named as a tax haven and tarnishing its reputation.

1.5.3 Fisheries

The seas around The Bahamas are home to numerous species of fish, shellfish, turtles and marine mammals. Game fish and sport fish include amberjack, bonefish, dolphin, blue marlin (the national fish), white marlin, sailfish, swordfish, tuna, and wahoo. Limits and guidelines for the capture of these fish are well documented and have been in place for some time. Commercially important food species include the Queen Conch, the Nassau Grouper, the lane snapper, jacks and the spiny lobster. The Nassau Grouper has been fished into extinction in most other Caribbean countries. The Bahamas Government recently established a closed season for Nassau Grouper between November and March. Total fisheries catch for the year 2007 was valued at B$80.3 million dollars.

The citizenry of The Bahamas does not traditionally participate in the hunting of any marine mammal. Eight species of cetaceans occur in The Bahamas: the bottlenose, Atlantic spotted and spinner dolphins; and the minke, sperm, beaked, shortfin pilot and humpback whales. Monk seals were hunted into extinction over a century ago. Sharks are common throughout The Bahamas and various species include: black tips, bull sharks, hammerheads, lemon sharks, makos, nurse sharks and tiger sharks. Four species of turtle (green, hawksbill, leatherback and loggerhead) are known to nest in The Bahamas. Turtle capture and consumption by local fishermen are conducted to a limited extent in The Bahamas. A total ban on commercial sale of marine turtles was instituted on September 1, 2009, as a measure to prevent these activities and protect these endangered species. Scientific names of these species are listed in Annex 2.

Bahamian fisheries resource legislation is founded in the Fisheries Resources Act of 1977. The Act relies on a network of fisheries officers throughout the islands that enforce the regulations of the Department of Marine Resources. These regulations include restrictions of equipment type, vessel size, catch limits and designation of The Bahamas' Exclusive Fishery Zone (EFZ). Long line fishing is prohibited in The Bahamas, and only Bahamians are allowed to participate in commercial fishing within territorial waters.

Successful fisheries regulation includes protection of near shore and wetland habitats, such as sea grass, mangrove and coral communities, which provide important nursery grounds for many reef and pelagic species. Global warming is of particular concern. Many fisheries resources rely heavily on coral communities, which are sensitive to even the slightest change in water conditions, such as temperature and turbidity. Climate change, overfishing, endangered species, poaching, invasive species introduction and pollution are all concerns of fisheries resource managers.

Corals and the reefs they form also protect the island coastlines against erosion and storm action. As natural breakwaters, coral reefs generate new sand through natural erosion of the coral skeletons. This protection of coastlines and the production of sand ties fisheries resource management directly to one of The Bahamas' major tourism products - sandy beaches. With the advent of ecotourism and recent biomedical discoveries of useful chemicals found in corals, the benefits of establishing Marine Protected Areas (MPA) to protect marine resources like coral reefs has been recognized within The Bahamas. Burke and Maidens (2004) indicate that about 30% of the 4,000 mi^2 of coral reef within The Bahamas is under threat from overfishing and coastal impacts.

Soft corals of the species *Pseudopterogorgia elisabethae* are now subject to harvest in The Bahamas and may form a new industry. Extract from *P. elisabethae* is known to be useful in reduction of irritation, swelling and redness of the skin (Nava Dayan in BEST 2002).

1.5.4 Agriculture

While small-scale agriculture is commonplace throughout the archipelago, it remains a very small percentage of the national GDP. Backyard farming is gaining popularity due to community initiatives throughout the country and focus on a small number of native and introduced fruit species. Food crops grown on the subsistence level also include corn, cassava, sweet potatoes, beans and pigeon peas. The number of farmers involved in subsistence agriculture is now on the decline, and the average age is increasing. Many farmers in Family Island communities also own goats, sheep or cattle for meat production, and there is significant egg and broiler production. Inputs for all agricultural products, such as feed and fertilizer, are imported.

The World Resources Institute (WRI) indicated in The Bahamas' Country Profile (2003) that the country produced an average of 1,000 metric tonnes of roots and tubers between 1996 and 1998, and 8,000 metric tonnes of meat during the same period. The total cropland in The Bahamas (1999) was estimated at 10,000 hectares (ha). From 1998 to 2000, The Bahamas imported roughly 98.1% of its total cereal consumption. Approximately 90% of food consumed in The Bahamas is imported, and includes all sugar, virtually all dairy products and most carbohydrate foods. Numerous bakeries operate in The Bahamas, but generally use imported ingredients. While there is room for growth in the agricultural sector, growth is seasonal and food import is necessary to meet the high demand in the hotel and restaurant industries.

1.5.5 Waste Management

The islands of The Bahamas currently do not have any factories engaged in the production of metal, paper or plastic. Therefore, all such material must be imported. Expenses associated with the export of these materials for recycling or other disposal hinders the removal of such waste from the country. Most communities have an area designated (officially or unofficially) as a dumpsite. The Environmental Health Services Act of 1987 provides regulations, penalties and provisions for remediation of pollution emission into the environment of The Bahamas. The regulations included in the Act govern emissions of pollutants and contaminants or disposal of solid waste and litter into the air, land or water. In Nassau, the landfill site has recently been reorganized, so that items brought into the dumpsite are now sorted. Ventilation of cells at the landfill allows methane gas to escape. This action prevents fires and collapsing pockets of gas, which present hazards to persons at the dumpsite and surrounding communities. Similar upgrades are in place in Grand Bahama, and the Family Islands are expected to follow suit.

Throughout The Bahamas, contamination of groundwater resources is an issue. The groundwater reserves are prone to contamination from various sources including: pathogens and nitrates from sewage; leachates from landfills or illegal dumping; industrial wastes, pesticides, fertilizers, fungicides and herbicides from agricultural use; leakage or spillage from underground fuel storage tanks; release of toxic chemicals and oils; improper waste handling from automobile repair and service; and zinc from wear of automobile tires on road surfaces (SENES 2005).

1.5.6 Energy Production and Transport

The Bahamas currently does not participate in energy generation from nuclear power. The primary source of energy for electricity generation, transportation and domestic use is the combustion of imported fossil fuels. These are also the primary sources of CO_2 emissions (65%) in the country (SENES 2005). Gasoline and diesel oil are used for transportation while liquefied petroleum gas (LPG) is used for cooking. Heavy reliance on air conditioning and refrigeration results in the release of hydrochlorofluorocarbons (HCFC's) into the atmosphere due to poor maintenance or improper disposal. A small amount of biomass may be used in the production of charcoal or as fuel wood for cooking particularly in rural areas. There are currently no facilities for the production of electricity from biomass. Boating, fishing, agriculture and other commercial industries contribute insignificant amounts to carbon emissions.

1.5.7 Industry

Brewing, distillation and furniture production represent the growing industrial sector in New Providence. Chemical and pharmaceutical manufacture industries are currently present in Grand Bahama. The oil refinery in Grand Bahama Island is no longer in operation. The Industries Encouragement Act of 1970 has been revised (1999) and provides benefits for persons wishing to develop industries in The Bahamas. The Act provides assistance for persons to source funds for necessary equipment, as well as, general tariff and tax breaks. The Act also contains safeguards against products or processes which may be detrimental to The Bahamas or its environment. Several companies produce and package food products such as fruit preserves and pepper sauces. Some small garment production operations exist in Nassau and Andros that produce hand-batiked garments. The industry producing straw work is of traditional importance to the islands of The Bahamas. Baskets, hats and accessories made by local artisans are popular souvenirs for tourists. There have also been recent developments in the jewellery industry, particularly with the use of conch shells. Morton Salt Company Limited has operated in The Bahamas since 1954, and was recently acquired (1999) by Rohm and Haas Company Limited.

1.5.8 Mining

Mining in The Bahamas is limited to the mining of rock and limestone sand. These activities are restricted by the regulations established in the Conservation and Protection of the Physical Landscape of The Bahamas Act of 1997. Only around 5% of the total surface area of The Bahamas is land and this land is needed for residential, agricultural and industrial development use. The quarry rock and sand resources mined throughout The Bahamas are generally not exported, but used instead to supply local demand for building material.

1.5.9 Ship Registry

The Bahamas' ship registry is among the three largest ship registry centres in the world. More than 1,600 ships were registered in The Bahamas in 1995. The Bahamas' Merchant Shipping Act of 1976 established guidelines for the maintenance of a ship registry and regulations for the vessels within the registry. Recent changes to the Act (2001) are in keeping with global standards and continue to make The Bahamas an attractive location for the registering of marine vessels. Some the changes include lowering of tariffs and fees for yachts and small cruise ships. Registration of foreign ships is limited to those ships that weigh over 1,600 net tons, are under 12 years old, and are considered pleasure yachts.

1.6 THE ENVIRONMENT

1.6.1 Introduction

The archipelagic configuration of the Islands of The Bahamas, allow the development of many distinct endemic species, and slight variations within species between islands. There are limited resources within the islands and this translates to fewer niches for terrestrial organisms. Considering the large expanse of open ocean that an animal must cross to arrive in The Bahamas from the neighbouring continents, animal diversity is very low, but highly unique. (Raffaele et. al 1998).

The Bahamas has a long history of environmental protection starting in 1952 with the Wild Birds Protection Act. This Act of Parliament makes provisions for protection of wild birds, enforcement through designation of wardens and punishment through fines and imprisonment. The Act also makes provisions for scientific collection and establishment of reserves.

The Wild Animals Protection Act of 1968 makes similar provisions for Abaco's wild horses, the Bahamian hutia and iguanas. The Bahamas National Trust Act of 1959 established The Bahamas National Trust (BNT) to preserve sites of "natural beauty". The BNT holds jurisdiction over more than 25 national parks and protected areas throughout the country and is the only non-governmental organization in the world with this mandate. The Bahamas continues to make strides in the protection of the environment. The establishment of The Bahamas Environment, Science and Technology (BEST) Commission in 1994 and the Conservation and Protection of the Physical Landscape Act of 1997 made way for increased conservation action and the promotion of the use of scientific data in future management decisions. The Bahamas Government has committed recently to protecting 20% of all near shore marine resources by the year 2020 through the Caribbean Challenge presented to the Convention on Biological Diversity in Bonn, Germany in May 2008.

1.6.2 The Bahamas Environment, Science and Technology (BEST) Commission

The Bahamas Environment, Science and Technology (BEST) Commission employs scientific officers who review plans for commercial, industrial or residential development within The Bahamas. Their mandate includes:

- Advising Government on the environmental implications of development proposals;
- Coordinating policies and programs for environmental protection;
- Fostering development of science and technology in The Bahamas;
- Developing a national conservation strategy and action plan;
- Proposing legislation to support national conservation strategy and plan;
- Preparing an inventory of natural resources, including species, habitats and ecosystems;
- Developing a national system of parks, protected areas and reserves, to provide for in situ conservation of inventoried resources; and
- Coordinating responses to the international environmental conventions to which The Bahamas is party.

The Government of The Bahamas has expressed its desire to achieve sustainability and eliminate poverty. The BEST Commission's review of proposals is a safeguard against development that is detrimental to The Bahamas, and ensures the sustainable exploitation of natural resources.

1.6.3 International Legal Instruments on the Environment

The Bahamas is a signatory to many International conventions and treaties that impact the national, regional or global environments. Each of the following treaties has implications on pollution, and the remediation of pollution, conservation and protection of natural resources, and the protection of endangered wildlife:

- Vienna Convention for the Protection of the Ozone Layer Concluded at Vienna on 22 March 1985 (Ratified on 1 April 1993);
- Montreal Protocol on Substances that Deplete the Ozone Layer Concluded at Montreal on 16 September 1987 (Ratified on 4 May 1993);
- Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (Ratified on 4 May 1993);
- Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (Ratified 4 May 1993);
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal. Concluded at Basel on 22 March 1989 (Ratified 12 August 1992);
- United Nations Framework Convention on Climate Change Concluded at New York on 9 May 1992 (Signed 12 June 1992; ratified 2 September 1994);
- Convention on Biological Diversity (Signed 12 June 1992; ratified 2 September 1994);
- Washington Convention or Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES);
- Law of the Sea Convention (1982);
- International Convention for the Prevention of Pollution from Ships (MARPOL 1973 and 1978) (Effective application: 16 February 1979 and 2 October 1978 respectively);

- International Coral Reef Initiative;
- Agenda 21;
- The Barbados SIDS Action Plan;
- Wider Caribbean Initiative on Generated Waste (MARPOL);
- UNEP Programme of Action;
- Action Plan of the Summit of the Americas;
- Programme of Action of the UN Commission on Sustainable Development;
- Programme of Action of COP II;
- International Convention for the Prevention of Pollution of the Sea by Oil (Ratified 22 October 1976);
- Amendments to the International convention for the Prevention of Pollution of the Sea by Oil, 1954, Concerning Tank Arrangements and Limitation of tank Size (Ratified 16 February 1979);
- Amendments to the International Convention for the Prevention of Pollution of the Sea by Oil, Concerning the Protection of the Great Barrier Reef (Ratified 16 February 1979);
- Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Use of Outer Space and Under Water (Ratified 11 August 1976);
- Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies (Ratified 11 August 1976);
- International Convention on Civil Liability for Oil Pollution Damage (20 January 1976);
- International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Ratified 30 March 1983);
- Protocol relating to Intervention on the High Seas in Cases of Marine Pollution by Substances Other than Oil (Ratified 30 March 1983);
- International Convention on the Establishment of an International Fund for Compensating Oil Pollution Damage as Amended (Ratified 16 October 1978);
- Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxic Weapons, on their Destruction (Ratified 26 November 1986);
- United Nations Convention on the Law of the Sea of 10^{th} December, 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (Ratified 16 January 1997);Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region;
- Cartagena Convention to Negotiate Final Protocol Concerning Pollution from Land-Based Sources and Activities;
- Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean (SPAW); and
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention).

1.6.4 Biodiversity

The biodiversity of The Bahamas has been described by the BEST Commission in The Bahamas Country Study Report (1995). Raffaele et al describe the birds of The Bahamas as part of their guide to West Indian avifauna. White (1998) gives an in-depth, island-by-island description of the bird species occurring within The Bahamas. Correll and Correll (1982) describe the plant species in extreme detail. Issues pertaining to the prevention of biodiversity loss are contained in the National Biodiversity Strategy and Action Plan (NBSAP) prepared by the BEST Commission in 1998. This plan is essential to the fulfilment of the country's obligations under the CBD.

The flora of The Bahamas is generally referred to as "bush" by locals. The "bush" is classified as high coppice (inland hardwood forests) and seaside or coastal coppice (low growing salt tolerant trees and shrubs). Mangrove wetlands (referred to as swamps) and pine forests also are important plant communities in The Bahamas. All islands are covered to a greater or lesser extent with high and low coppice and mangrove forests. Pine forests, however, only occur in the northern islands referred to as the Pine Islands, mainly Abaco, Andros, Grand Bahama and New Providence.

Common hardwood species in the coppice areas include seagrape, mahogany, gum elemi, buttonwood, horseflesh, and poisonwood with numerous other trees, vines and shrubs. Black, white and red mangroves and silver and green buttonwood occur in the archipelago. Twelve tree species of traditional or ecological importance have been included in the Conservation and Protection of the Physical Landscape Act. These trees are protected from harvest. Agencies like The Bahamas National Trust are promoting xeriscaping in an effort to increase the use of native plants in landscaping to conserve water. Many non-native fruit trees have been introduced to The Bahamas for cultivation and some have escaped or become naturalized and can be found throughout The Bahamas.

Endemic animal species found in The Bahamas include various butterflies, moths, and other insects and arthropods, birds, lizards, iguanas, crabs, snakes and the Bahamian hutia, the only native land mammal. Some cave bats also occur throughout the islands.

Blue holes and subterranean cave systems in islands such as Andros are also thought to be home to unidentified species. The opportunity to see these organisms, which only occur in The Bahamas, presents a viable tourism product. The small populations and limited distributions of some of the organisms present a looming threat of extinction in some cases. Lack of research and scientific data further compounds the decision-making process regarding protection and sustainable use of living resources.

The Bahamian hutia was thought extinct until 1966 when it was found on East Plana Cay. It is believed that the hutia was driven to near extinction by the introduction of dogs and cats with the first settlers in the islands. Hutias have since been reintroduced to islands in the Exuma Cays Land and Sea Park. This reintroduction, however, may have been detrimental to the habitat on those islands. The high reproductive rates of hutias, along with the absence of animals, which may have preyed on them in the past, have allowed their population to bloom. They are voracious herbivores and the plant populations on cays with hutias have been altered drastically. Hutia seem to eat all the most edible plants first, and then consume other plant species virtually eliminating one species at a time until only the least edible plants remain in abundance. There is also evidence that the hutia may have spread to adjacent islands within the park.

The Abaco parrot has been the subject of various studies, and it is the only Amazon parrot known to nest in the ground. This behaviour makes the Abaco parrot vulnerable to predation by introduced animals such as dogs, cats, raccoons and feral pigs.

The iguanas present on various islands are protected along with the hutia, the Bahama Parrot and Abaco's wild horses, which some experts consider near extinction.

A large number of islands in The Bahamas may yet contain discoveries of new species or populations of other species thought to be extinct.

The primary human impacts on the environment throughout The Bahamas continue to be the introduction of invasive species, habitat destruction and pollution. The natural environment is annually exposed to risks associated with extreme events, tropical storms and hurricanes which are exacerbated by climate change climate and climate variability. Mean sea levels have risen across The Bahamas, since 1903, by one foot. Coral bleaching events were recorded, as well as storm surges, intense rainfall events and prolonged droughts which have resulted in damage to the mangrove, slow growing coppice and pine ecosystems.

1.6.5 Threat of Invasive Species

The Bahamas as a leader in the tourism sector is open to imports (deliberate and accidental) of exotic species from around the globe and even more so from neighbouring countries. As an archipelago, the proximity of the islands to one another within the chain and coral reefs that surround them may promote dispersal between the islands for some organisms. Conversely, the distance between the islands and their small size may prevent dispersal of organisms between islands, without human help.

Invasive plant species in The Bahamas are primarily escaped ornamentals brought to the islands for decorative purposes. These introduced invasive plant species such as Casuarinas, Hawaiian seagrape, paper bark tree (Melaleuca) and Brazilian pepper now occur on most inhabited islands. The aforementioned species are exceedingly common in the more populated islands of New Providence, Grand Bahama, and Abaco.

Invasive animals such as rats, dogs, cats, and livestock are common throughout the islands with many of them feral. Raccoons, introduced from the United States, are present in the northern islands of Abaco, Grand Bahama and New Providence. They cause crop damage to watermelon farms in Abaco and may impact the Abaco parrot population in coming years. Stray dogs and cats may kill or harass birds, snakes and lizards throughout the inhabited islands and may contribute to local extinction. Livestock consumption of specific plant species may significantly alter habitat in The Bahamas which can result in extreme changes in biodiversity over small areas. Donkeys, horses and hogs are also found on Abaco and Inagua.

The Pacific lionfish invaded the waters surrounding The Bahamas and are found in marine habitats, shallow waters and depths up to 400 feet. Stomach contents of lionfish have been found to include small fish, octopuses, and shrimp. This evidence is proof of potentially serious impacts on fisheries resources and biodiversity of Bahamian coral reef ecosystems. Perhaps because of the potential impact to the fisheries and tourism industries, cooperative lionfish removal initiatives are underway throughout the islands. This is also the first invasive species with a targeted exploitation campaign. The Department of Marine Resources and environmental NGOs in The Bahamas have recently begun promoting the consumption of lionfish.

Poaching of fish, iguanas and snakes in The Bahamas for the foreign pet trade are of concern to resource managers and law enforcement officers. Commercial poaching of fish by neighbouring countries is also a major concern, and the archipelagic nature of The Bahamas and limited resources of personnel and equipment make border control difficult. Burke and Maidens (2004) describe overfishing as the single greatest threat to coral reef ecosystems in The Bahamas and the wider Caribbean. Targeted removal of food species affect the natural balance in the ecosystem and eventually may cause trophic cascades (a systemic collapse) within communities.

Habitat destruction including clearing of land for development, dredging of harbours and destruction of mangroves and wetlands for the creation of marinas pose serious threats to Bahamian biodiversity.

Waste and refuse that wash ashore from illegal dumping into waterways and wetland areas and from sailing and boating activities can be seen on nearly all islands of The Bahamas.

1.6.6 Land Use, Land Use Changes and Forestry

The thin, dry, calcareous soils of The Bahamas are generally low in fertility and soon become exhausted when used for farming. Historically, subsistence farming was a common activity. The slash and burn farming method would see large plots cleared and the foliage burnt so that the ashes would quickly return a small amount of nutrients to the soil. The land would typically become exhausted after a few seasons of farming and when yield dropped significantly, a new area was cleared. Due to the rapid spread of this type of agriculture, most islands now have very little old growth or pristine forests.

Large-scale agricultural operations including cotton, citrus, pineapple, sisal, tomatoes and watermelon have seen limited or short-lived success in the thin Bahamian soil.

The tourism industry has boomed in recent decades and luxury resorts are being built throughout The Bahamas, predominantly along the coastlines. Some have been heralded as sources of jobs, while others have posed environmental concerns. New Providence coastlines have been extensively cleared for hotels, luxury housing complexes and private homes. The island’s interior is now subjected to unprecedented urban sprawl. Large tracts of land are being cleared for housing, business developments and road construction throughout the island.

Grand Bahama has been developed as a major oil transhipment point and its cruise ship facilities rival those of Nassau Harbour in New Providence. The Morton Salt Company on Inagua Island is the only large development on that island which otherwise remains mainly undeveloped.

Other islands in the archipelago have also been affected by rapid urbanization and development. Family islands such as Acklins, Crooked Island, the Exuma Cays, Mayaguana and Ragged Island remain virtually unchanged over the past century.

The lumber industry in the 20th century was not sustainably managed in The Bahamas. A sawmill operated in Abaco until 1943, and in Grand Bahama until 1970, leaving the pine forests virtually denuded. Similar operations in New Providence and Andros were much smaller though they amounted to similar effects on the environment. Abaco currently has the largest area of pine forest habitat in The Bahamas, but very few of the original trees remain standing there. After its eclipse, the logging industry left numerous logging and access roads throughout the aforementioned islands, which are now used by hunters in those islands and to a limited extent bird watchers and persons participating in ecotourism. The Abaco race of the Bahama Parrot is currently known to be the only Amazon parrot to nest in ground cavities. It has been suggested that this may be in response to the removal of the vast majority of trees, large enough to hold nesting cavities which is normal for the parrots in Inagua. Stahala (2004) and Gnam (1990 & 1991) discuss the ecology and conservation of the ground nesting Bahama parrot. The pine forests are recognized as an important and exploitable resource. Cutts (2004) and Patterson and Stevenson (1977) provide useful guides for identification of the trees of The Bahamas. The restoration of the forests is important to the viability of future sustainable use activities as well as to the many under-storey broadleaf plants, orchids, bromeliads, ferns and vines. Crabs in the forests of Andros are an intimate part of that island's heritage and culture. The Abaco Parrots nest exclusively in the pine forests of Abaco. Henry (1974) thoroughly describes the distribution of Bahamian pine forests. Little et al (1971-1976) described and inventoried the hardwood forests at that time.

The Bahamas has a long history of forest exploitation dating back to the 1700s when almost all large sized valuable hardwood species were exported. The last extensive exploitation ended in the early 1970s when the pine forests were harvested for pulpwood. Today, in The Bahamas the forests are rebounding and forestry itself is facing a revival. The country, once again possesses substantial natural forest resources comprising pine forests, coppice hardwoods and mangrove forests, with approximately 80% of forest resources on state lands (Crown land) and the remaining 20% on private lands.

Estimates of the extent of the natural pine forest resources is approximately 500,000 acres, and is widely deemed the most productive of the three vegetation types, based on inventory data collected in the 1986 under the FAO/BHA/TCP, forestry development project. The specie (Pinus caribaea var. bahamensis) is located on the four of the most northerly islands in The Bahamas, namely Abaco, Andros, Andros, Grand Bahama, and New Providence. The overall aim of FAO forestry development project was to determine the pine forest resource, to propose appropriate management and to assist in the development of management capability. The Coppice (hardwood) forest was never inventoried, and predominates in the central and southern Bahamas, comprising noteworthy valuable species such as mahogany, buttonwood, rat wood, gum elemi, black ebony, brazeletto, horseflesh, lignum vitae and red cedar. Mangrove ecosystems dominate on the leeward shores of most islands and its area is estimated at some 4,286 km2.

The Bahamas Parliament enacted the Forestry Act 2010, which established a Forestry Unit within the Ministry of the Environment and Housing. A Director of Forestry was appointed who has overall responsibility for the administration of the Forestry Unit, the Forestry Act, and for the management and development of forests.

The Forestry Unit is mandated to develop the forest resources of The Bahamas to their maximum potential by applying sound, scientific, and sustained yield forest management principles and concepts. The Act calls for the declaration of a national forest estate comprising forest reserves, protected forests and conservation forest to be managed in the national interest. A National Forest Plan and Forest Management Plans for the National Forest Estate will be prepared with appropriate guidelines to effectively and efficiently manage Bahamian forests. These plans will also assist in the development of small scale forest based industries to reduce wood imports. Also of great significance are the opportunities for biodiversity conservation, ecotourism, soil and water conservation, microclimate regulation, climate change, agro-forestry development and environmental enhancement.

1.7 HEALTH

The Ministry of Health holds responsibilities in human physical and mental health. It manages numerous public clinics throughout the islands and two major hospitals. The Public Hospitals Authority (PHA) and the Department of Public Health (DPH) are the two main agencies within the Ministry. The Department of Public Health oversees the development of healthcare programmes and manages health care clinics throughout The Bahamas. The Public Hospitals Authority now holds title to and responsibility for all the hospital properties previously held by the Government of The Bahamas. The PHA is also responsible for National Emergency Medical Services (NEMS), The Bahamas National Drug Agency (BNDA), the Materials Management Directorate (MMD) and Grand Bahama Health Services (GBHS). NEMS, BNDA and MMD are part of the shared services group with responsibilities shared between the PHA and the DPH. The Princess Margaret Hospital in New Providence and the Rand Memorial Hospital in Grand Bahama are the two public hospitals. Sandilands Rehabilitation Centre in Nassau cares for and rehabilitates persons with various infirmities and mental illnesses, including drug addiction, senility, and blindness. Health care professionals from other Caribbean nations contribute to the workforce in this area. Forty-three public clinics throughout the Family Islands provide limited health care to residents, but major medical needs are accommodated at the two hospitals. In the event of emergencies, air ambulances between islands provide transportation to the major hospital facilities.

1.7.1 Vector-borne Diseases

Vector–borne diseases represent a health and an economic threat to The Bahamas. Dengue, malaria, and yellow fever are not endemic to the country. Between 1998 and 2011, The Bahamas had a dramatic rise in the number of conformed cases of dengue fever. Thus in 1998 there were 365 cases, in 2003 155 cases and in 2011 there were 3,500 cases. The actual cases may have been higher than those reported (Bain, 2011). In 2006, 19 imported cases of malaria were reported in the island of Exuma due to *Plasmodium falciparum*, but with no associated mortality. In 2008, there was a single case of dengue fever reported.

The responsibility for vector control is shared between the Ministry of Health and the Department of Environmental Health Services. During the review period, vector control programs focused primarily on eradication and control of *Aedes aegypti* and anopheles mosquitoes. The vector control strategies employed included aquatic weed control, aerosol pesticide, larvaciding, education, training and other social marketing initiatives.

Despite active vector control programs, in 2006, 19 imported cases of malaria were reported in the island of Exuma due to *Plasmodium falciparum*, but with no associated mortality. In 2008, there was a single case of dengue fever reported.

The National Insurance Act of 1972 and the National Health Insurance Act of 2006 established the National Insurance Board (NIB) and the National Health Insurance Commission (NHIC) respectively. The National Insurance Act regulates payment of a form of social security by all employed Bahamians and allows all Bahamians access to health care and income in times of sickness, injury, disability, maternity, death, retirement or unemployment. The National Health Insurance Act allows insured citizens access to a standard package of health care services. Both of these legal instruments are aimed at improving the overall standard of health within The Bahamas and improving the overall quality of life for all people of the nation.

Summary of National Circumstances

CRITERIA	2010
Population (2010 Census)	**346,900**
Relevant area Total (Km^2)	**13,943**
Land area (Km^2)	**10,070**
GDP at current market price	**US$ 8.552 billion (2010 estimate)**
GDP per capita at current market price (2010)	**USD24,279**
Share of industry in GDP (%)	**14.7**
Share of services in GDP (%)	**84.1 (2001)**
Share of agriculture in GDP (%)	**1.2**
Urban population as % of total population	**83.9 (2009)**
Total labour force (2009)	**184,000**
Percentage of workforce unemployed (%)	**7.6**
Population in absolute poverty (% 2004)	**9.3**
Life Expectancy at birth (years)	**73 (2007)**

Table 5: Summary of national circumstances. *Source: Central Bank of The Bahamas*

CHAPTER 2: NATIONAL GREENHOUSE GAS INVENTORY

2.1 INTRODUCTION

In accordance with Article 4.1 (a) of the United Nations Framework Convention on Climate Change (UNFCCC), all parties are required to update and report periodically on their national inventory of anthropogenic greenhouse gas emissions and/or removals. A National Climate Change Committee was formed and convened in March 1996. An initial inventory was conducted and reported to the UNFCCC Secretariat in The Bahamas First National Communication in 2001.

With a slightly different composition than the initial inventory, the National Climate Change Committee conducted the second national inventory of greenhouse gases in The Bahamas.

The National Climate Change Committee organized a National Communication Workshop in July 2007, which also served as a working session for the second Greenhouse Gas Inventory. At the working session the potential greenhouse gas sources, which were identified during the initial GHG inventory were reviewed for relevance and additional sources considered.

Subsequent meetings of the National Climate Change Committee provided for the review of data categories and the analysis of fuel sources for imports into The Bahamas.

Greenhouse Gas (GHG) emissions and their removal by sinks have been calculated for The Bahamas for the year 2000. Where appropriate the inventory relies on three-year averages of activities, except in the Energy Category where yearly average figures are used.

Electricity generation and the transportation sector are the two most significant sources of greenhouse gas emissions in The Bahamas. There is no primary fuel production in The Bahamas and all fossil fuels are imported. International marine and air bunkering fuels and the storage and transmission of fossil fuel, represent fuel exported through The Bahamas.

During the compilation of the initial national GHG inventory, it was recognized that there were problems “in the compilation, gathering and access to data held in the public domain”. The process for accessing and retrieving data collected for statistical purposes in The Bahamas was governed by rules that were not easily overcome and that “a framework for reporting of the data and obtaining access to the data did not exist”. As such, data held in statistical databases could not be made available for the inventory without violating existing rules and regulations. This issue applied to all sectors. The lack of disaggregated data did not allow for relevant information from sources to verify the reference approach. A statistical survey was required to collate and verify existing data.

The initial inventory relied on data obtained from the Central Bank of The Bahamas and from the Customs Department database. In order to perform the greenhouse gas inventory for The Bahamas, nationally derived import data was used.

In preparing the second national inventory, decision trees were developed for all sectors to identify data sources for the sectors.

Data for other sectors was taken from the Central Bank of The Bahamas' Quarterly Statistical Reports, as well as directly provided by the Department of Statistics, the Department of Environmental Health, the Department of Lands and Surveys and the Water and Sewerage Corporation. The data in the Central Bank's Quarterly Statistical Reports on oil trading is supplied directly to the Central Bank by the local oil companies and is disaggregated into oil imported for domestic consumption, and for the bunkering of foreign ships and aircraft. Oil that is imported for transshipment or for refining and subsequent re-export has been excluded from the trade account, since no change of ownership occurred according to the procedures used by the Central Bank of The Bahamas.

2.1 METHODOLOGY

The Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC), was used to produce the national inventory of greenhouse gases for The Bahamas. In some cases, the data available was not immediately suitable for input into the IPCC spreadsheets.

In such cases, assumptions were made to allow the incorporation of this data. The problems and constraints experienced in undertaking the inventory in 1994 were reviewed as part of the second inventory in 2000. All of the problems experienced in the initial inventory were encountered in the second inventory with the added constraint that many of the resource personnel had been re-assigned or left their positions associated with the focal point.

The IPCC Reference Approach had to be modified in order to accommodate the type, format and accuracy of the data collected by national authorities.

In some instances, national regulations governing the use of statistical data also impacted this process.

- A "top-down" approach was applied using the aggregate statistical data compiled by the Central Bank of The Bahamas on fossil fuels, but no "bottom-up" comparison was attempted, as the essential statistical data was unavailable in the disaggregated format required for input into the IPCC spreadsheet.
- In many cases, a new data collection exercise would have had to be conducted to obtain data in the format needed.
- In some instances, the types of national data were simply not available: In the transport sector, for example, data on fuel usage and numbers, types and sizes of vessels in the marine transport, commercial, and recreational fishing sub-sectors, were not available.
- Limited data was available from the electricity sector which is dominated by two large power producers, and this allowed broad categorization of energy data into power production and transportation.

Given these constraints, the Central Bank's Aggregated Statistical Summary of fuel imports provided the highest quality verifiable data source available for immediate use in a format that allowed for the initial national inventory of greenhouse gases in a modified Tier 1 Approach. Central Bank's Statistical Survey of 1994, which focused on disaggregating the fuel used in international bunkering, allowed for some refinement of the inventory process. Verification of the data was undertaken in discussion with the fuel suppliers in The Bahamas, and through consultation with the Customs Department. Additionally, work by other Government Agencies, notably by the Ministry of Agriculture in the 1994 Agricultural Census, also provided reliable data for the agricultural sector.

In order to improve the reproducibility and accuracy of future national inventories, seven activities were proposed as part of the initial inventory:

Actions Proposed to Improve Inventory Process

Steps must be taken to allow for verification of data, using multiple sources, so as to permit the use of a "top-down" and "bottom-up" comparison.

The compilation of statistical data and the nature of the reporting process needed to be addressed. A detailed examination of the transport sector, focusing on fuel usage in private and public vehicles, in marine transport, in domestic aircrafts, and in agriculture, should be undertaken.

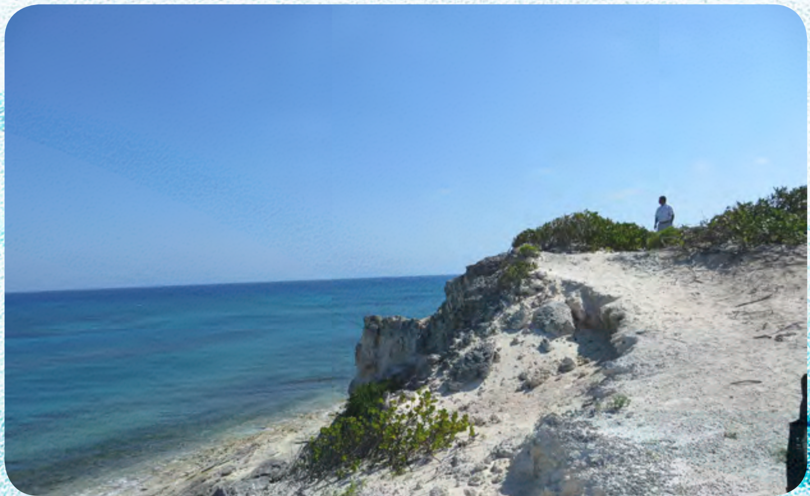
A national system for data collection, storage, archiving and retrieval also needs to be developed, and persons trained in its use.

Land use, land use changes and forestry, will require special attention, as this initial national inventory relies heavily on data collected by a Land Resources Survey (Little et al., 1971 – 1976) completed some 25 years ago.

A system for updating and reporting changes in land use needs to be developed so as to provide reliable data for future national inventories.

The issue of carbon sequestration in the shallow waters of The Bahamas requires scientific study in order to verify the initial assessment, and to determine strategies for enhancing the capacity of the system to sequester carbon.

Additional and continuous capacity building to assist with the performance of future inventories and the establishment of memoranda of understanding between Climate Change Committee and various statistical databases for retrieval of inventory data.



The IPCC guidelines were followed as data sources permitted, and default values provided were used. The IPCC reference approach was used for the energy sector. Thus, a top down approach was used as data was not available or not in the required format that would enable a bottom-up verification of emission in the energy sector.

A verification exercise was carried out following the inventory process, which sought to verify sample data points obtained from the Central Bank report. The verification exercise revealed only one instance of discrepancy between Central Bank data and actual data.

The industrial profile of The Bahamas changed slightly between 1994 and 2000 with a contraction in the industrial output of the country. Industrial activities that remained included brewing and distilling, some chemical plant output, some pharmaceutical production, the production and export of solar evaporated salt, and the re-export of crude oil.

The Bahamas National Greenhouse Gas Inventory was organized into five main categories as described in the Revised IPPC 1996 Guidelines.

GHG emissions were mainly from imported liquid fossil fuels consisting of gasoline, jet aviation, and other kerosene, gas and diesel oil, liquefied petroleum products (principally liquefied propane gas (LPF), and lubricants (See Fig. 5). Table 6 summarizes the quantities of fuel imported for the two previous inventory years as well as the year 2000. The data was verified through discussions with the local oil companies and by reference to The Bahamas Customs database.

Fuel Imports in Thousands of Barrels of Oil Equivalent (BOE) for 1990, 1994 and 2000.

Fuel Oils	1990	1994	2000	% Total (2000)
Gasoline	1287	1303	1499	34
Jet Kerosene	187	148	235	6
Gas/diesel oil	1759	1301	2685	56
Residual Fuel Oil (Bunker C)	879	1442	33 (888)(1)	1 (27)
LPG	156	160	96	3
Other oils	225	33	93	1

Table 6: Fuel imports in thousands of barrels of oil equivalent (BOE) for 1990, 1994 and 2000.
Note: Revised figure (in brackets) based on information received from major users

Reported Trend of Petroleum Imports (1990-2000)

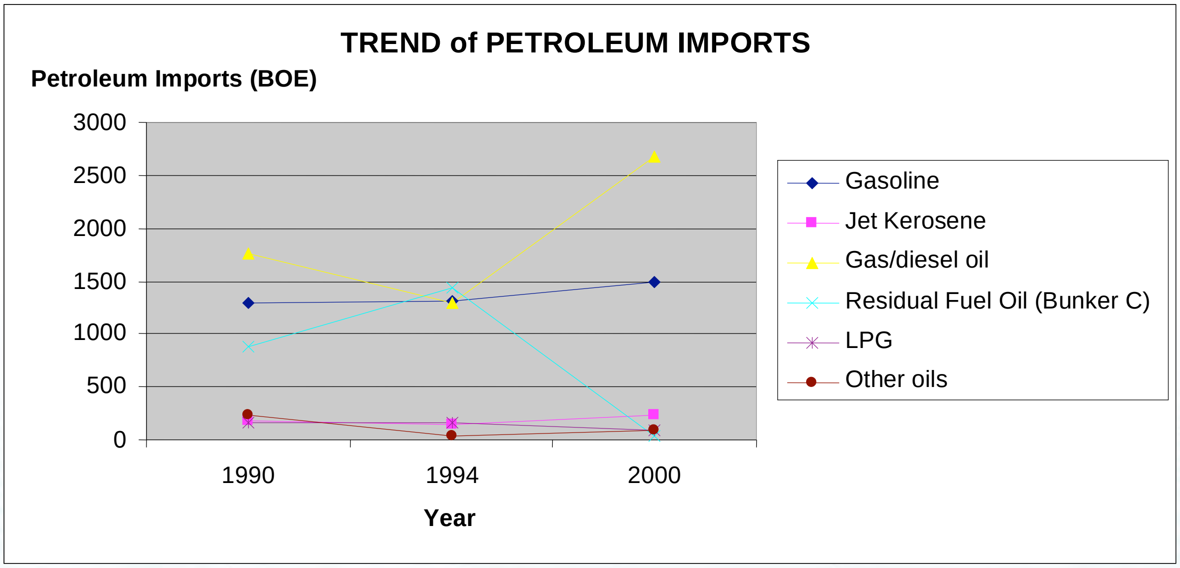


Figure 5: Trend of Petroleum Imports Reported for 1990-2000

INVENTORY PROCESS

Summmary of Emissions

A tabular summary of emissions by gas is presented in Table 7 below. CO_2 emissions are the most significant emissions for The Bahamas.

Summary of Emissions in 2000

Emissions by Gas	Gg	GWP	CO_2 Eq.	Tonnes CO_2
CO_2 Emissions				
Energy	660.4448	1	660.4448	660,444.81
LUCF onsite burning of forests	**4.35**	**1**	**4.3500**	**4,350.00**
Methane Emissions	Gg Gas			
Livestock	**0.233737**	**21**	**4.9085**	**4,908.49**
Solid Waste	0.06940	21	1.4574	1,457.39
Comm/Industrial Wastewater	**0.002675**	**21**	**0.0562**	**56.17**
Wastewater and Sludge	0.054368	21	1.1417	1,141.73
LUCF on site burning of forests	**0.500000**	**21**	**10.5000**	**10,500.00**
N_2O Emissions	Gg Gas			
Animal Waste Mgmt Systems	**0.00115**	**310**	**0.3573**	**357.25**
Grazing Animals	0.00387	310	1.2008	1,200.81
Agricultural Soils	**0.00539**	**310**	**1.6705**	**1,670.46**
Leaching	0.03414	310	10.5837	10,583.68
Human Sewage	**0.01969**	**310**	**6.1054**	**6,105.39**
LUCF	0.00013	310	0.0415	41.54
NO Emissions	**Gg Gas**			
LUCF onsite burning of forests	0.12000			
NMVOC Emissions	**Gg Gas**			
Fugitive Emissions	2.312			
Road Surfacing	**0.17349**			

Table 7: Summary of emissions in 2000

2.1 Emissions Process

Sources - Energy Sector

A list of potential greenhouse gas sources was compiled and organized into three broad categories during initial seminar(s), in July of 2007 (See Table 8).

GHG Point Sources in The Bahamas

Energy: Fuel Combustion	Halo-carbon Use	Solvents
Electricity Production	**Refrigeration**	**Paint Application**
Freeport Power / - (Diesel, Bunker 'C', Propane	Air-conditioning	Degreasing & Dry Cleaning
Diesel, Bunker 'C'	**Aerosols & Solvents**	**Anesthesia**
Manufacturing Industries		Propellant Usage
Diesel Oil – PFC		
Uniroyal, Borco, Polymer, Hotels, Laundries, Blanco Bleach		
Bacardi, Battery Companies		
Transportation		
Domestic – Mail Boats, Pleasure Craft & Other Vehicles		

Table 8: Potential GHG sources in The Bahamas

Energy for residential, commercial and limited industrial applications in The Bahamas is chiefly produced through the transformation of imported liquid fossil fuels. Residual fuel oil and diesel/ fuel oil account for the entire total of energy produced in the Electricity Sector. The data for energy production and consumption activities are based on the latest information as contained in the Central Bank of The Bahamas reports on petroleum imports, exports and usage.

The import of fossil fuels for use in power generation and transport represents the major use of fuel in the energy sector in The Bahamas. The storage of fuel represents a smaller fraction of fuels in the sector and is reported separately.

International Bunkers represents the largest fraction of CO_2 emissions in The Bahamas; it is inventoried as part of the inventory process, but is not counted in the National Totals.

Emissions from Energy

Greenhouse gas emissions for The Bahamas for the inventory year totaled some 660.48 Gg of CO_2 Equivalent. In 1994, some 85 % of all diesel/ gas oil was used in power generation. In year 2000, this figure had dropped to 52%, which represents a rapidly increasing contribution of the transport sector to the GHG emissions in The Bahamas as well as a movement away from the more expensive gas oil for electricity generation. The Carbon Dioxide (CO_2) emissions produced from the consumption of fossil fuels for public electricity production totaled some 37.1 % of the total CO_2 emissions in The Bahamas for the year 2000. The total installed capacity of power plants in The Bahamas for the year 2000 was approximately 500 MW with maximum demand of 327.9 MW. Total annual units of power generated between 1990 and 2000 grew from 750.4 million kWh to 1,664.8 million kWh.

Comparison of Carbon Dioxide Emissions From Fossil Fuel Energy Sources in The Bahamas for 1994 and 2000 (Gg CO_2).

Fuel Type	2000	% Total	1994	% Total
Gasoline	470.7	25.22%	476.5	25.53%
Jet Kerosene	55	2.95%	43.6	2.34%
Gas and diesel oil	802.4	43.00%	593.5	31.80%
Residual fuel oil	424.8	22.76%	696.9	37.34%
LPG	39.7	2.13%	40.8	2.19%
Other oils	101.5	5.44%	14.9	0.80%
Total (Gg CO_2)	1894.2		1866.2	

Table 9: Comparison of Carbon dioxide emissions from fossil fuel energy sources in The Bahamas for 1994 and 2000 (Gg CO_2).

Trend of Carbon Dioxide Emissions in 1994 and 2000

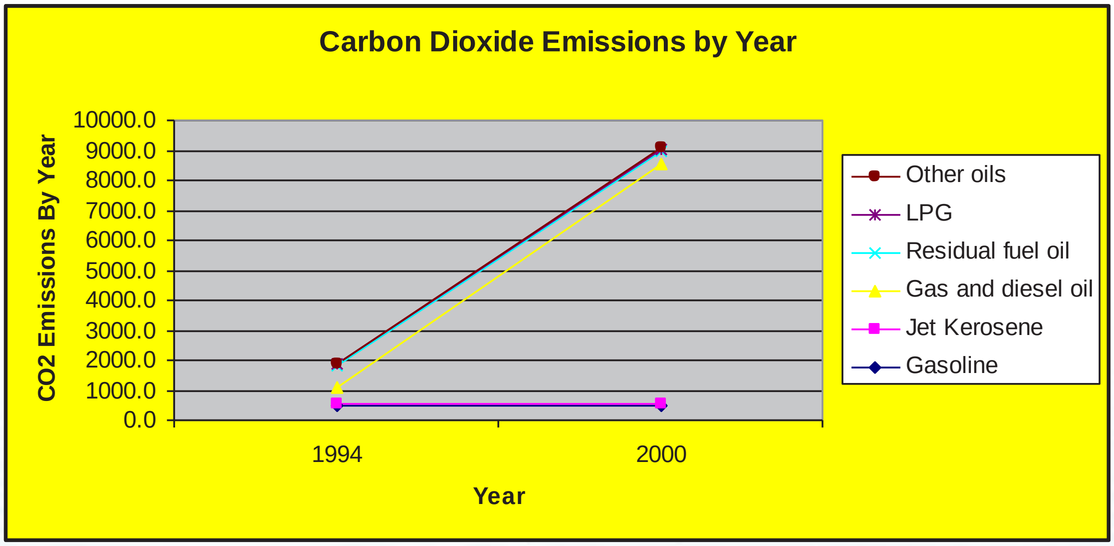


Figure 6: Trend of Carbon Dioxide Emissions in 1994 and 2000

Estimated Emissions of Other Greenhouse Gases in The Bahamas for the years 1990, 1994 and 2000 (Gg gas).

Year	Methane (CH_4)	Nitrous Oxide (N_20)	Carbon Monoxide (CO)	NMVOC's
1990	2	0	4	3
1994	1	1	4	3
2000	0.86	0.06	---	2.47

Table 10: Estimated emissions of other Greenhouse Gases in The Bahamas for the years 1990, 1994 and 2000 (Gg gas).

There were no significant variations between 1990 and 1994. There was, however, significant change between these years and 2000, for methane and Nitrous Oxide and this was attributed to shrinkage in the industrial sector.

Fugitive Emissions

Quantities on the order of 3,287 metric tons of fuel are stored on an annual basis and transshipped outside The Bahamas. Primary seals, in floating roof tanks are employed at the oil storage and trans-shipment facility. A single facility *(South Riding Point Holding Ltd.)* represents the primary source of fugitive emissions in The Bahamas which is estimated at 2.3 Gg of non-methane volatile organic compounds (NMVOC).

Memo Items: CO_2 Emissions from International Bunkering

The Central Bank Quarterly Statistical Report aggregated the oil sold in international bunkering activities based on oil reports from the Customs Department and Oil companies' reports. A statistical exercise was conducted for 1990 in the initial inventory to disaggregate the data into the following: (i) gasoline for motor vehicles and small boats; (ii) jet fuel for aircraft; and (iii) gas oil for larger marine transport vessels leaving The Bahamas. This exercise was repeated for the 2000 inventory, as the data source and methodology were consistent with the previous inventory.

CO_2 emissions from the two categories of bunkering Aviation and marine accounted for 881.86 Gg CO_2 and 791.15 Gg of CO_2 respectively.

Carbon Dioxide Emissions From International Bunkering (Gg CO_2)

	1990	1994	2000	% Total (2000)
Aviation	**492**	**341**	**882**	**53**
Marine	**404**	**305**	**791**	**47**
Total all Bunkers	**896**	**645**	**1673**	**100**

Table 11: Carbon dioxide emissions from international bunkering (Gg CO_2).

Emissions from Waste

Liquid waste disposal is mainly by septic tanks as less than 20% of homes are linked to public sewerage drainage, collection, treatment and disposal facilities. A large tourism sector and a high standard of living contribute to the estimated 11.1 Gg of CH_4 emissions.

Municipal solid waste on New Providence Island is currently disposed of at the Harold Road disposal facility, a 100-acre site of which approximately 45 acres has been filled since it opened in 1972. Garbage is deposited on the surface, spread by mechanized equipment and partially covered.

Bahamians and visitors together generate more than 171,270,000 tonnes of municipal solid waste annually, with New Providence Island contributing about 77% and Grand Bahama 17% of this total, leaving only about 6% or 15,800 tonnes annually generated on the other Family Islands.

84% of waste generated in New Providence and Grand Bahama was assumed to be deposited to a managed site in the year 2000. The SWDS in Grand Bahama came into full operation in the year 2000.

Solid waste is disposed into unlined public dumps across The Bahamas. The estimated per capita waste stream from all sources was 1.82 Kg/person/day.

This report is also intended to provide the methodology and framework for future calculations.

Sources – Waste Sector

The table below shows a list of potential greenhouse gas sources, which is compiled and organized into three broad categories.

GreenHouse Gas Sources

Solid Waste Disposal Sites (SWDS)	Waste Water Handling	Waste Incineration
Nassau	**Nassau** **Commonwealth Brewery** **Caribbean bottling** **Pepsi Cola Bottling** **Bacardi**	**Nassau**
Freeport	**Freeport**	**Freeport**
Other Islands	**Other Islands**	**Other Islands**

Table: 12: Potential greenhouse gas sources

Emissions from Industrial Processes

This sector is being considered for the first time in the inventory process for completeness. Information on emissions is difficult to obtain with any degree of reliability. The sector is small and does not contribute significantly to the national emissions, with 0.0562 Gg CO_2 equivalent emissions estimated during the period from commercial and industrial wastewater.

Land Use Change and Forestry (LUCF)

The initial inventory documented the background of land use and land use changes in The Bahamas. “Forests are critical components of the climate system. Their potential for sequestering greenhouse gases is enormous, and they act as an additional reservoir to trap carbon dioxide (C02) emissions. The Commonwealth of The Bahamas was covered with forests, mainly of tall, tropical hardwood and slow-growing trees in the drier south central and southeast. In the North and North Central Bahamas large areas of Pine (*Pinus caribaea* v. *bahamensis*) are found. Mangroves occupy the large marine inter-tidal expanses between the hard ground and sea. Large areas of the tropical hard wood forests were cut down to make room for plantations, housing, firewood and for their economic value in the tropical hardwood areas. Most of the primary forests were cut as land was converted initially to plantations and then as these failed to a rotating “slash and burn” agricultural uses. In the pine islands forests were cut for timber to build boats and houses, for fuel wood and particularly to clear land for cane cultivation.

The regeneration of significant areas of tropical hard wood has been noticed in some regions of The Bahamas. This is being contrasted with recent developments that are competing with fauna for land space. No commercial logging activity is being practiced on the pine islands consequently; these islands are also in a young phase of re-growth.”

As with the initial inventory, the entire landmass of The Bahamas - its mangroves, tropical hardwood forests and pine islands, including the understory, were accounted for as significant areas under some sort of native vegetation.

Forest Cover in The Bahamas by Type and Area

Type	Area (kha)	Type
Pine forest	227.8	Tropical moist
Pine under-storey	227.8	Tropical moist
Tropical hardwood coppice	701.8	Tropical dry
Mangrove forest	690.4	

Table 13: Forest cover in The Bahamas by type and area (kha).

A list of potential greenhouse gas sources and removals was compiled for the various LUCF Sectors as follows:

Potential Sources of LUCF Emissions and/or Removals

Changes in Forest and other Woody Biomass Stocks	Forest and Grassland Conversion	Regrowth
Tropical Forest Biomass Stocks	Moist long dry season	Moist long dry season
Plantations Other Forests	Dry Season	Moist short dry season
Moist; Seasonal and Dry Forests	On site burning	Abandoned Lands
Biomass Cleared	Off site burning	
Biomass burned	Biomass decay	
Decaying biomass	Non CO2 sources	
Forest and Grassland conversion		

Table 14: Potential sources of LUCF emissions and/or removals

Emissions/Removals from LUCF Sector

The LUCF sector records net emissions of CO_2 in the amount of 1513.67 Gg of CO_2. The sector has also recorded emission of trace gases in the amount of 0.12 Gg of CO_2. The sector has recorded removals of CO_2 in the amount of 4159.61 Gg of CO_2 as shown in Table 15 below.

Estimated Removals of CO_2 by LUCF Sub-categories

Removals of CO_2 by LUCF sub-categories			
Removals	Gg CO_2	CO_2 Equivalent	CO_2 (tonnes)
Abandonment of managed lands	2,802.34	2,802.34	2,802,340.00
Changes in Forest and other woody stocks	1,357.27	1,357.27	1,357,270.00
Total CO_2 Removed	4,159.61	4,159.61	4,159,610.00

Table 15: Estimated removals of CO_2 by LUCF sub-categories

Agriculture

The previous recorded trend in The Bahamas away from livestock husbandry to a heavy reliance on imports for all foodstuffs continues in the intervening period between inventories. Some local husbandry of livestock does occur in The Bahamas, but this is done on a relatively small scale. There are two commercial producers of fowl in The Bahamas. The Agricultural process suffers from heavy competitive forces of imports into the country.

Livestock numbers in certain islands continues to fall. The number of goats and sheep on islands such as Eleuthera, Long Island and Exuma has declined in recent time. Other islands are also recorded as having stock but in much smaller numbers. The Food and Agricultural Organization (FAO) was used as the basis of all estimates with the projected figures from The Bahamas' 1994 Census of Agriculture used a check on the FAO data. Agricultural soils were covered under Land Use Change and Forestry in the initial inventory and are included in this Sector for this inventory. Data on the total imports of fertilizers and or the types used was derived from Department of Statistics figures for the year 2000.

Livestock Numbers in The Bahamas From 1994 Agricultural Census

Type of Animals	Numbers of Animals	
	1994 Census	From FAO Year 2000
Cattle (non-dairy)	796	669
Sheep	6292	6292
Goats	13580	13580
Pigs	4777	4777
Poultry	750,000	2,350,000

Table 16: Livestock numbers in The Bahamas on the Agricultural Census of 1994. Sources: Department of Agriculture and Department of Statistics (1996) and FAO (2000).

Emission from the Agriculture Sector

Estimates of Methane (CH_4) emissions from Enteric Fermentation were 0.23 Gg. Total annual Emissions of N_2O from Domestic Livestock was less than 1/100 of a Gg per year. Direct Emissions of N_2O from Agricultural Fields excluding cultivation of Histosols was estimated at 0.01 Gg per year. Emissions of Nitrous Oxide (N_20) soil emissions from grazing animals pasture range and paddock was estimated at less than 1/100 of a Gg per year. Indirect emissions of Nitrous oxide (NO_2) from atmospheric deposition of NH_3 and NO_x were estimated at less than 0.01 Gg. Indirect N_2O emission from leaching was estimated at 0.03 Gg.

CHAPTER 3: NATIONAL MITIGATION ASSESSEMENT

3.1 INTRODUCTION

Climate change mitigation encompasses the activities, policies and measures enacted to reduce the emissions of greenhouse gases (GHGs) from sources and increase GHG removals by sinks in both energy and non-energy sectors. The Bahamas is a country actively investing in measures to mitigate climate change and increase sustainable action. This chapter provides an introduction to the initiatives being considered by the Government of The Bahamas to mitigate the effects of climate change. These initiatives cover a subset of all possible mitigation efforts for the country of The Bahamas

Based on Article 12 of the Convention, Non-Annex I countries to the UNFCCC are not required to set specific GHG reduction targets or commitments, but instead are encouraged to propose and quantify policies and measures to mitigate climate change within their countries.[13]

To address the UNFCCC guidelines for climate change mitigation, the Government of the Commonwealth of The Bahamas has committed to the following National Energy Vision as stated in the National Energy Plan:

> "The Bahamas will become a world leader in the development and implementation of sustainable energy opportunities, by aggressively re-engineering our legislative, regulatory, and institutional frameworks; retooling our human resources; and implementing a diverse range of well researched and regulated, environmentally sensitive and sustainable energy programmes and initiatives, built upon our geographical (both proximity and diversity), climatic (sun, wind, and sea) and traditional economic strengths (tourism and banking)."[14]

3.2 POLICIES AND MEASURES TO MITIGATE CLIMATE CHANGE

Of the numerous possible efforts to mitigate climate change, The Bahamas National Energy Policy Committee has proposed new measures focusing on energy efficiency and renewable energy deployment. The focus on the following proposed goals is meant to target a lower dependence on imported oil.

1. A reduction in energy demand due to energy efficiency measures of 30% relative to a business-as-usual scenario by 2030.
2. An increase in share of renewable energies in electricity generation of at least 15% by 2020 and 30% by 2030.

Policy Targets and Objectives

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[13] UN, 1992 http://unfccc.int/resource/docs/convkp/conveng.pdf. p. 16
[14] NEPC report p.4 http://www.best.bs/Webdocs/NEPC_2ndReport_FINAL.pdf (exact text)

Short-Term Targets (1-5yrs)

Specific policy targets and objectives have been recommended that would allow The Bahamas to reach the goals stated above.[15] These policies focus on energy efficiency measures and renewable energy options. The Bahamas has developed a number of short-term, medium-term and long-term targets with specific objectives that the country intends to pursue in lessening its dependency on fossil fuel combustion for its energy needs and also to promote sustainable energy future. The short-term (1-5 years) targets include:

a) A Complete phase-out of incandescent light bulbs and their replacement with reduced mercury compact fluorescent light bulbs (CFL);

b) Investigate and implement waste-to-energy technology options for New Providence;

c) Develop a common basis to measure and compare the average annual unit cost of each form of energy consumed by sector and geographic area ($/gallon, $/kWh, $/bbl);

d) Initiate public buildings energy usage reduction strategies;

e) Explore interconnections between islands to enhance efficiency and promote the potential for renewable energy;

f) Assess the Commonwealth's wind potential as well as identify potential sites for pilot and/or demonstration facilities;

g) Introduce an integrated traffic management system and public transport system by:

- Reducing average commute times on New Providence by 20%;
- Increasing ridership of public transport to 10-20%; and
- Employing advanced energy efficient lighting systems in public spaces supported by signage and traffic management systems.

The short-term objectives through (i) energy conservation are: to develop and implement a public sector energy conservation programme and marketing campaign; to develop and implement a consumer-oriented energy conservation campaign; to develop and execute an implementation strategy for the economic incentives announced in the 2008-2009 budget cycle; (ii) energy production management are: to review and establish a guideline for independent power producers and to explore the option of combining heat and power and cogeneration technologies to support the ongoing effort of capacity deferment. The short-term objectives through assessment of renewable energy potential are to: identify the data gaps and then formulate and implement solutions for closing the gaps and setting realistic targets and to

[15] Selected Policy Targets and objectives have been included in the text here. For a full list, please see Annex 2

investigate the potential exploitability of various renewable energy sources and technologies, including waste to energy, wave, tidal, wind, photovoltaic systems and solar water heating units.

Medium-Term Targets (5-10yrs)

The medium-term targets are to:

a) Increase the penetration of renewable energy sources in the Commonwealth to 15% of supplies;

b) Deploy renewable energy technologies in several small communities, aiming towards >50% of power from renewable sources;

c) Reduce dependence on imported fuel oils by:

- Increased building energy efficiency by introducing standards in public buildings for cooling public spaces, heating water, lighting and the deployment of the highest energy star ratings of equipment;
- Increased use of solar hot water systems to 20 to 30% of all households;
- Increased deployment and usage of energy efficient lighting systems and fenestration systems (windows) in public buildings;
- Increased public awareness and education on renewable energy potential and usage; and
- New requirements for all government financed homes and buildings to use, install, operate and maintain solar water systems.

d) Initiate a pilot of demonstration project for ocean thermal energy conversion potential starting with taking measurements at Clifton, New Providence and North Eleuthera;

e) Develop a means to estimate the average annual unit cost of renewable sources of energy; and

f) Increase fuel efficiency for motor vehicles to 30-35 mpg for 70% of licensed vehicles through the application of incentives to import and use more efficient vehicles in private and public sector transport.

The medium-term objectives through renewable energy implementation plan is to develop and implement a renewable energy programme to encourage the private sector to develop projects to produce electricity using renewable sources (e.g. solar, wind, ocean-thermal) for possible exploitation by The Bahamas Electricity Corporation. The programme can be used to establish targets for renewable electricity sales. Through the Energy Commission, the objective is to establish a permanent energy commission responsible for overseeing the implementation of selected national energy initiatives. , Using the national energy policy, the energy commission can develop energy efficiency standards that can be incorporated into existing regulatory regimes. Stakeholder consultation, compliance promotion and enforcement of the proposed standards should be done. With regard to fuel economy transport in the medium-term the objectives are to:

- Develop and implement a programme to increase the average fuel economy of vehicles. This program could include periodic vehicle emission testing as a part of the vehicle registration process, a ban on the import of vehicles older than five years, or improved enforcement of road traffic and safety legislation;
- Improve the quality of diesel oils imported for local consumption to reduce particulate emissions in order to improve air quality in urban centers; and
- Develop and implement a national strategy for integrated traffic and transportation system management.

Long-Term Targets (10-20 years)

The long-term targets include:

a) Increase the penetration of renewable energy sources in the Commonwealth to 30% of supplies;

b) All installations of water heaters are solar water heaters;

c) Develop a programme to pursue cost-effective opportunities in reducing energy consumption; and

d) Develop extended targets for changes in the energy mix based on extended unit cost and economic impact estimates by energy source, informed by local experiences and historical data.

The long-term objectives are to: reduce the rise in energy consumption and reduce use on a per capita basis; develop and implement a programme to pursue cost-effective opportunities to reduce further energy consumption by various target sectors and individual consumers; develop and implement a programme to minimize greenhouse gas emissions; and establish funding mechanisms for identifying, implementing and promoting sustainable energy use and technology innovation that support efforts to achieve the targets outlined in the national energy action plan.

Technical Potential of Renewable Energy

To further understand how the renewable energy measures can be met, The Bahamas recently underwent an assessment of renewable energy technical and economic potential. Technical potential amounts to approximately 50 times the present power demand in The Bahamas and is defined as the maximum electric generation yield of suitable sites (e.g. lands, roofs, etc.) taking into consideration natural and technical restrictions. Present economic potential is defined as the technical potential, which is economically viable in 2010 at oil cost of $70/barrel. Future economic potential in 2030 is expected to increase significantly due to decreasing costs of renewable energies and increased commercial viability.

Potentials of Renewable Electricity Generation in The Bahamas

Technology	Technical Potential	Present Economic Potential	Future Economic Potential
Solar Water Heaters	7,500	200	200
Building-integrated PV	3,700	-	220
Open-field PV Power Plants	12,000	-	12,000
Wind Power	82,000	150	200
Bio-energy	3,700	1,300	2,500
Ocean Energy: OTEC, wave	12,000	-	5,500
Waste to Energy	150	110	110
Total	**121,050**	**1,760**	**20,730**

Table 17: Potentials of renewable electricity generation in The Bahamas [GWh/year][16]

3.3 SCENARIO MODELING: LONG-RANGE ENERGY ALTERNATIVES PLANNING

In order to give a comprehensive picture of the policies and measures proposed in The Bahamas National Energy Policy, a scenario analysis was conducted using the Long-range Energy Alternatives Planning system (LEAP)[17] for the energy sector. LEAP is intended for energy planning and climate mitigation assessment and can be used to quantify energy demand and supply, greenhouse gas emissions and costs across any number of scenarios.

The scope of this analysis covers the energy and GHG emissions related to four specific measures in the energy sector over the time period of 2010 to 2030. Non-energy sector measures, transportation measures, and costs associated with each measure were considered outside the scope of this assessment. Though this kind of analysis will not show the total energy or emission savings that are possible for The Bahamas, it will provide a quantitative estimate for how the proposed measures will affect the energy system.

The analysis includes a comprehensive picture of historical energy demand and supply in The Bahamas from 2000 to 2009 based mainly on the in-country data, but supplementing with international data sources as needed. The energy data includes information on energy use by fuel in each major demand sector (households, commercial, industry, hotels and transport). Historical consumption data was compiled from electric utility reports and petroleum imports statistics. On the supply side, the data set includes information on transmission and distribution

[16]NEPC Report p.13 - GWh = 10^6 kWh; solar water heaters are expected to replace electrical water heaters; economic potential of solar water heater is limited to total hot water demand in The Bahamas; and economic potential of waste-to-energy power plant assumes a sufficient level of waste fees exist to run a 15 MW installation on New Providence.

[17] LEAP, developed by the Stockholm Environment Institute, www.sei-international.org; software distributed through the COMMEND website: www.energycommunity.org

losses in addition to electricity production. This historical data helps establish trends in energy consumption, which can be used as a starting point for the scenario analysis.

The analysis also includes one baseline scenario. It tells a story of how The Bahamas energy system could develop over the time period of 2010 to 2030, and presents a mitigation scenario that involves a subset of policies and measures discussed in this chapter. The result of comparing the mitigation and baseline scenarios showcases the energy and emission savings that result from enacting the included mitigation policies.

For a detailed listing of assumptions and results associated with this LEAP modeling, see Annex II.

Baseline Scenario

A baseline scenario is a story of how a particular energy system might evolve over a future time period. This baseline scenario is not a prediction of what will happen with particular certainty, but rather is a representation of one reasonable future for The Bahamas over the time period of 2010 to 2030 in the absence of any additional policies or measures.

The baseline scenario includes demand projections for electricity and petroleum products within five sectors: households, commerce, industry, hotels and transport.

Energy consumption in The Bahamas is dominated by the household, commerce and transport sectors. Measures have been included in the mitigation scenario to target reductions in demand in the household, commerce industry and hotel sectors. No transport sector measures have been modeled for this exercise due to a lack of detailed data. Note that all data points from 2000-2009 are historical values. Projections begin in 2010.

Total Energy Demand by Sector

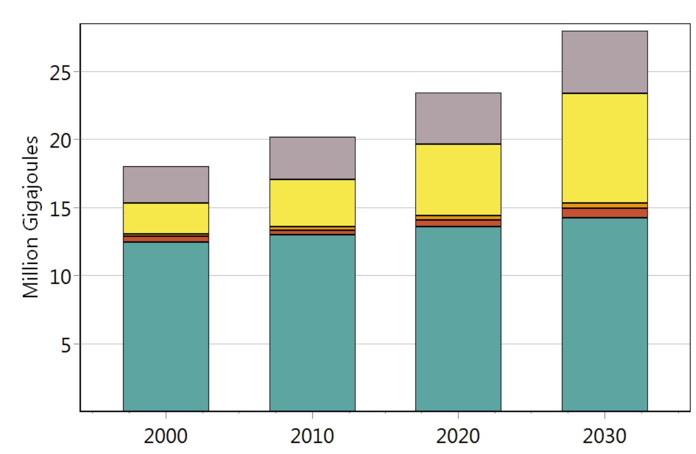

Figure 7: Total energy demand by sector, baseline scenario [Million Gigajoules]

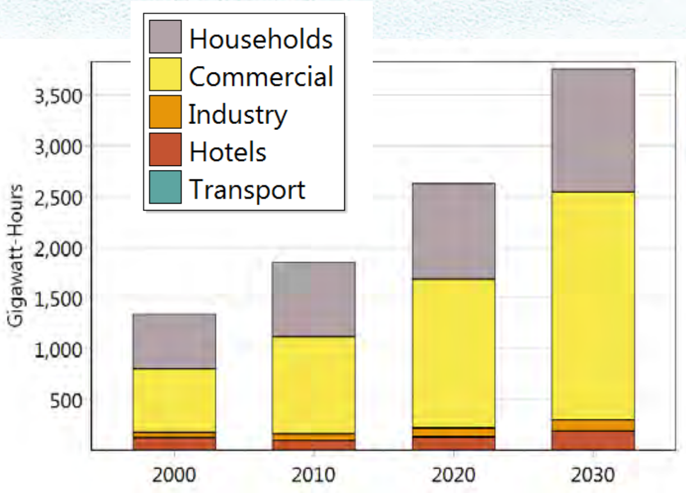

Figure 8: Total electricity demand by sector, baseline scenario [Gigawatt-hours]

Energy consumption was projected based on current conditions established by historical data and population and GDP projections. In LEAP, energy consumption is calculated using two variables: activity level and final energy intensity. An activity level is an indicator of the social or economic activity for which energy is consumed in a given sector, such as population or GDP. Final energy intensity defines the energy consumption per unit of activity level, such as Gigajoules per capita. Specific projections for each sector are defined in the sections that follow. These assumptions are used in years 2010 through 2030.

3.1.1.1 Households

The household sector included national consumption data and projections for electricity, kerosene and propane fuels. The sector is dominated by electricity consumption, and is assumed to increase as electric devices replace kerosene and propane.

Fuel Shares in the Household Sector

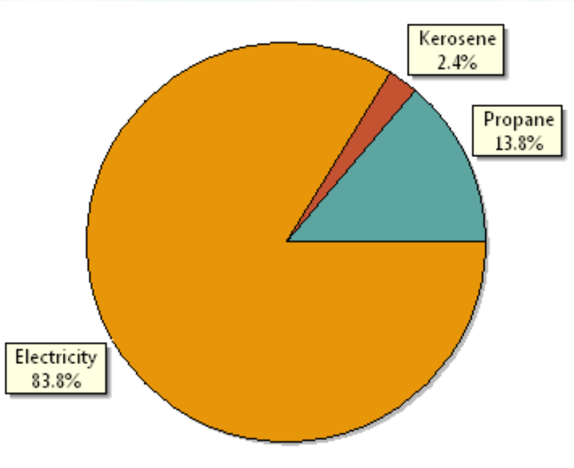

Figure 9: Fuel shares in the household sector in 2010, baseline scenario [%]

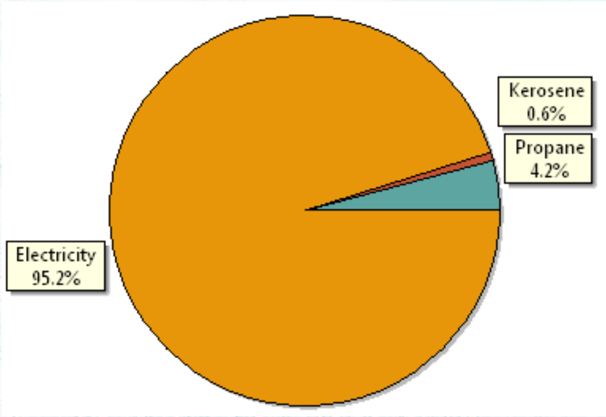

Figure 10: Fuel shares in the household sector in 2030, baseline scenario [%]

Total energy consumption was projected forward to the year 2030 using total population projections and historical trends of per capita consumption by fuel. Population projections were provided by the Department of Statistics[18] and yield a growth rate of about 0.94% per year from 2010 to 2030. Historical trends of per capita consumption led to an assumption of 0.89% annual growth.

[18] http://statistics.bahamas.gov.bs/

3.1.1.2 Commerce

The commercial sector includes only electricity data due to available data. Sectoral electricity consumption was projected based on historical trends for electricity consumption and commercial GDP data (i.e. the subset of national GDP allocated to commercial activities) from The Bahamas Central Bank[19]. In the commercial sector, GDP is expected to grow at a rate of 1.3% per year and energy consumption per unit of GDP is expected to increase at a 3.0% annual rate.

3.1.1.3 Industry

For the purposes of this assessment, it was assumed that electricity is the only fuel consumed in industrial processes. The industry sector is modeled much like the commercial sector, making use of trends in sectoral GDP data and electricity consumption. Industrial GDP was assumed to grow 2.7% every year and electricity consumption per unit of GDP was assumed to be constant due to a lack of consistent trend in historical data.

3.1.1.4 Hotels

Hotels were assumed to consume only electricity, and like the commerce and industry sectors, consumption was projected based on trends in sectoral GDP data and electricity consumption. GDP from the hotel sector was assumed to grow 3.6% every year and electricity consumption per unit of GDP was assumed to be constant due to a lack of consistent historical trend.

Fuel Shares in the Transport Sector

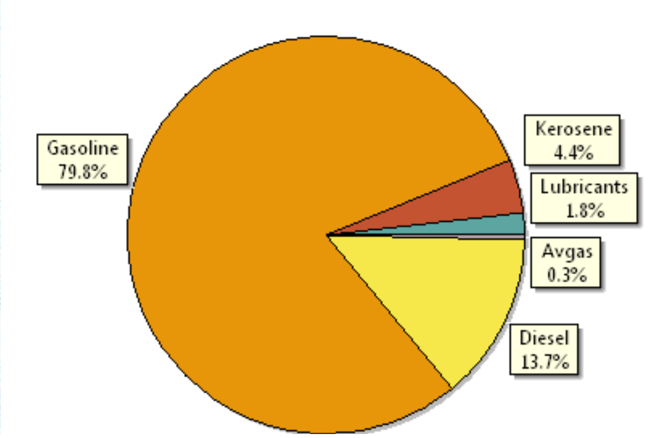

Figure 11: Fuel shares in the transport sector in all years, baseline scenario [%]

[19] http://www.centralbankbahamas.com/

3.1.1.5 Transport

The transport sector consumes a combination of various petroleum products. Historical consumption and fuel shares, which can be seen in Figure 11, are based on data related to annual oil imports to The Bahamas, and were assumed to remain constant over the period of 2010 to 2030. Total consumption was projected forward based on trends in transportation GDP, assumed to grow at 3.3% per year, and historical fuel consumption, assumed to decrease at 2.8% per year.

Capacity Expansion

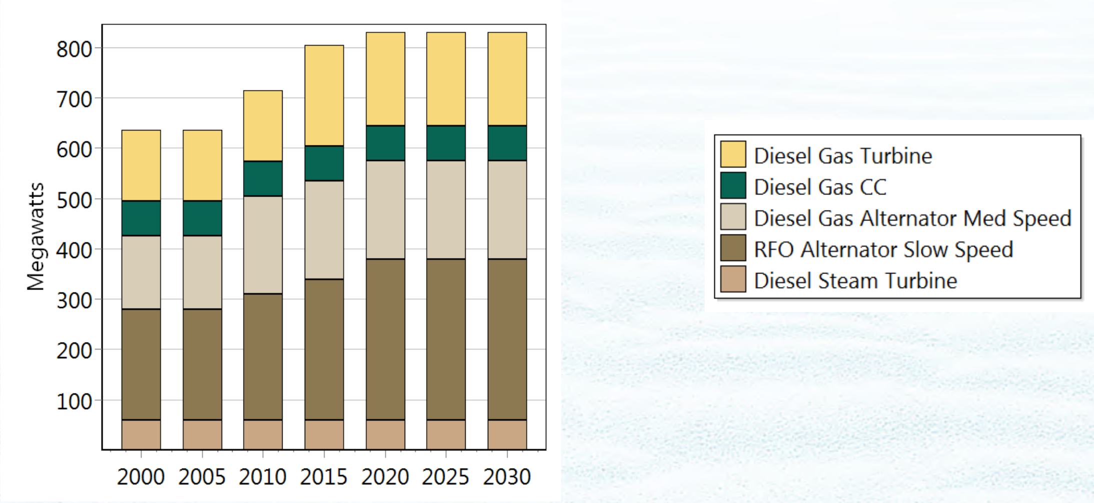

Figure 12: Capacity expansion, baseline scenario [MW]

3.1.1.6 Electricity Generation

The baseline scenario also includes projections for fossil fuel-based power plant capacity in The Bahamas.

All future power plants are built according to utility expansion and retirement plans, and include mainly diesel and residual fuel oil gas turbines and alternators. [20] Figure 12 shows the plans for installations of new power plants in MW. Plants are then dispatched to meet electricity consumption defined in the demand branches above in proportion to the available capacity.

Mitigation Scenario

This mitigation scenario is a representation of an alternative future for The Bahamas. The mitigation scenario follows the same basic approach as the baseline and includes the same historical data up to the year 2009. Based on the key policies and measures being explored by the Bahamian government, this mitigation scenario included the following four components:

1. *Rooftop Solar Thermal Hot Water Heaters Replacing Electric Hot Water Heaters In Residential Homes* - It was assumed that 100% of the hot water demand could be met by solar thermal by 2030;
2. *Distributed PV Generation In Residential Homes* - It was assumed that 100% of household photovoltaic (PV) potential could be achieved by 2030;
3. *Energy Efficiency Measures* - It was assumed that all other energy efficiency measures would amount to a 30% reduction in electricity demand compared to the baseline by 2030; and.
4. *New Renewable Generation Mix* – It was assumed that renewable power plants would be introduced to allow for 15% renewable generation by 2020 and 30% renewable generation by 2030.

Components one, two and three were modeled as demand-side measures, diminishing the requirements for grid electricity in The Bahamas. Component four is a supply-side measure, changing the electricity mix of the Bahamian grid. These quantitative targets are based on the Fichtner potential reports.[21] Each of these is described in more detail below.

Rooftop Solar Thermal

Approximately 90% of Bahamian households use electric water heaters, and this demand accounts for 10-15% of electricity production.[22]

Solar thermal hot water heaters are a well-established alternative technology, available with a variety of features to match the budgets of individual households.[23] Based on the study

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[20] CC = combined cycle power plant; RFO = residual fuel oil

[21] Fichtner, Explore Alternatives for BEC's Expansion Plan, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, September 2010.

[22] Fichtner, Promoting Sustainable Energy in The Bahamas, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, June 2010. P. 2-1.

referenced in the Technical Potential section, available rooftop area is sufficient to cover the entire electric hot water demand in The Bahamas. It was therefore assumed that 100% of hot water demand would be met by solar thermal technologies by 2030, and this capacity would ramp up incrementally starting in 2010.

Residential Photovoltaic

Two types of photovoltaic (PV) measures are considered in the mitigation scenario: distributed generation in the residential sector (component 2) and grid-connected generation on the supply side (component 4). This measure includes only the portion of PV potential allocated to households.

Distributed generation from rooftop PV is an efficient way to make use of available roof areas and avoid transmission and distribution costs. It is assumed that this generation will come from households under net billing or net metering arrangements. This measure assumes that household PV installations will be gradually taken up starting in 2010, and will reach 100% of household PV potential by 2030.

Energy Efficiency Measures

In addition to the solar hot water heaters and residential PV measures that will decrease overall demand for electricity, many other energy efficiency measures are achievable by The Bahamas over the time period of 2010-2030. Energy audits of households, hotels and public buildings were conducted to give insight into currently available technologies and potentials.[24] Energy efficiency measures to reach the target of 30% by 2030 may include:

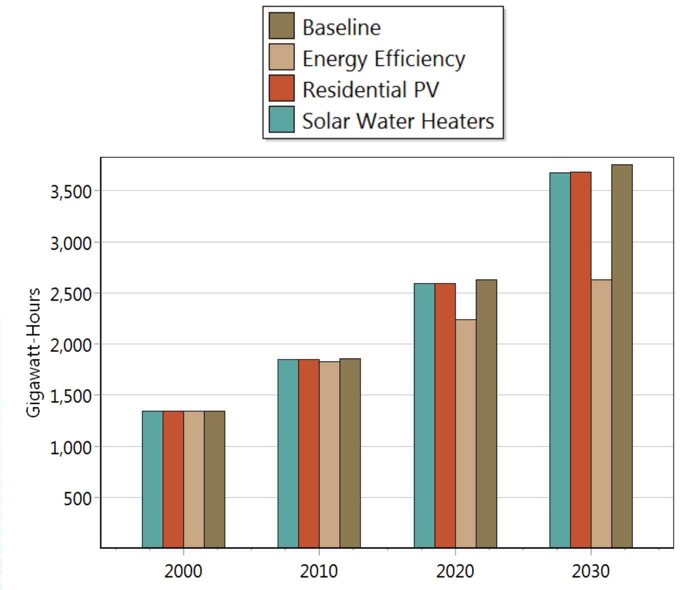
- Improved use of passive measures such as natural shading and ventilation;
- Installations of intelligent systems and monitoring (e.g. motion detectors for lights and air conditioning, monitoring of energy consumption);
- Reuse of grey water for gardens and parks; and
- Education programs.
- Replacement of old inefficient appliances (e.g. refrigerators, freezers, washing machines)

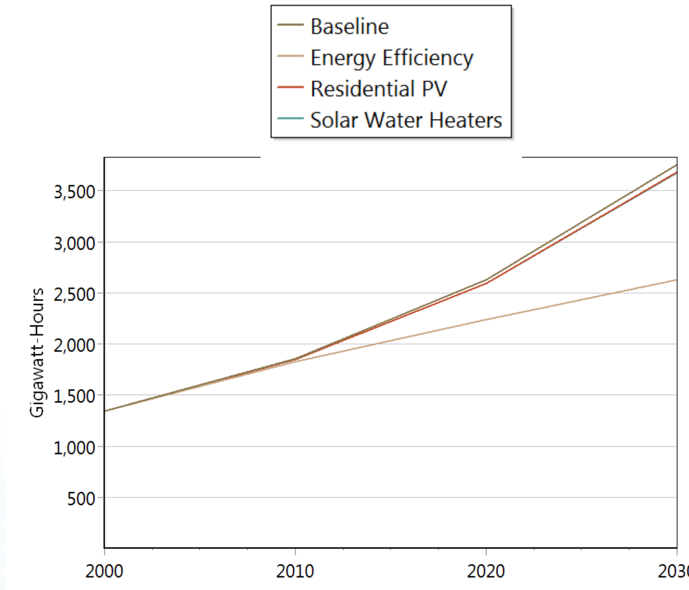
A combination of these measures (and many others) is assumed to collectively be able to reduce electricity consumption in 2030 by 30% compared to the baseline scenario. This measure has the greatest electricity reduction potential of the demand-side policies when compared with the baseline scenario, as can be seen in Figures 13 and 14.

Total Electricity Consumption for Three Demand-side Policies

[23] Fichtner, Promoting Sustainable Energy in The Bahamas, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, June 2010. P. 1-8.
[24] Fichtner, 2010, Promoting Sustainable Energy in The Bahamas, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, June 2010. P. 3-1.

Total Electricity Consumption for Three Demand-side Policies





Figures 13 and 14: Total electricity consumption for three demand-side policies as compared with the baseline scenario [Gigawatt-hours][25]

Renewable Grid Electricity Generation

The fourth component to the mitigation scenario was the only supply-side measure included. To reach the renewable generation targets, five technologies were considered. All quantitative mitigation targets are based on the potentials developed by the Fichtner studies.[26] Biomass shows the most promise in terms of near-term electricity production potential in The Bahamas. The 15 Megawatt waste to energy power plant is being considered both for electricity generation purposes and also for waste management purposes. The ocean thermal electric conversion (OTEC) systems considered are expected to be a viable technology option for The Bahamas by 2030. Table 18 shows the renewable capacity additions modeled in the mitigation scenario.

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[25] The Residential PV measure and the Solar Water Heater measure have very similar reductions, and therefore the line for solar water heaters cannot be seen in Figure 8.

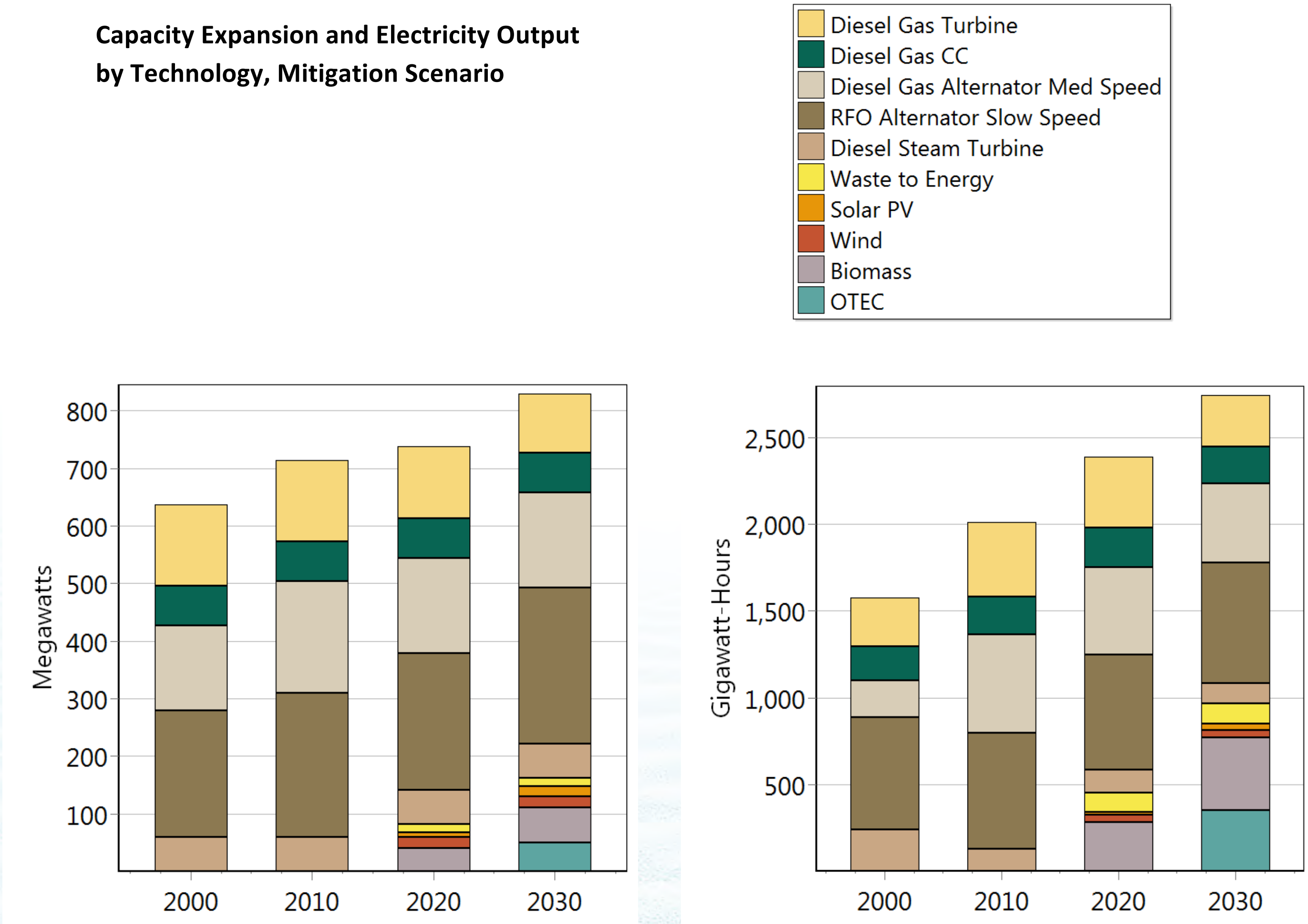
[26] Fichtner, Explore Alternatives for BEC's Expansion Plan, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, September 2010. P. 4-7.

Renewable Electricity Generating Capacity and Generation in 2030, Mitigation Scenario

Technology	Capacity [MW]	Generation [GWh]
Biomass	60	1510
Waste to Energy	15	400
Solar PV	17	130
Wind	20	150
OTEC	50	1250

Table 18: Renewable electricity generating capacity and generation in 2030, mitigation scenario

Figures 15 and 16 show the additions of renewable energies to national electric grid capacity in an overall electricity generation. Note that renewable additions to capacity are not always proportional to electricity generation by the same technology because of performance parameters and the intermittency of renewables such as wind and solar. Biomass, OTEC and waste to energy are base load plants, and can therefore generate more electricity than wind and solar per unit of capacity.



Figures 15 and 16: Capacity expansion [MW] and electricity output [GWh] by technology, mitigation scenario.

3.2 RESULTS

Outputs of the mitigation scenario are put into context by comparing them back to the baseline scenario. This comparison highlights the potential demand reductions and emission savings possible if such policies and measures were enacted.

Solar hot water heaters and residential PV policies are able to reduce household electricity demand by 6% and 5%, respectively in 2030. The energy efficiency scenario reduces electricity demand across all sectors by 30% in 2030. Total electricity demand reductions in the mitigation scenario amount to over 1200 Gigawatt-hours, approximately 34% of the baseline electricity consumption in 2030.

Electricity Demand and GHG Emission Savings in 2030

Policy/Measure	Electricity Demand Savings [GWh]	GHG Emission Savings [kT CO_2e]
Solar Hot Water Heaters	75	69
Residential PV	69	64
Energy Efficiency	1125	1032
Renewable Generation	0	843
Mitigation	1269	1988

Table 18: Electricity demand and GHG emission savings in 2030 based on individual policies explored and the comprehensive mitigation scenario

Figure 17 shows the dynamic reductions in electricity demand over time based on the three demand-side mitigation policies included in the mitigation scenario. The dotted white bar represents the avoided demand, or the amount that is required in the baseline scenario that is not required in the mitigation scenario.

Avoided Electricity Demand in Mitigation Scenario as Compared With the Baseline Scenario

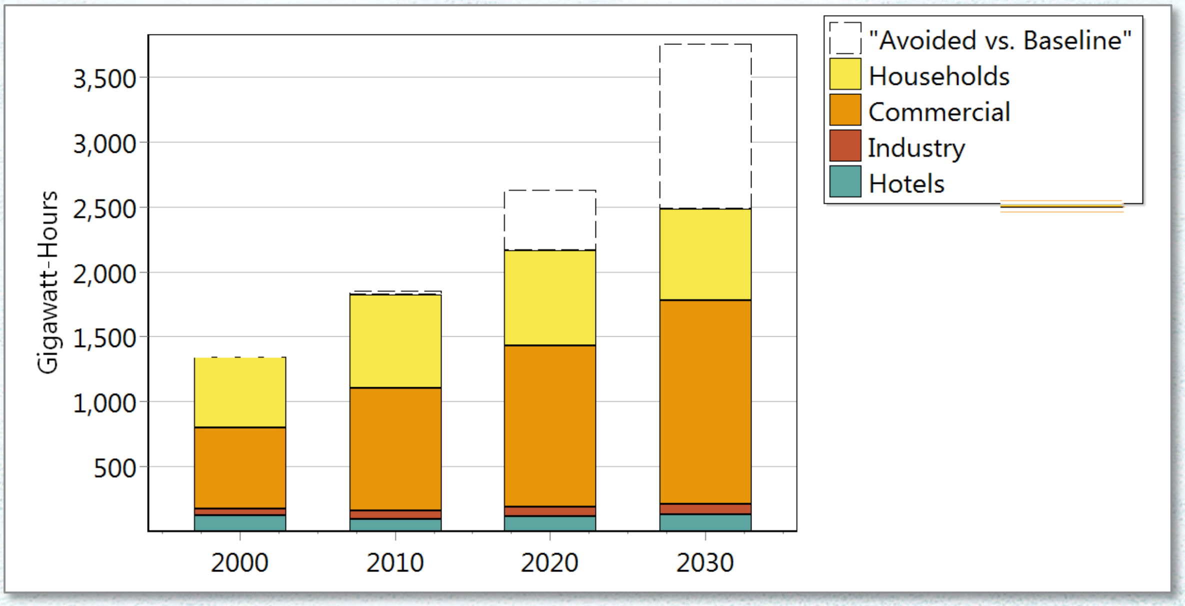


Figure 17: Avoided electricity demand in mitigation scenario as compared with the baseline scenario [Gigawatt-hours]

The electricity demands avoided due to solar PV, solar water heaters and energy efficiency in turn decrease the overall electricity generation required by power plants. Figure 18 shows a comprehensive picture of the electricity supply mix and the avoided electricity generation leading up to 2030.

Avoided Electricity Generation by Technology in the Mitigation Scenario as Compared With the Baseline Scenario

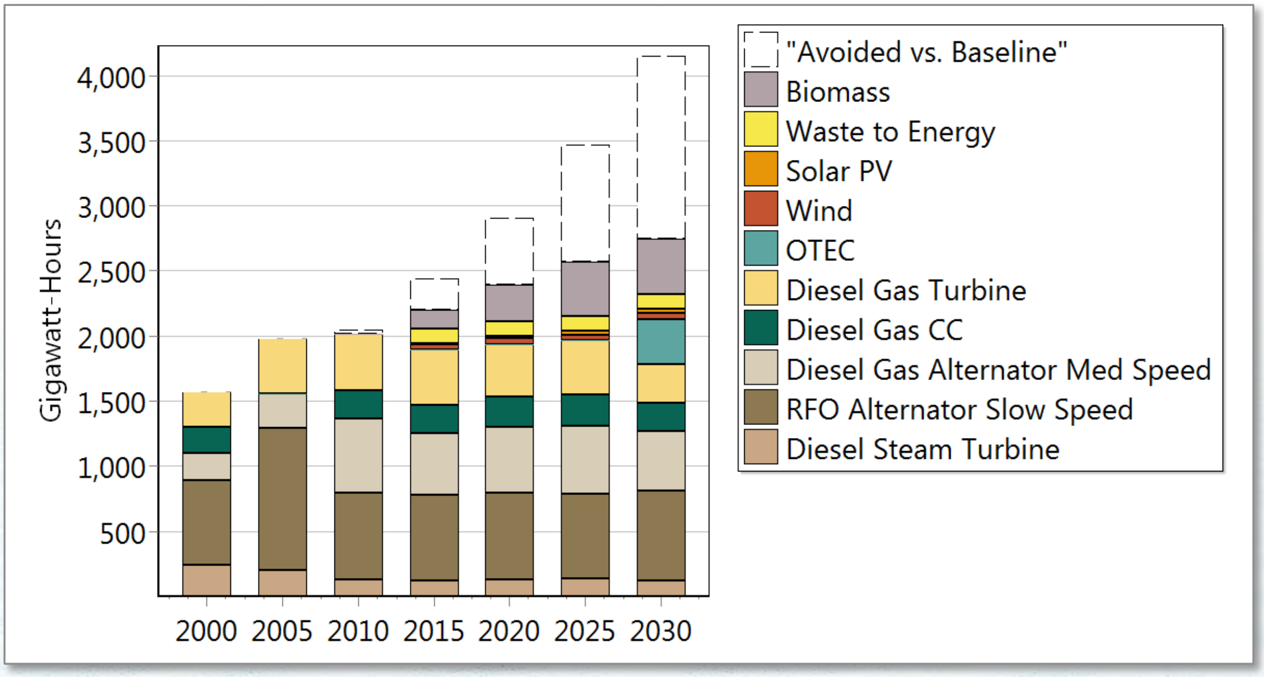


Figure 18: Avoided electricity generation by technology in the mitigation scenario as compared with the baseline scenario [Gigawatt-hours]

Based on the renewable energy potential in The Bahamas and the power plant expansion plans assumed for the mitigation scenario, The Bahamas could feasibly produce over 30% of their electricity from renewable generation sources by 2030.

Renewable Electricity Generation by Technology in the Mitigation Scenario

Table 19: Renewable electricity generation by technology in the Mitigation scenario [GWh]

	2010	2015	2020	2025	2030
Biomass	0	140	280	420	420
Waste to Energy	0	112	112	112	112
Solar PV	0	4	15	26	37
Wind	0	44	44	44	44
OTEC	0	0	0	0	350
Total Generation Required	2,014	2,195	2,338	2,568	2,743
% Renewable Generation	0%	13.6%	19.3%	23.4%	35.1%

Table 19: Renewable electricity generation by technology in the Mitigation scenario [GWh]

Table 19 includes overall GHG savings from each policy measure found in the mitigation scenario. The energy efficiency and renewable grid electricity measures provide the majority of the savings. These measures mainly displace residual fuel oil and diesel fuel from electricity generation.

Avoided GHG Emissions by Fuel in the Mitigation Scenario Compared With the Baseline Scenario

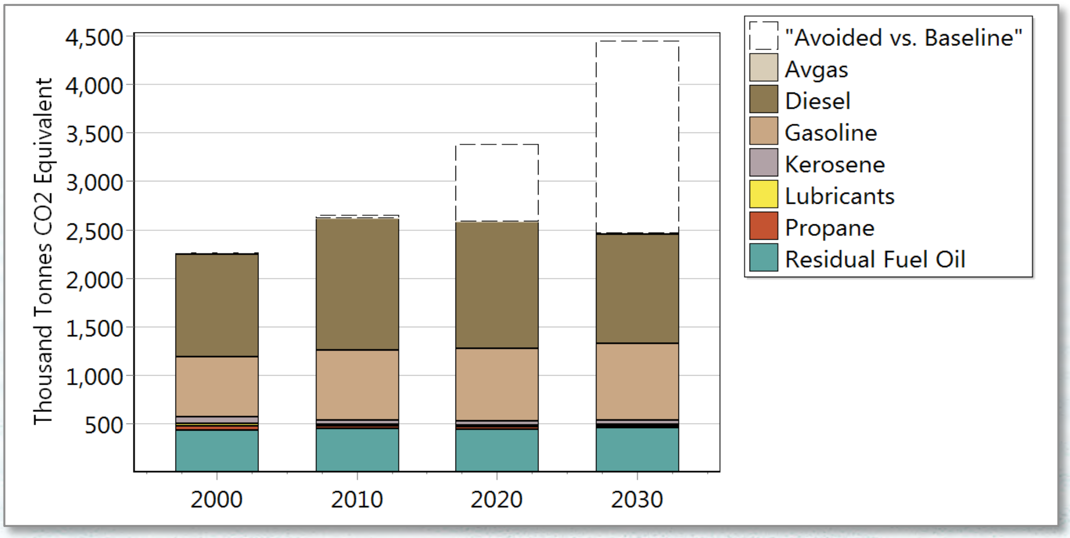


Figure 19: Avoided GHG emissions by fuel in the mitigation scenario as compared with the baseline scenario [Thousand Tonnes CO_2 equivalent][27]

The scenario analysis for The Bahamas included only policies for the energy sector, and more specifically policies related to the generation and consumption of electricity. As documented in the Greenhouse Gas (GHG) Inventory chapter, The Bahamas also has a GHG emission sink from the land use change and forestry sector. If these savings were to be included in an analysis like LEAP based on the estimates in GHG inventory calculations, net emissions would be negative, as can be seen in Figure 19.

[27] Only primary resources are included in this graph. This means that electricity is not included, and instead, the fuels used to produce electricity are shown (i.e. diesel and residual fuel oil).

Avoided Emissions by Sector for the Mitigation Scenario compared With the Baseline Scenario Including Land Use Change and Forestry

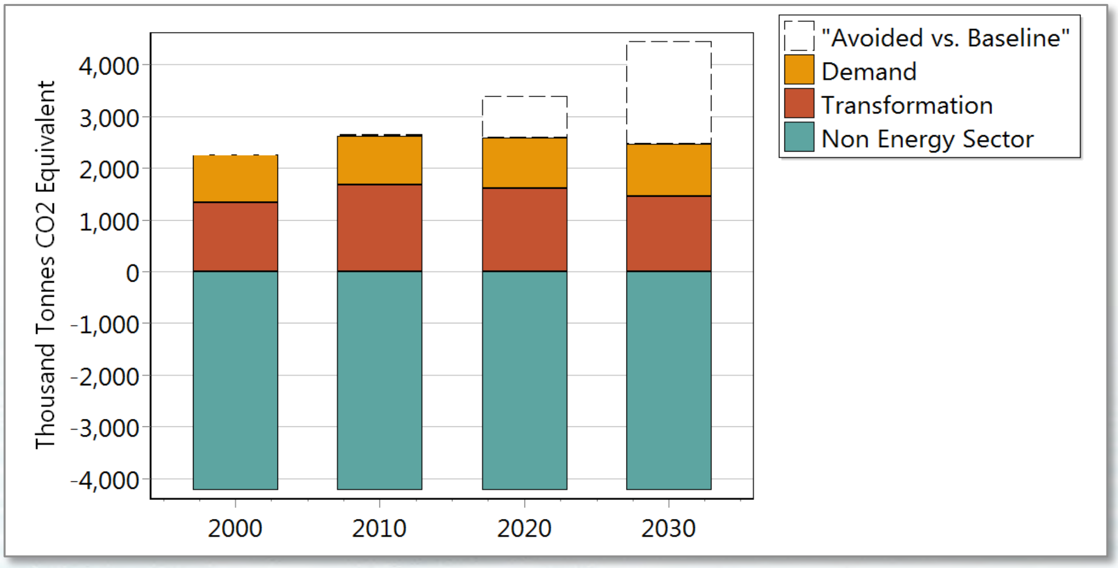


Figure 20: Avoided emissions by sector for the mitigation scenario as compared with the baseline scenario including land use change and forestry [Thousand Tonnes CO_2 equivalent][28]

[28] This assumes no change in GHG emissions or savings from the non-energy sector from the 2000 GHG inventory. Transformation includes emissions from electricity production, transmission and distribution.

3.3 NEXT STEPS

The mitigation assessment described in this chapter is purely theoretical. In order to establish, enforce and monitor the policies and measures discussed in this chapter, barriers related to energy efficiency, scaling up renewables and the transport sector would first have to be addressed.

Barriers to Energy Efficiency

The large-scale deployment of energy efficiency measures faces the following non-economic barriers:

- Lack of awareness, knowledge and skills among users, planners, designers and service providers about energy efficient alternatives to the incumbent technologies and the opportunities of energy efficiency;
- Higher up-front investments – albeit most energy efficiency measures are highly cost competitive. In particular, private consumers tend to prefer no/low investment and low running costs instead of high running costs to high up-front investments;
- Limited availability of high efficient technologies – the size of the Bahamian market limits the choice between different appliances, etc., so that often only inefficient default technologies are promoted; and
- Landlord-tenant problem, i.e., the house owner who installs and invests in a renewable energy plant does not benefit from the lowered running energy costs, but the tenant as the energy consumer does. [29]

Barriers to Renewable Energy Deployment

Scaling up renewable energies to meet the proposed policy measures will undoubtedly face the following barriers:

- Lack of awareness, knowledge and skills among users, planners, designers and service providers regarding how renewable energy technologies and opportunities can be applied;
- Lack of access to capital to cover the high up-front investments e.g. financial institutions/ lending facilities are not ready to finance renewable energy projects since they are not familiar with the concept;
- Independent power producers (IPP) are not granted grid access by law;
- Lack of incentives for The Bahamas Electricity Corporation (BEC) to buy electricity from IPP rather than transferring all costs to the final customer;
- Lack of clear technical and commercial grid connection rules, i.e. grid connection must be negotiated by case, which is time consuming; and
- Uncompetitive technologies under present conditions. However, this picture may change with costs of some renewable energy technologies further decreasing, and prices of competing fossil fuels increasing. [30]

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[29] Policy report p.23/44 (exact text)

Barriers to Transport Modelling

As mentioned previously, the transport sector was not included in the quantitative mitigation assessment due to a lack of detailed data. If addressed, the following data gaps will greatly broaden the scope of future mitigation studies:

- Passenger vehicle numbers, types, model years;
- Commercial land vehicle numbers, types, model years;
- Passenger, recreational, cargo and commercial marine vessel numbers and types;
- Passenger and private aircraft numbers and types;
- Mileage and consumption data of all fuel types and vehicle categories and classes;
- Existing traffic control systems;
- Public transit statistics;
- Petroleum product pricing and marketing trend factors; and
- Petroleum product shipping, delivery and distribution frequencies and practices. [31]

[30] Policy report 19/44 (exact text)
[31] Policy report 13/44 (exact text)

CHAPTER 4: CLIMATE CHANGE IMPACTS, VULNERABILITY AND ADAPTATION

4.1 INTRODUCTION

Like other Small Island Developing States (SIDS), The Bahamas is highly vulnerable to adverse impacts of climate change and sea-level rise. The clear, warm waters, white sandy beaches, warm climate and close proximity to large tourism demand centers, such as the United States of America (USA) and Canada make The Bahamas a prime tourist destination. Thus, tourism is the mainstay of its economy accounting for 60% of the gross domestic product (GDP).

The existing mechanisms and infrastructure for addressing disasters and to responding to the adverse effects of climate change include the National Emergency Management Agency (NEMA), and an effective early warning system. In addition, the GOB has had to provide infrastructure and support mechanisms to respond to sow on-set events, for example, the placement of seawalls.

However, the development and effectiveness of these mechanisms is hampered by limited resources, the frequency of extreme events and the extent of impacts across the archipelago. Further, as is shown in this assessment, The Bahamas will not be able to sustain the level of economic development highly skewed by tourism for the long-term unless it addresses the root causes of the adverse impacts of climate change and sea-level rise.

The vulnerability and adaptation assessment conducted and presented here fulfils the requirements of and obligations to the United Nations Framework Convention on Climate Change (UNFCC). It also serves to highlight the imminent threat of climate change and sea-level rise to its long-term survival. The vulnerability and adaptation assessment further highlights the efforts made by the Government of The Bahamas (GOB) in dealing with concomitant issues relating to the adverse impacts of climate change and sea-level rise, variability and extreme events. Some of these issues are covered in the Chapter on National Circumstances (pages 40 - 71).

The capacity of The Bahamas in addressing adverse effects of climate change are often compromised of limitations on response capabilities, socio-economic conditions, financial resources, insurance and associated economic services for managing climate change risks. While this may constitute a limitation in the assessment, many of the vulnerable sectors in this study have direct/indirect implications and linkages to the overall capacities and capabilities.

This is the first V&A assessment conducted in The Bahamas, and it focuses on the most vulnerable sectors of the economy. The V&A assessment was conducted using a range of frameworks underpinned by consultations with the following: key stakeholders; literature surveys; analysis of information contained in the First National Communication; data and information generated from national, regional and international sources; and from modeling the impacts and adaptations of climate change and sea-level rise under the various greenhouse gas emissions scenarios provided in the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES 2003).

4.1.1 Implications from IPCC Fourth Assessment Report (AR4)

The Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report (AR4) concluded that "for the next two decades, a warming of about 0.2°C (32°F) per decade is projected for a range of SRES emission scenarios. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century." The IPCC (IPCC 2007) further concluded that while there is now higher confidence in projected patterns of warming. Other regional-scale features, such as including changes in wind patterns, precipitation, some aspects of extremes, ice, global warming and sea level rise are all a result of human activities. These features would continue for centuries due to the time scales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilised.

These conclusions have serious implications for many countries including SIDS like The Bahamas. The Bahamas is already committed to at least a warming of 0.2^{o}C over the next two decades. Recent analysis of temperature records show that the average annual temperatures have been steadily increasing over the last 30 years (1971-2000), and this trend is likely to continue in the foreseeable future.

The observation record of temperature in The Bahamas has shown that the mean annual temperature has increased by about 0.5^{o}C since 1960, at an average of 0.11^{o}C per decade (McSweeney, et. al. 2009). The rate of increase is most rapid in the warmest seasons (JJA and SON) at 0.13^{o}C and 0.15^{o}C per decade respectively. As for rainfall, observational record shows that mean rainfall over The Bahamas has not changed significantly since 1960.

4.1.2 Sea Level Monitoring

With regard to sea level monitoring, The Bahamas has four tide gauges at Nassau Harbour, Lee Stocking, Inagua and Settlement Point, Grand Bahama. The first three tide gauges were provided and installed in 2002 under the project - Caribbean: Planning for Adaptation to Climate Change (CPACC) Project of the Organization of American States (OAS). Unfortunately, data strings for Inagua and Lee Stocking Island have been shortened due to monitoring disruptions caused by tropical cyclones. A tide gauge at Settlement Point has been operated and maintained by the United States of America's National Oceanographic and Atmospheric Administration as part of the Global Sea Level Observing System (GLOSS) network, since 1978.

The Perry Institute for Marine Sciences has made additional observations, at Lee Stocking Island in the Exuma Cays that include records of the physical processes controlling water temperature, water level and circulation. Some of the observations are in-situ, and are made in the shelf waters of Exuma Sound, the adjacent shallow waters of the Great Bahama Bank to the west, and in the connecting tidal channels. Sea level recordings have been made by various entities over the past century, but no long-term records exist for any individual site across The Bahamas.

4.2 APPROACHES AND FRAMEWORKS FOR VULNERABILITY AND ADAPTATION ASSESSMENT

The vulnerability and adaptation assessment (V&A) report presented here is in line with the guidelines provided by the UNFCCC guidelines for the preparation of the national communications adopted at the eighth session of the Conference of the Parties to the UNFCCC. The information generated for the V&A assessment followed two principal approaches: (i) a consultative process involving key stakeholders and/or sectors and (ii) a modeling approach using climate change and sea-level rise projections for different time horizons in the future. These approaches enable the impact analyses, identification of adaptation options, measures and strategies. The V&A assessment is regarded as a living document; i.e., it will be updated and presented on a regular basis and will depend on the availability of resources and expertise. The periodicity of V&A assessment is considered significant for The Bahamas as the needs and priorities for adaptation to climate change over the long term will more than likely change as with the projected changes in climate change and sea level.

A number of approaches and frameworks were used in conducting the assessment of vulnerability and adaptation in The Bahamas. All of the frameworks and approaches are based on and are closely aligned with the common methodology of the following Intergovernmental Panel on Climate Change (IPCC 1996); United States Country Studies Handbook on Vulnerability and Adaptation Assessments (1996); and the UNEP Handbook on Vulnerability and Adaptation Assessments (1998). Additionally, a number of other approaches were used to collect information and to help characterize future climate change risks. These include focussed meetings and consultations to find out past, present and future activities relating to V&A in the various sectors and to ascertain the needs and priorities for V&A within each of the sectors. Stakeholder consultations initially took about one month and continued through the V&A process. Consultations were held with the following organisations:

Government Departments/Agencies	
Bahamas Environment, Science and Technology (BEST) Commission	Department of Environmental Health Services
Department of Meteorology	Bahamas National Geographic Information System
Department of Marine Resources	Water and Sewerage Corporation
Tourism	Lands and Surveys
Bahamas Electricity Corporation	Department of Forests
National Emergency Management Agency	
Non-Government Organisations	
The Bahamas National Trust	Bahamas General Insurance Association
The Nature Conservancy	Pan-American Health Organisation

4.2.1 Assessment of Vulnerability and Adaptation

The consultations found that while climate change and sea-level rise are recognised as serious threats to relevant sectors of the economy most sectors do not necessarily incorporate climate change issues in their operations. With the exception of the Department of Meteorology, BEST Commission, and the Water and Sewerage Corporation, climate change and sea-level rise concerns and issues are not explicitly addressed in other sectors. Many of these sectors have indicated that this may be attributable to the lack of information on the adverse impacts of climate change except for the most identifiable impacts resulting from hurricanes.

The stakeholder consultations were followed by a kick-off workshop on climate change vulnerability and adaptation assessment to: (i) brief the stakeholders (thematic working group on V&A/participants) on V&A assessment in the context of preparing the second national communication under the new UNFCCC guidelines[32]; (ii) introduce a range of frameworks, approaches, methods, tools, and data sources for conducting V&A assessment; (iii) provide a forum for participants to share knowledge, experience, and difficulties in preparing the V&A component; and (iv) examine ways of overcoming these constraints/gaps.

The workshop brought together participants from the various government departments, agencies and ministries, as well as, representatives from the non-government organisations. The workshop involved presentations on specific topics covering the various aspects of V&A assessment and group exercises. The group exercises focused on vulnerability analysis using

[32] The UNFCCC guidelines for the preparation of national communications from Parties not included in annex I to the Convention is contained in decision 17/CP.8 http://unfccc.int/resource/docs/cop8/07a02.pdf#page=2 .

both bottom-up and top-down approaches. A number of resource people were available to help facilitate and respond to queries and/or comments raised by the participants.

4.2.2 Training: Learning-by-doing

The second component focusing on climate change vulnerability and adaptation assessment (V&A) for The Bahamas was facilitated by a training workshop on climate change. The workshop focused on building the capacity of The Bahamas experts to conduct V&A. This will help to identify, evaluate and prioritise key vulnerabilities, adaptive strategies, policies and measures that need to be implemented to improve and enhance the adaptive capacity of The Bahamas, as a nation.

The training of The Bahamas *Experts to Assess Climate Change Impacts, Vulnerability and Adaptation*, was held from May 3 to 8, 2010, in Nassau, The Bahamas. The workshop was organised by The Bahamas Environment Science and Technology Commission (BEST). National experts representing the key sectors (agriculture, forests, water resources, energy, coastal resources, and health) attended and participated in the training workshop.

The overall goal of the training workshop was to provide training in the use and application of BahamasSimCLIM[33] for examining impacts and adaptations to climate variability and change in The Bahamas. The workshop was organised to achieve the following:

1. To build the skills for integrating and testing model components to be used for examining the effects of climate variability and change, through hands-on training on: -
   - The use of BahamasSimCLIM software programme;
   - Adjustment and/or selection of the parameters of the climate change models to fit The Bahamas situation; and
   - Evaluation of the performance and sensitivity of the impact models under the various environmental and climatic conditions found in The Bahamas.
2. To conduct an initial model-based impact assessment using SimCLIM for The Bahamas (BahamasSimCLIM), in order to ensure that the team members have the knowledge and skills to use the system for impact assessments to:-
   - Identify a set of scenarios and protocols for use in the assessment, including consideration of: the baselines for comparison; the time horizons; GCM patterns; emission scenarios; climate sensitivities to be selected within BahamasSimCLIM; and the inclusion of climate variability and extremes;.
   - Decide upon the outputs of the model runs that should be used as indicators of impact;
   - Obtain crop and water impacts under the set of baseline and climate change scenarios; and
   - Processing and analysing the results of the simulations.

The training workshop involved presentations on specific topics covering the various aspects of climate change assessment and group exercises. Each participant had a laptop supplied by

[33] BahamasSimCLIM is a tool for generating climate change and sea-level rise projections using the various SRES emission scenarios. The tool has an open structure which allows it to be populated with the country-specific data and is linked to the several biophysical models for conducting integrated assessments. BahamasSimCLIM uses ensemble of 21 GCM patterns for generating climate change and sea-level rise projections for The Bahamas. More information on this tool and its applications can be obtained from http://www.climsystems.com/.

their respective government offices. Each laptop had a BahamasSimCLIM system, site licenses, model components, site specific data, and an instruction manual installed. Two resource people were available to help facilitate the training and respond to queries and comments raised by the participants.

The training was based on the *SimCLIM Essentials for The Bahamas: Training Book I*, an instruction booklet which allows for a step-by–step process of navigating through the software. Apart from navigating through instructions on the main component sessions were centred on the following: creating synthetic scenarios; generating scenarios and showing changes from baseline conditions; creating site-specific climate change scenarios; creating sea-level rise scenarios and running an impact model including a model for rain water collection/use. Other specific tools include a climate data browser and an extreme event analysis.

The training allowed for the following: the creation and/or generation of climate change and sea-level rise scenarios; familiarization of the participants with the interpretation of results; appropriate use of global circulation models and the use of the IPCC Special Report on Emission Scenarios (SRES) for scenarios on greenhouse gas emissions.

Another important aspect of the training was the ability and/or capacity to input country-specific or site-specific data to The BahamasSimCLIM system. This enabled The Bahamas experts to populate the model with Bahamas-specific site data prior to, during and after the SNC process. Participants also learnt that this tool will help The Bahamas design and implement climate change-related projects as a planning tool for project design, development and implementation.

Sectors that are important to climate change vulnerability and adaptation assessment work in The Bahamas include agriculture, water resources, forests, coastal resources, human health, energy, fisheries and disaster preparedness.

4.3 Evidence of Climate Change in The Bahamas and Projection to 2100

Recent analysis of the temperature record in The Bahamas shows that average annual temperatures have been steadily increasing over the last 30 years (1971-2000) and this trend is likely to continue in the foreseeable future (McSweeney, et al. 2009). The observation record of temperature in The Bahamas has shown that the mean annual temperature has increased by about 0.5^{o}C since 1960, at an average of 0.11^{o}C per decade (McSweeney, et al. 2009). The rate of increase is most rapid in the warmest seasons (JJA) and SON) at 0.13^{o}C and 0.15^{o}C per decade respectively. As for rainfall, observational record shows that the mean rainfall over The Bahamas has not changed significantly since 1960. The general trend for The Bahamas shows an increasing temperature from 1960-2006 (Figure 21). Figure 21 also provides projected trends up to 2100 under A2, A1B and B1 emissions scenarios (McSweeney, et al. 2009).

Trends in Annual and Seasonal Mean Temperature for the Recent, Past and Projected Future Under A2, A1B and B1 Emission Scenarios

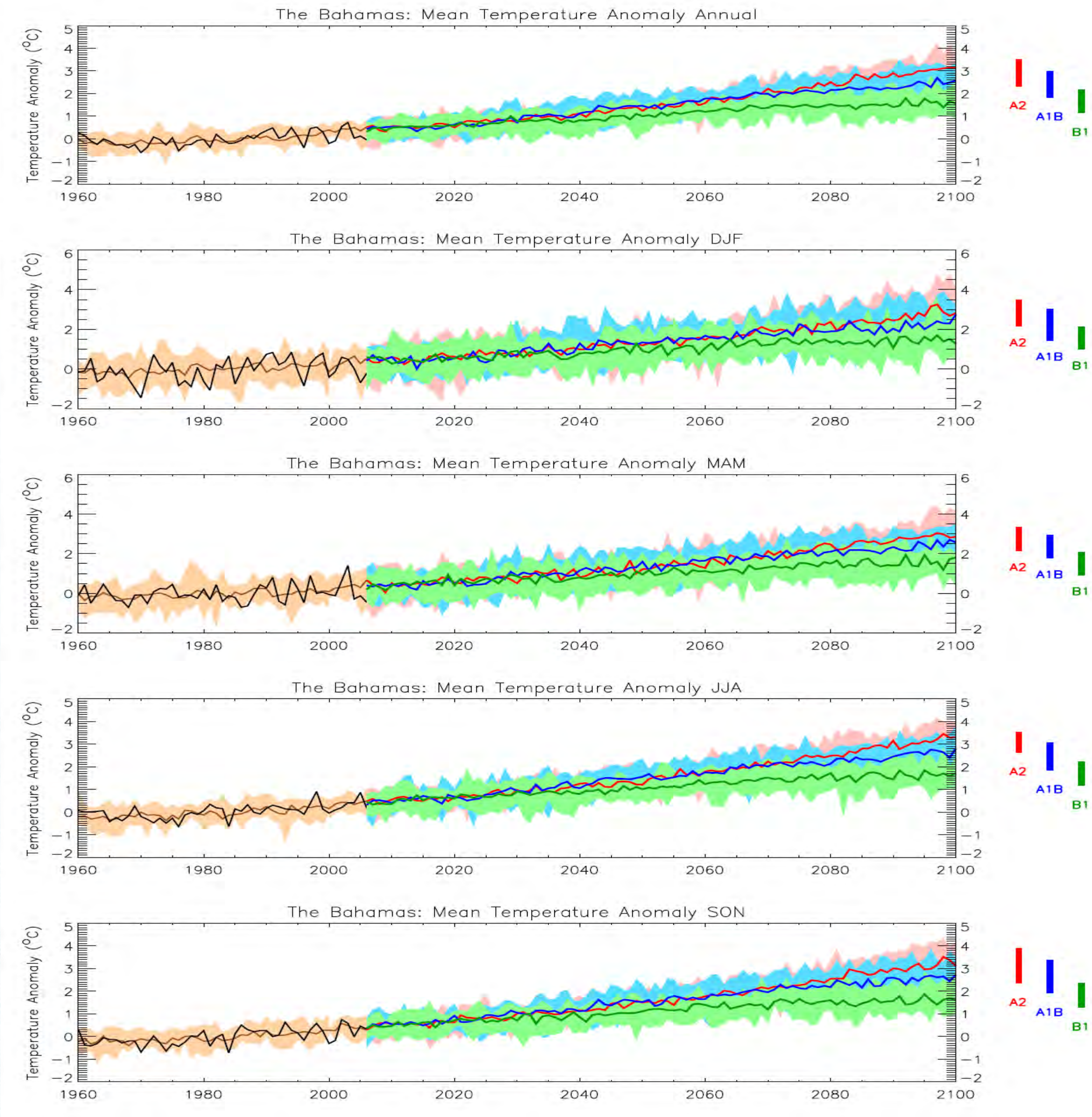


Figure 21: Trends in annual and seasonal mean temperature for the recent, past and projected future under A2, A1B and B1 emission scenarios. All values shown are anomalies, relative to the 1970-1999 mean climates. Black curves show the mean of observed data from 1960 to 2006, Brown curves show the median (solid line) and range (shading) of model simulations of recent climate across an ensemble of 15 models. Coloured lines from 2006 onwards show the median (solid line) and range (shading) of the ensemble projections of climate under three emissions scenarios. Coloured bars on the right-hand side of the projections summarise the range of mean 2090-2100 climates simulated by the 15 models for each emissions scenario (reproduced from McSweeney, et. al. 2009).

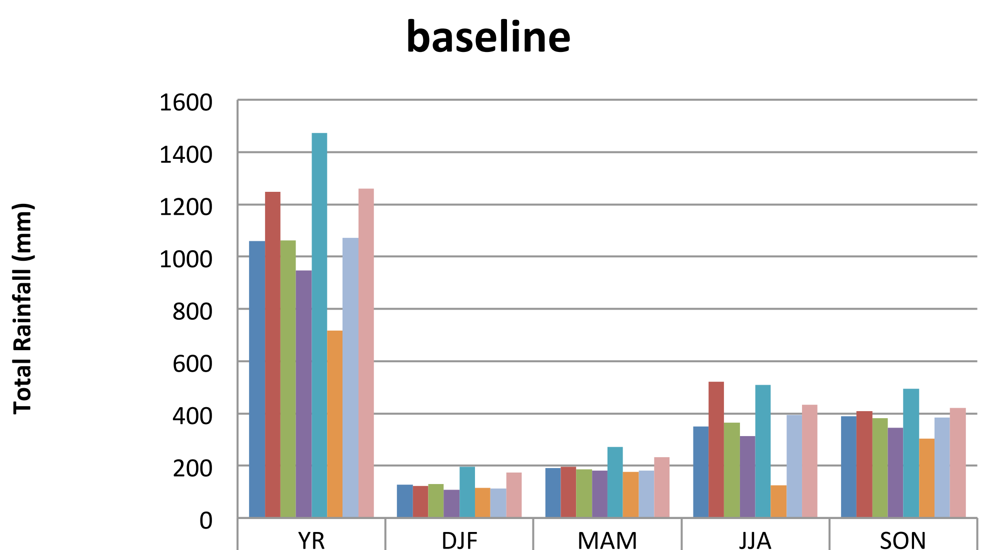
4.4 Climate Change and Sea Level Rise Projections

Projections of future changes in climate are from a baseline, the average over the period 1961-1990. For sea-level rise projections the baseline is 1990. The SimCLIM software (Warrick 2009) which uses the results of the GCMs in the IPCC intermodal comparison database was used to generate the calculations. Where possible, ensemble results were used.

4.4.1 Precipitation

The baseline precipitation for the entire The Bahamas and seven of its islands is given in the table below (yearly total, as well as seasonal sums, all in millimetres).

Seasonal Rainfall in The Bahamas



	YR	DJF	MAM	JJA	SON
Bahamas	1059	128	192	351	388
New Providence	1248	123	196	521	408
Eleuthera	1063	129	187	364	383
Exuma	948	109	180	313	346
Grand Bahamas	1472	196	272	510	494
Inagua	717	114	176	124	303
Andros	1072	113	180	394	385
Abaco	1260	174	232	433	421

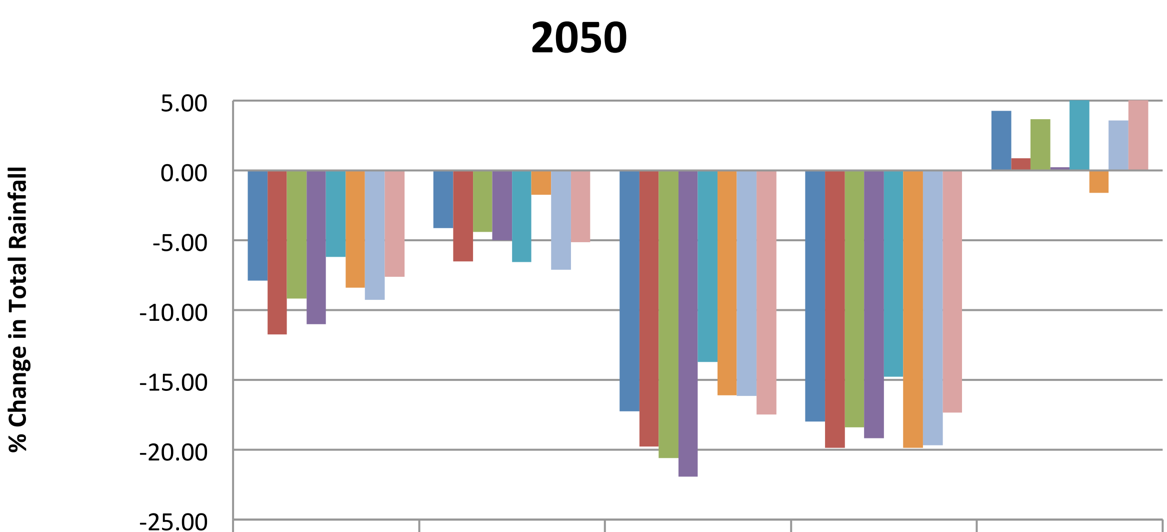
Table 20: Annual seasonal rainfall in The Bahamas

The “wettest” island (Grand Bahama) gets twice the amount of rain (1472 mm) of the “driest” island (Inagua, 717 mm) annually, but for the June/July/August season, it is four times more (510 mm vs. 124 mm). Thus, more rain falls in the northwest (Grand Bahama, Eleuthera, and Abaco), Central (Andros, New Providence) and less in the southeast (Exuma, Inagua).

Decreases in summer rainfall in all islands are expected with significant decreases in Exuma, Eleuthera and New Providence. During the winter Inagua will remain “driest” while all other islands to the northwest will experience an increase in rainfall by 2050. The northwest Bahamas will be wet while the southeast Bahamas will experience dry conditions.

Using the median result of a 21-GCM ensemble, the A1FI emission scenario, with high climate sensitivity rainfall changes (%) likely to be expected by 2050 will mean a decrease in rainfall by as much as 10% for annual precipitation, and 20% in some seasons for most islands (Table 21 below). Winter will be drier in Inagua while all islands to the northwest will have an increase in precipitation.

Results of the 21-GCM Ensemble for The Bahamas 2050



	YR	DJF	MAM	JJA	SON
Bahamas	-7.88	-4.12	-17.26	-17.99	4.25
New Providence	-11.76	-6.50	-19.79	-19.85	0.86
Eleuthera	-9.17	-4.38	-20.60	-18.41	3.67
Exuma	-11.00	-5.02	-21.92	-19.18	0.21
Grand Bahamas	-6.20	-6.58	-13.71	-14.79	6.92
Inagua	-8.38	-1.74	-16.12	-19.85	-1.62
Andros	-9.28	-7.09	-16.15	-19.68	3.57
Abaco	-7.63	-5.12	-17.47	-17.34	6.77

Table 21: Results of the 21-GCM Ensemble for The Bahamas 2050

Spatially, the distribution and change (%) in rainfall is expected to decrease by 10-20% by 2050. Most islands will decrease by 10% in annual rainfall and up to 20% decrease in some seasons due to climate change. For instance New Providence, Eleuthera and Exuma islands would experience up to 20% reduction in rainfall during the dry and wet seasons (March-August) by 2050.

Even within each island the rainfall changes will be significant. For instance in New Providence annual rainfall ranges from 1200-1400mm in New Providence; with less in the east than in the west of the island. The west is a highly developed and densely populated area, and less rainfall is likely to compromise future water supply. This will put additional pressure with increased risk of fires. The figure below shows precipitation for New Providence with a decrease of 11.3-12.1% thus indicating a west-east gradient (Figure 22 (b)). The average rainfall ranges from 1,204.1 mm to 1,367.5 mm (based on 1961-1990 record). There is a clear distinction between the eastern areas which receive less rainfall (by as much as 11% less) than in the western section of the island (Figure 22 (a)).

The change in rainfall for The Bahamas would decrease by as much as 5-11% in most islands. Drier regions such as the southeast (e.g. Inagua) will become drier while the wet regions in the northwest will experience a decrease in rainfall, but not as much as the southeast region. Decreases in rainfall will mean less recharge of the groundwater. Additionally, the seasonal differences will be greater ranging from a 6-20% decrease. Water resources on drier islands is the southeast will be highly compromised. Figure 23 shows the spatial distribution of rainfall in the entire Bahamas archipelago.

Precipitation Rates of New Providence

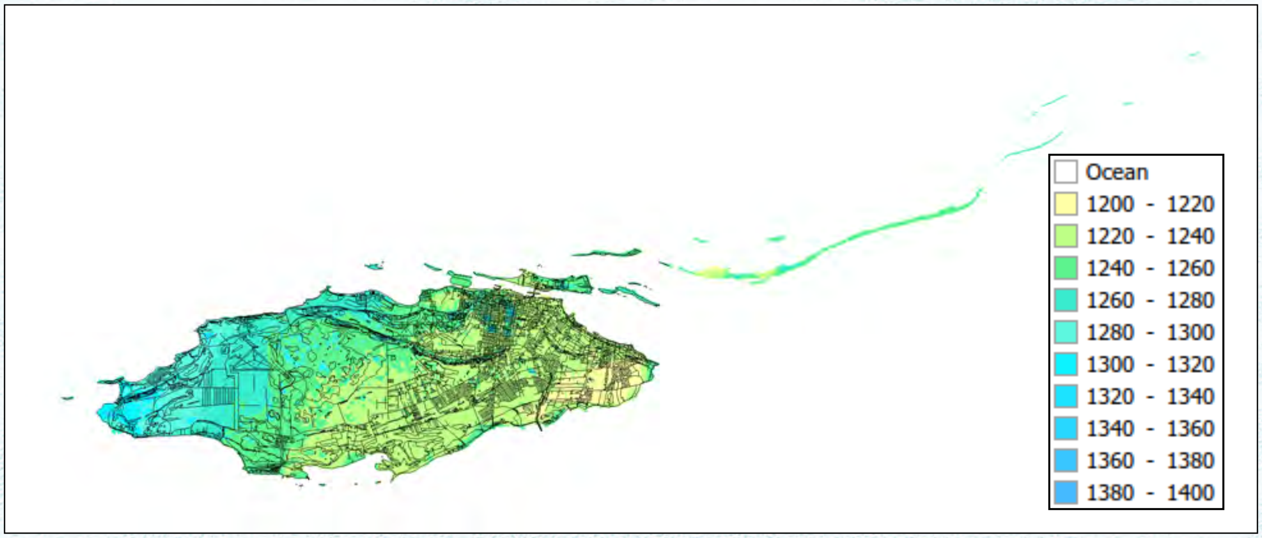


Figure 22 (a): Baseline precipitation New Providence (mm/yr)

Change in Precipitation in The Bahamas (1)

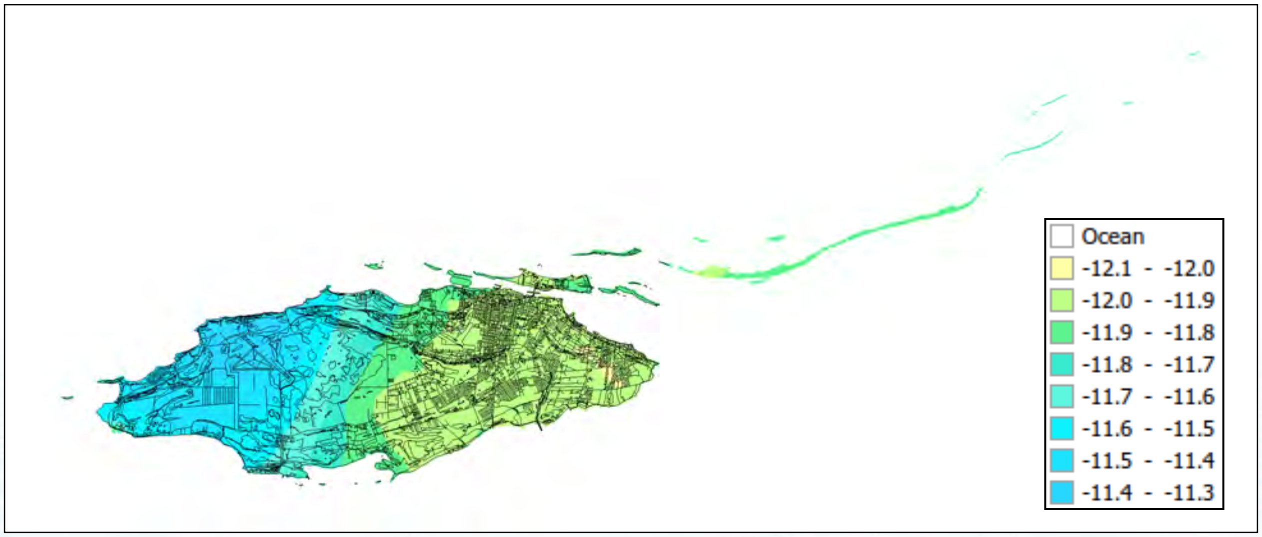


Figure 22 (b): Precipitation New Providence (A1F, high, 2050, 21-GCM ensemble) (decrease of 11.3-12.1%)

Change in Precipitation in The Bahamas (2)

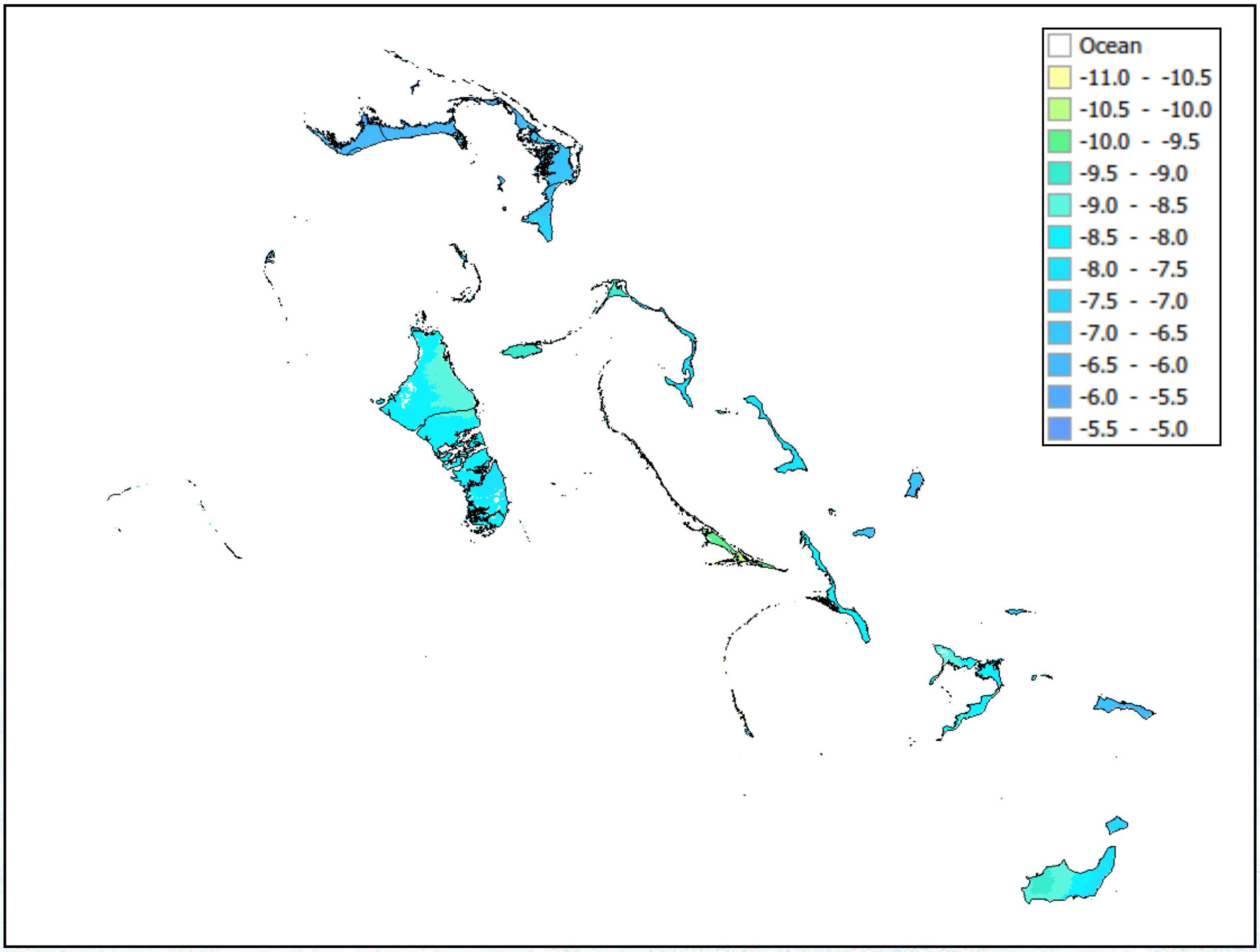


Figure 23: Change in precipitation for The Bahamas (A1FI, high, 2050)

Current climate variability was assessed through historic observations which are available for Nassau Airport (New Providence) (Figure 24). The total annual rainfall is shown to be highly variable ranging from less than 500 mm to 2500 mm per year.

Total Rainfall from Nassau Aiport, New Providence 1977-2009.

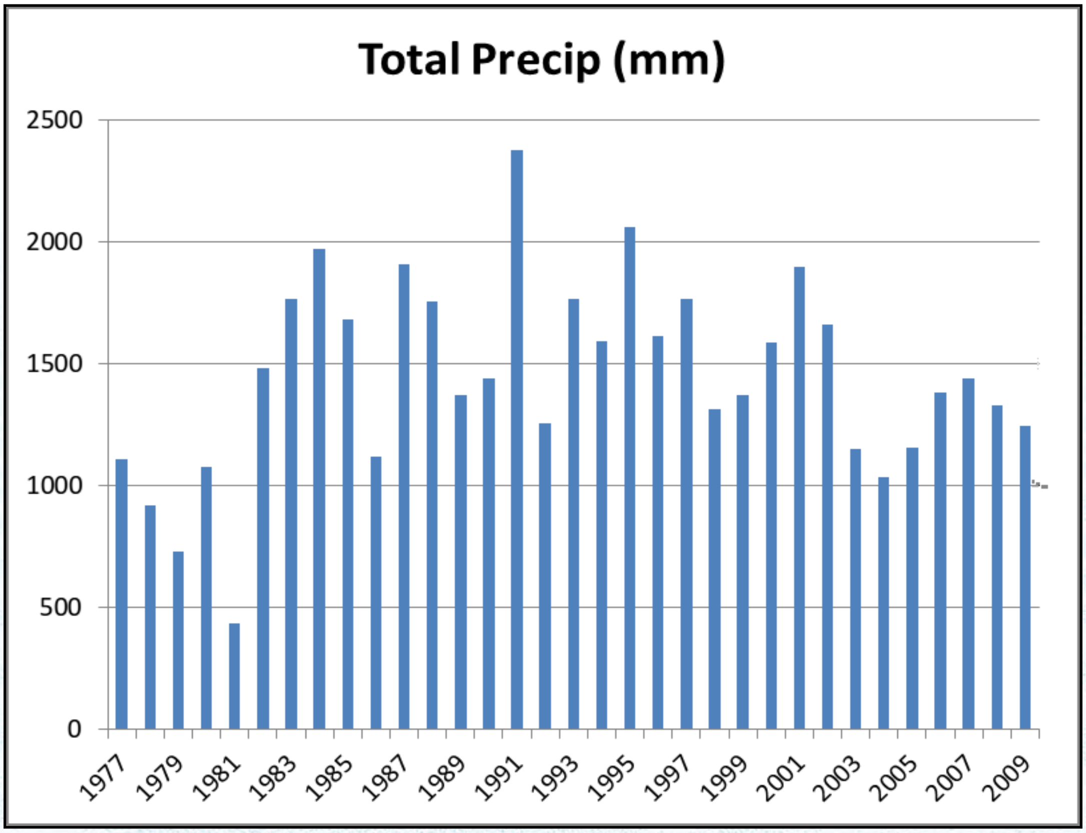


Figure 24: Total rainfall from Nassau Aiport, New Providence 1977-2009.

Seasonal variablity is also pronounced and this can have considerable implications for structuring adaptation plans for various rainfall impacted infrastructure and socio-economic activities.

The precipitation data can be analysed for both high (flood risk) and low (droughts), extreme events, current climate and climate change. By using the extreme value analysis tool, it was possible to calculate return periods for certain extreme rainfall events. Thus, Figure 25 shows that the most extreme rainfall event at Nassau Airport (481 mm of rain in one day) has a return period[34] of once in almost 60 (58.07) years and a 1:100 year event is almost 560 mm.

[34] A return period also known as a recurrence interval is an estimate of the interval of time between events like an extreme rainfall or extreme event of certain intensity or size. It is usually required for risk analysis (i.e. whether a project should be allowed to go forward in a zone of a certain risk and also to design structures so that they are capable of withstanding an event of a certain return period.

4.4.1 High Extreme Precipitation

Most Extreme Rainfall Record at Nassau International Airport

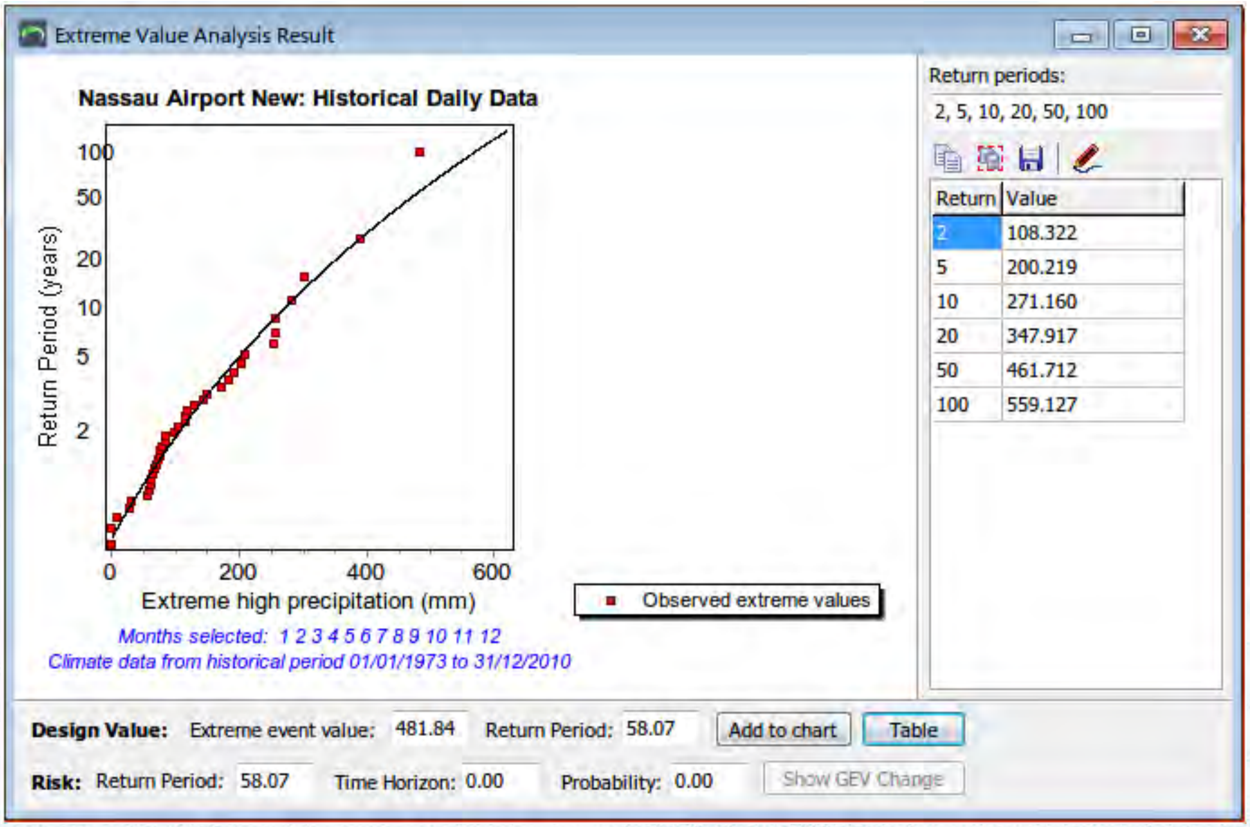


Figure 25: Most Extreme Rainfall Event at Nassau International Airport

As indicated in the projections for rainfall for 2050 and as shown above by the extreme event analysis, The Bahamas will experience a decrease in precipitation. This suggests that future extreme high events would be less severe. However, when daily outputs of 12 GCMs are applied, the analysis shows that by 2050 (with A1FI-high), the return period for the current most extreme event will have dropped to 42 years (from 58), while the 1:100 year event increases to 622 mm (from 560 mm) (Figure 26). This would mean that such events would become more severe and more intense.

This is important for flood-related infrastructure that will be built or renovated. The message from the more nuanced application of a daily GCM pattern extreme event analysis tool is that while the overall climate of The Bahamas is likely to become drier with time, extreme rainfall events will become more frequent and there will be greater one-day rainfall totals than historically experienced.

Daily Rainfall Record at Nassau International Airport

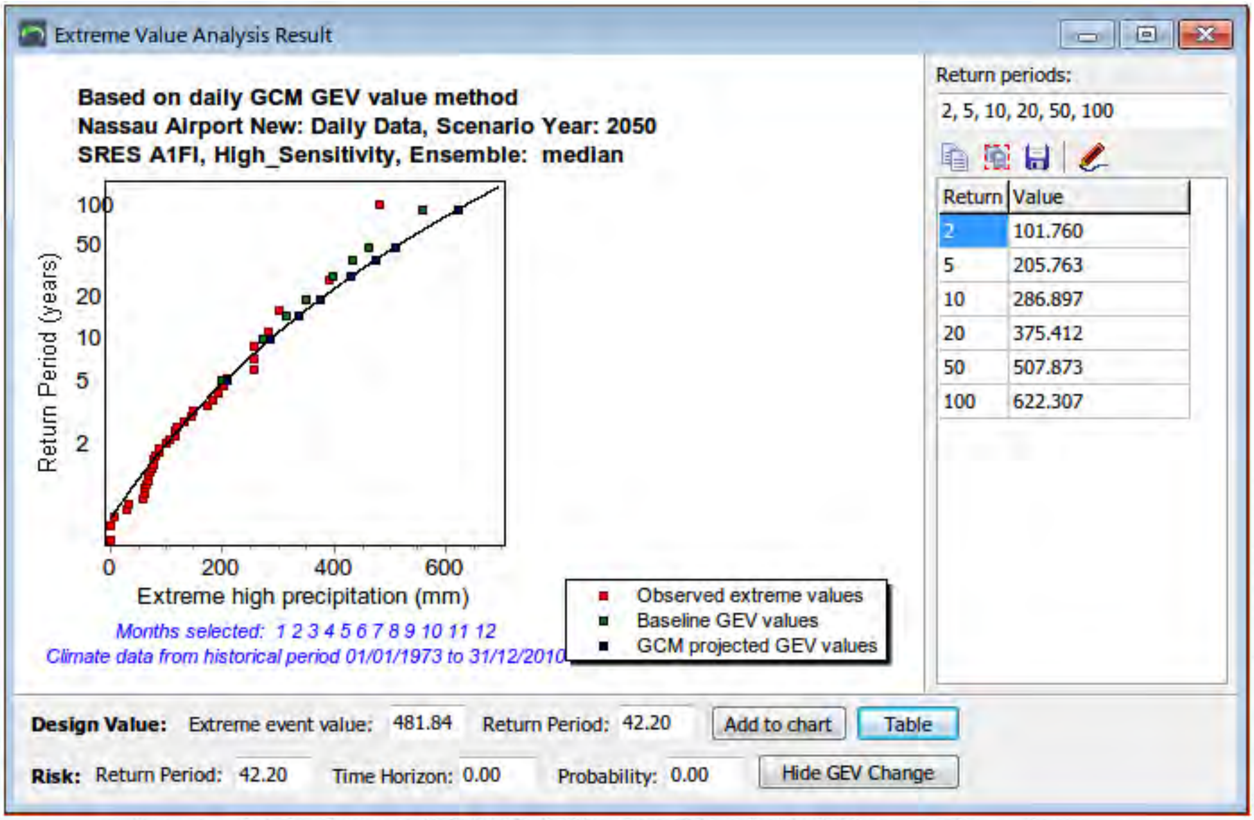


Figure 26: Daily rainfall (high extreme rainfall) under SRES A1FI High based on 12-GCM Ensemble for 2050.

4.4.2 Low Extreme Precipitation

For low extreme rainfall, a low amount of rain in a given period is calculated as an extreme event. In this case a 90-day period (three months) was chosen. Using the example for Nassau Airport, for every 10 years at least one three-month period will have less than 24 mm of rain (extreme low rainfall). However, by 2050, using the A1FI-high scenario and a 21-GCM ensemble, this will have dropped to 20 mm of rain (Figure 27). While the driest period (DJF) only shows a decrease of up to 7%, this analysis shows that for extreme droughts, the decrease in rainfall is closer to 17%. Again, the implication of this change is that droughts will become more severe. This will lead to higher temperatures and greater difficulties to secure energy efficient and potable water supplies. Increased temperature, coupled with an increased demand for water results in higher evaporation rates and less intermittent rainfall within the drought period.

Daily Rainfall Under SRES A1FI High

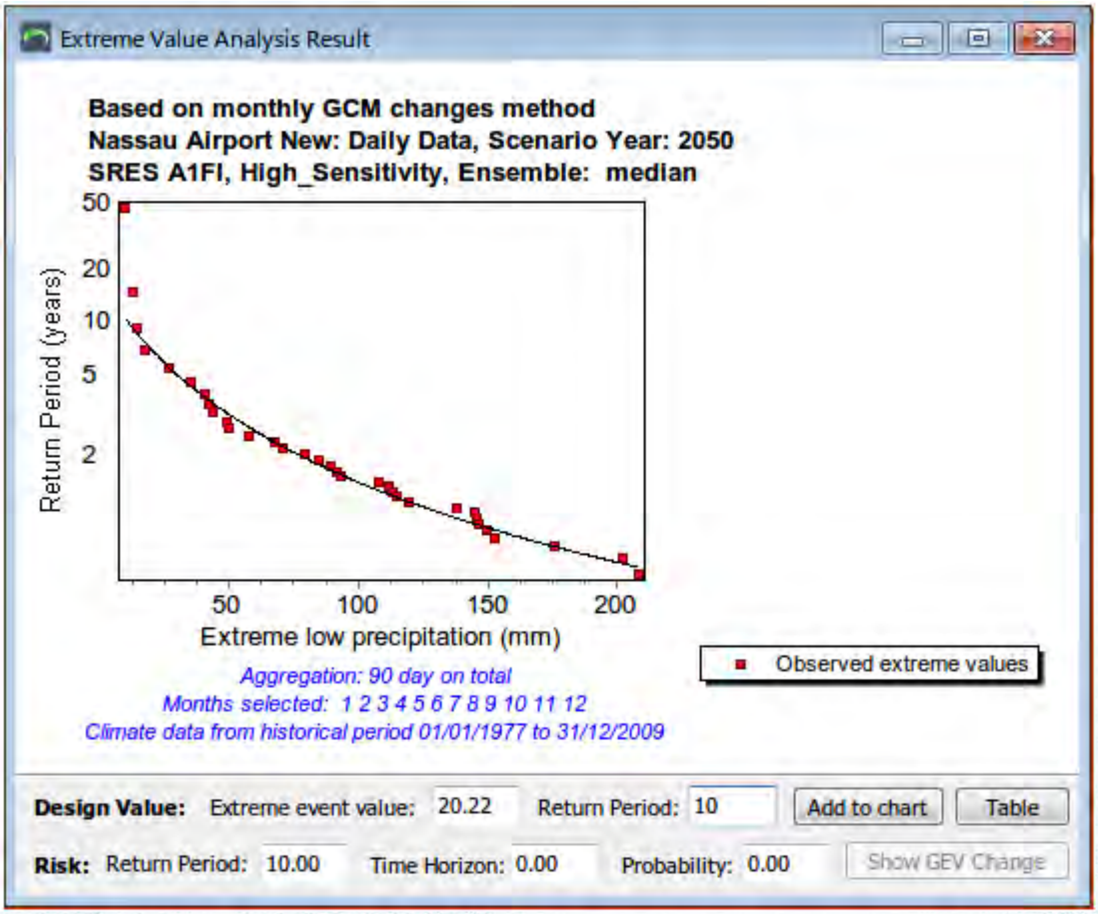


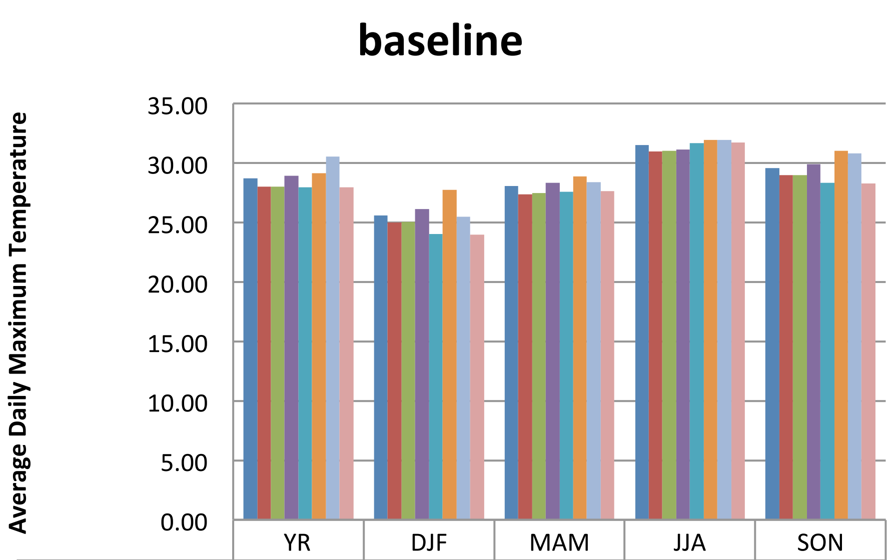
Figure 27: Daily rainfall (low extreme rainfall) under SRES A1FI High based on 12-GCM Ensemble for 2050.

4.4.3 TEMPERATURE

4.4.3.1 Extreme (High) Temperature

The baseline for daily maximum temperature for The Bahamas and seven of its islands is shown in Table 22. Maximum daily temperatures range from 27^{o}C to 31^{o}C for most islands with an average maximum temperature of 28.70^{o}C for the entire Bahamas. Analysis of extreme or maximum temperatures shows a 5^{o}C change from winter (DJF) and summer months (JJA).

Daily Maximum Temperatures for The Bahamas, 1960-2006

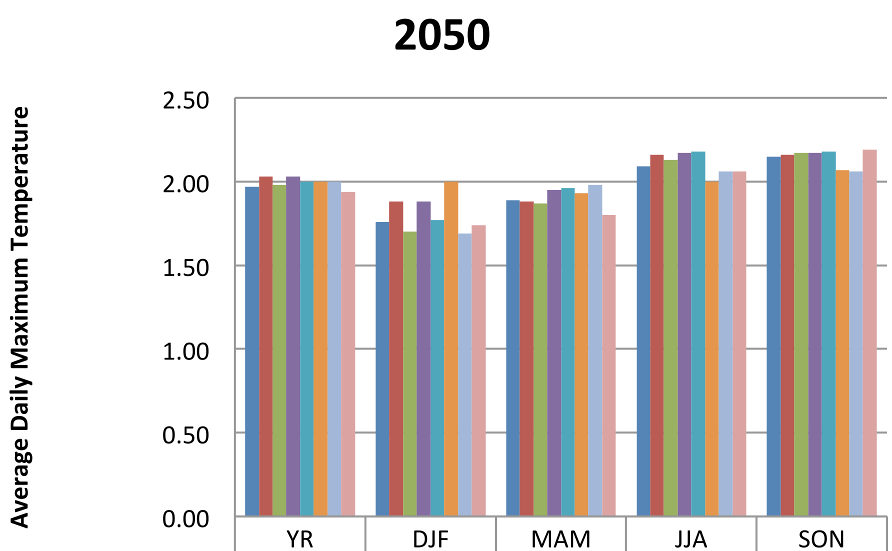


	YR	DJF	MAM	JJA	SON
Bahamas	28.70	25.61	28.08	31.49	29.58
New Providence	28.01	24.97	27.37	30.97	28.97
Eleuthera	28.02	25.05	27.47	31.00	28.99
Exuma	28.91	26.11	28.34	31.15	29.90
Grand Bahamas	27.97	24.02	27.57	31.69	28.31
Inagua	29.11	27.72	28.86	31.93	31.00
Andros	30.54	25.49	28.37	31.93	30.83
Abaco	27.95	23.99	27.61	31.70	28.27

Table 22: Average daily maximum temperatures for The Bahamas, 1960-2006.

However, projecting maximum temperature for 2050 using a 21-GCM ensemble the A1FI emission scenario and a high climate sensitivity, daily maximum temperatures are expected. It is projected that maximum temperature for The Bahamas will increase by 1.97°C, and the maximum temperature increase for the Family Islands will be 1-2°C. The winter months will be less than 2°C, and the summer months will experience the average daily maximum temperature increase of over 2°C. The drier islands in the southeast will experience higher temperatures during the winter months (DFJ) than the central and northwest regions. The range of daily average maximum temperature increase in The Bahamas is expected to be up to 2°C. This compares favourably with the expected global average daily temperature increase of 2.7°C. The lower increase in The Bahamas is due to the moderating effect of the surrounding waters.

Increase in Average Daily Maximum Temperature Under A1FI



	YR	DJF	MAM	JJA	SON
Bahamas	1.97	1.76	1.89	2.09	2.15
New Providence	2.03	1.88	1.88	2.16	2.16
Eleuthera	1.98	1.70	1.87	2.13	2.17
Exuma	2.03	1.88	1.95	2.17	2.17
Grand Bahamas	2.00	1.77	1.96	2.18	2.18
Inagua	2.00	2.00	1.93	2.00	2.07
Andros	2.00	1.69	1.98	2.06	2.06
Abaco	1.94	1.74	1.80	2.06	2.19

Table 23: Increase in Average Daily Maximum Temperature under A1FI, High Sensitivity, 2050

4.4.3.2 Baseline Average Daily Maximum Temperature, New Providence

Using the example of spatial distribution for average daily maximum temperature in New Providence, there was an increase in temperature of 0.2^{o}C - 0.9^{o}C from the baseline (1960-2006) which is consistent with the increase over the entire Bahamas (See Table 23). Thus, even under current climate, current atmospheric and oceanic conditions subtle differences in temperature and rainfall can be experienced depending on the geography of the island and the positioning of the prevailing trade winds. It is likely that these subtle differences could be amplified under future climate change.

Daily Maximum Temperature Projected for New Providence in 2050

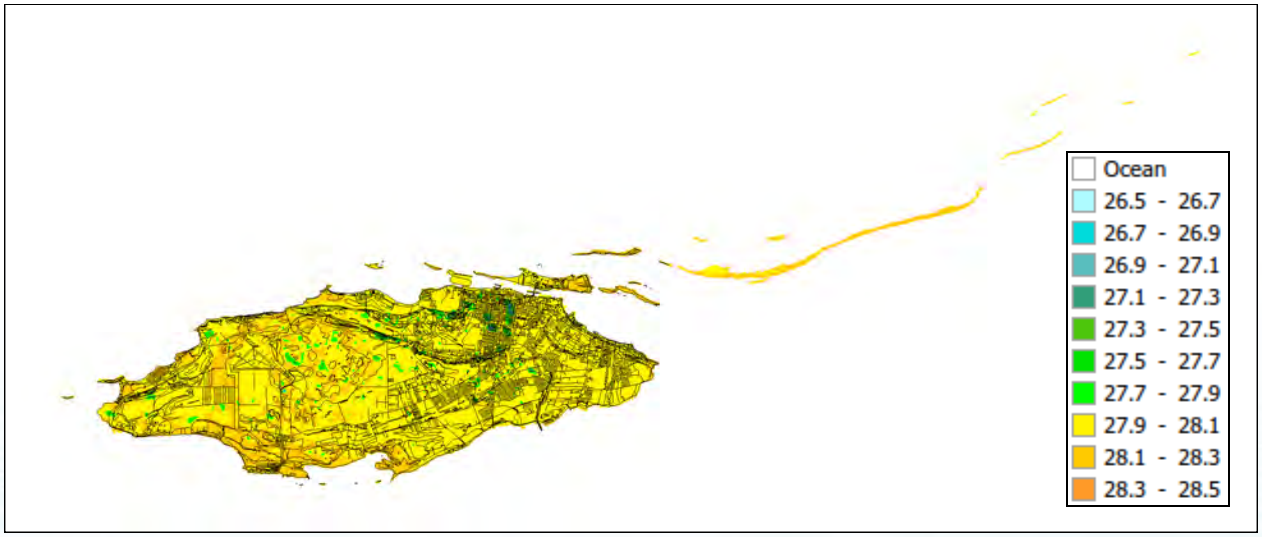


Figure 28: Average daily maximum temperature projected for 2050, New Providence.

Using the A1FI high scenario for 2050 and the 21-GCM ensemble, the projected temperature increase is spatially uniform over the island of New Providence (2.0^{o}C), ranging from 26.50^{o}C to 28.50^{o}C (Figure 28). However, the increase in average daily maximum temperature for The Bahamas ranges from 1.91^{o}C to 2.11^{o}C (Figure 29). The daily maximum temperature is highest in the northernmost island of Grand Bahama and in the southernmost island of Inagua (average over 2.0^{o}C). An increase of 1.93^{o}C to 1.97^{o}C in the central part of The Bahamas is expected. Interestingly, the largest island of Andros will have a temperature differential ranging from 1.91^{o}C in the north to 1.99^{o}C in the south. In Grand Bahamas, temperatures range from less than 2.0^{o}C in the west to over 2.0^{o}C in the east. The northern part of Andros and the western part of Grand Bahama are highly developed areas with most of the socio-economic infrastructure and activities located there. For most other islands the temperature increase will be fairly uniform. The implications of increase in daily temperatures are likely to be serious.

Daily Maximum Temperature Projected for The Bahamas in 2050

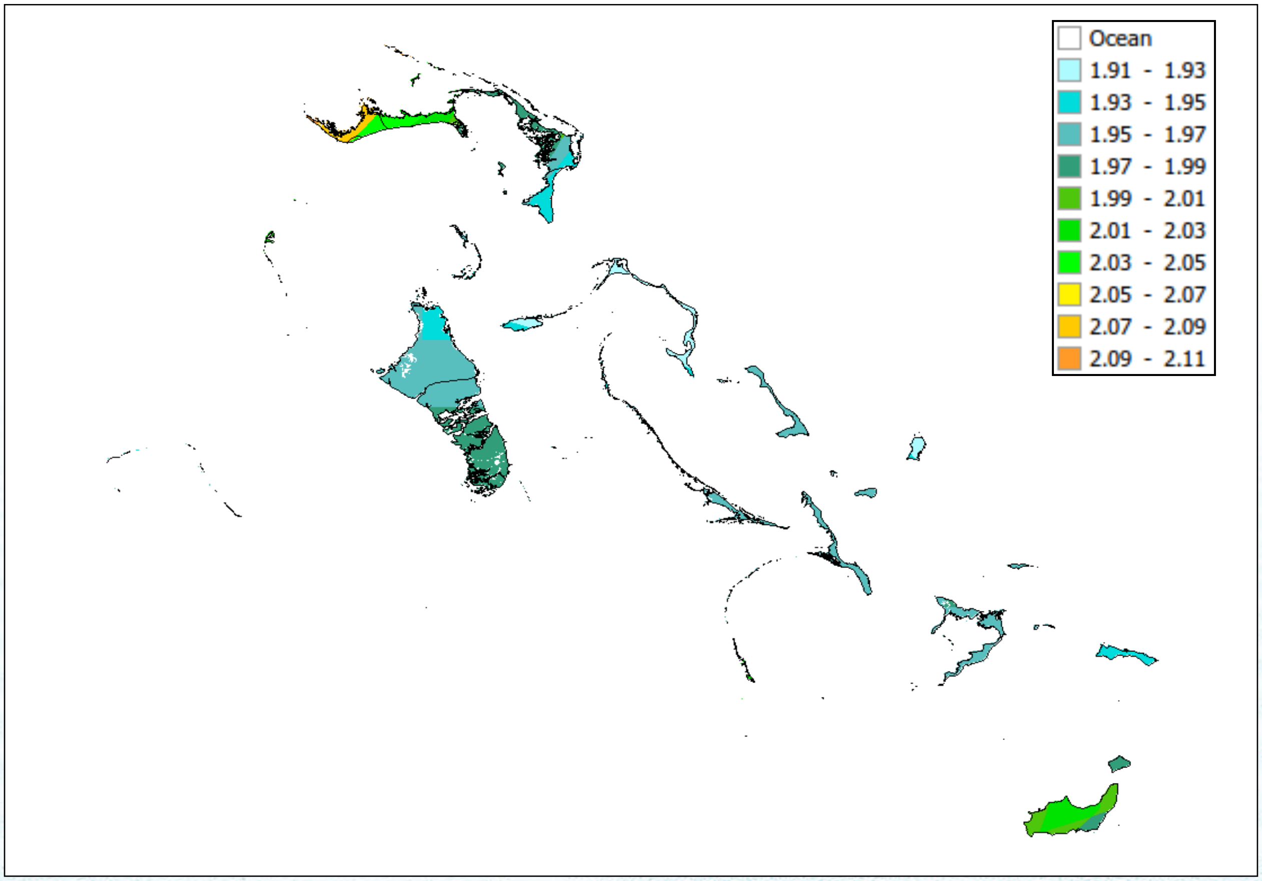


Figure 29: Average Daily Maximum Temperature for The Bahamas under A1FI for 2050

Observational records at Nassau Airport show a steady increase in average daily maximum temperature between 1974 and 2008 (34 years) (Figure 30).

Daily Maximum Temperature at Nassau International Airport, New Providence 1974-2008

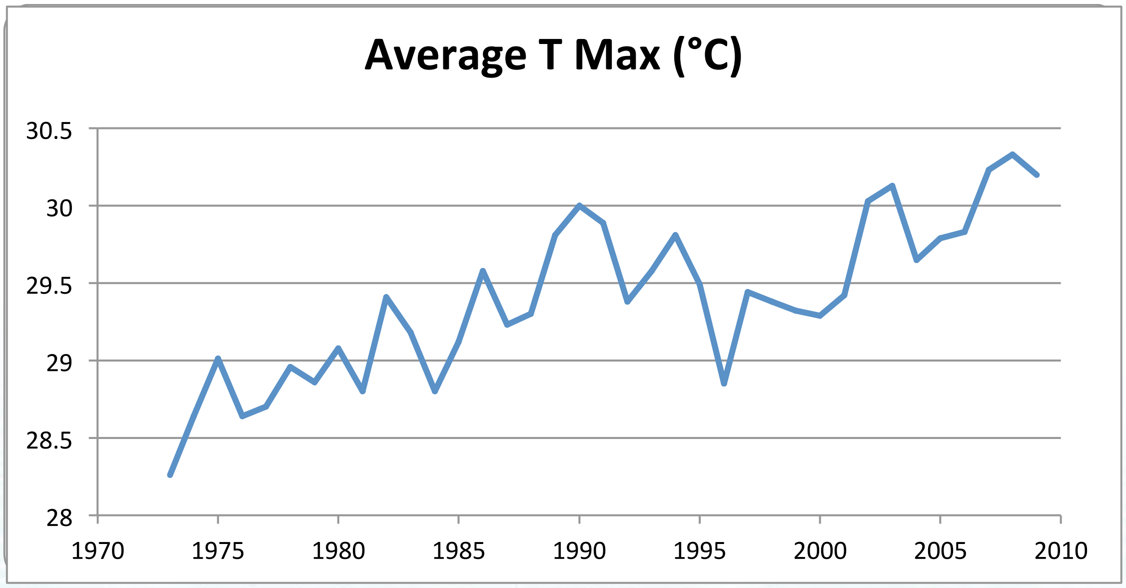


Figure 30: Average daily maximum temperature at Nassau Airport, New Providence 1974-2008

The use of extreme value analysis shows that the highest temperature extreme of 39.22°C has a return period of 74.31 years. Under the A1FI-high scenario, using a 21-GCM ensemble for 2050, the frequency will increase to 9.92 years. Thus, extreme temperatures are likely to occur more frequently by 2050 (Figure 31).

Extreme Value Analysis of Average Daily Temperature for Nassau International Airport

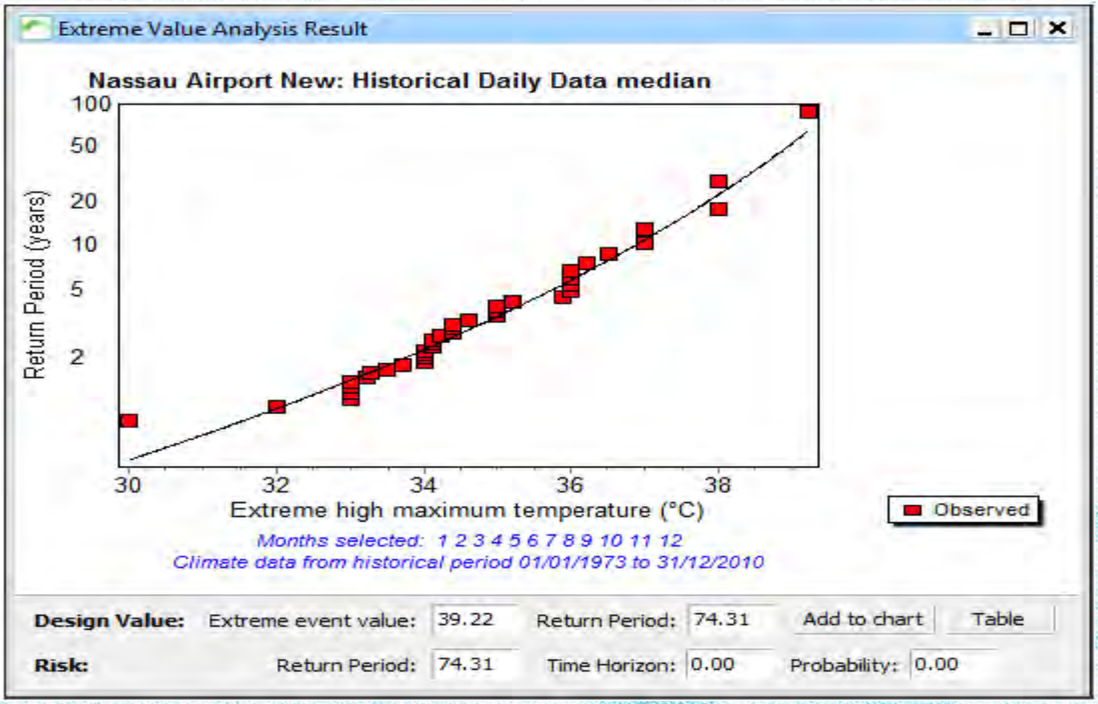


Figure 31: Results of extreme value analysis of average daily temperature for Nassau International Airport

As with extreme value analysis, the trends for maximum and minimum temperatures can be analysed.

Trends for Maximum and Minimum Temperatures at Nassau International Airport Between 1973-2010

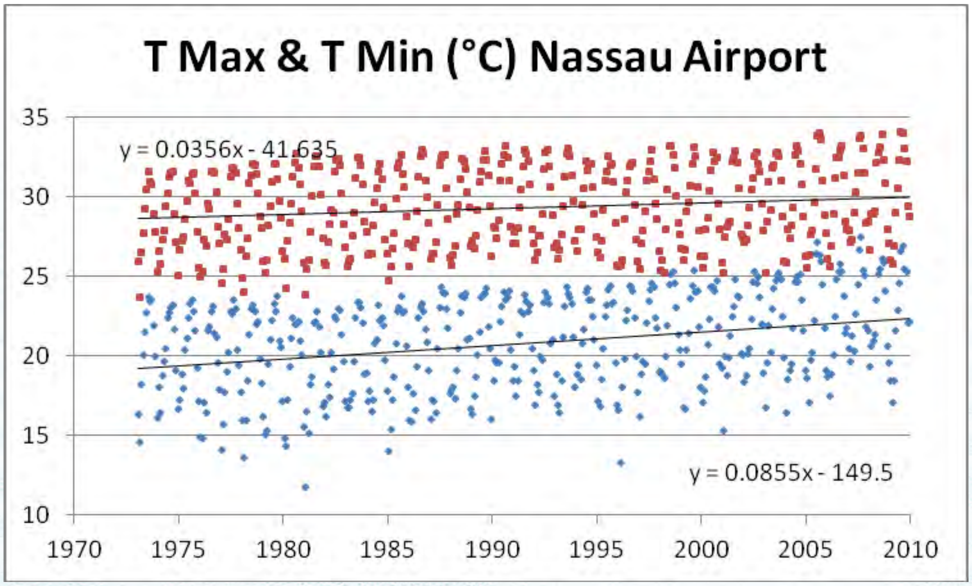


Figure 32: Trends for maximum (red) and minimum (blue) temperatures.

Figure 32 shows that minimum temperature (TMin) has risen at a rate of 0.05°C/yr faster than maximum temperature (TMax). The total increase for TMin was 3.24°C while the total for TMax was 1.35°C over almost 38 years. The increase in TMin is consistent with a faster rate of increase in night time temperatures than day-time temperatures globally (Meehl, et al. 2009).

4.4.4 Sea Level Rise

With respect to sea level rise, the analysis here uses historical hourly data from Settlement Point, Grand Bahama to uncover a trend. Although there are four tide gauge measurements available in The Bahamas, only Settlement Point has a good data set. By recursively fitting the data-points to a trend line assesses the rate of sea level rise in order to determine if the estimate converges. This analysis shows that relative (compared to a baseline that is exposed to vertical land movement) sea level rise at Settlement Point, Grand Bahama is between 0 and 0.5 mm/yr. Additionally, from the SONEL database (Santamaria-Gomez and Bouin, 2009) with vertical land movement data, the value of -0.7 mm/yr (land sinking) is estimated. Thus, sea-level rise is slower than the vertical land movement (i.e. sinking/subsidence) indicating that the impact of thermal expansion causing sea-level rise is minimal for Grand Bahama.

Sea Level Rise Recursive Estimate at Settlement Point, Grand Bahama

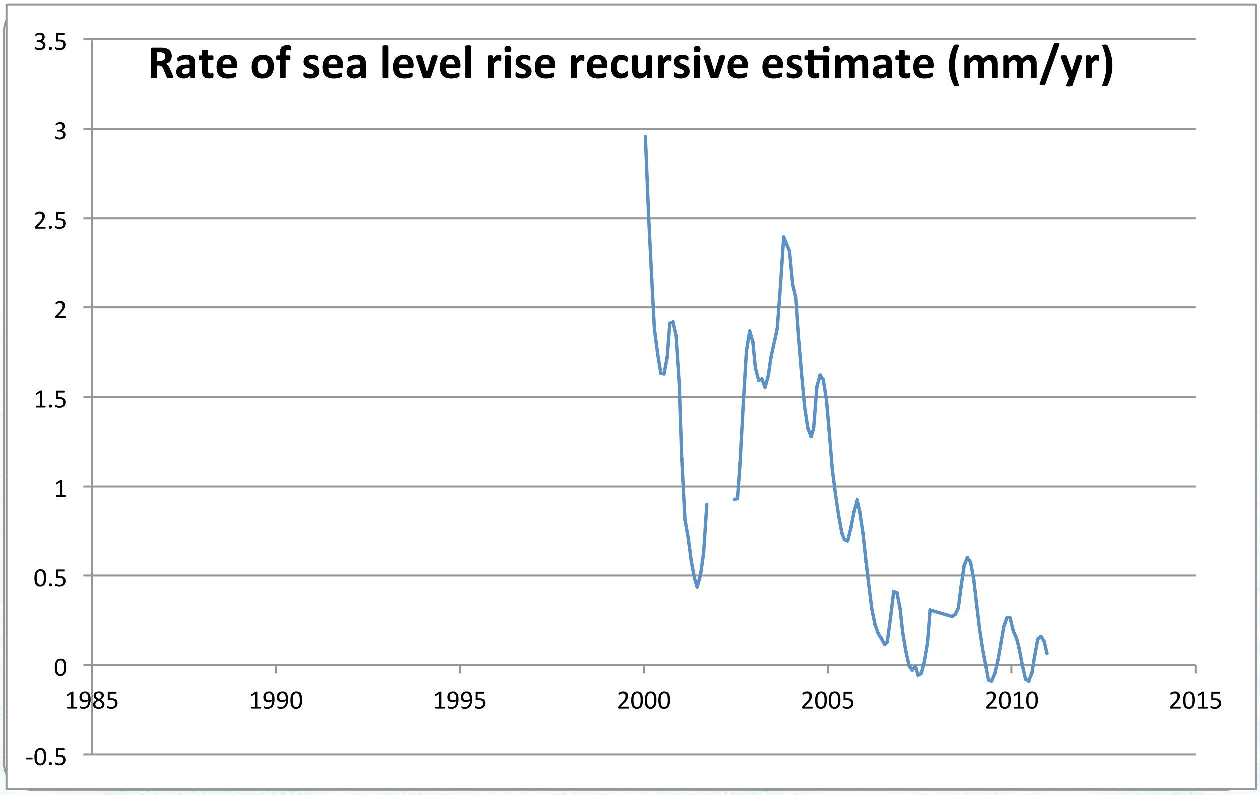


Figure 33: Sea level rise recursive estimate at Settlement Point, Grand Bahama (mm/yr).

While the historical evidence as presented above shows that sea-level rise is occurring at a slower rate than vertical land movement, it still indicates that sea level is rising at a rate of 0.2 mm/yr (the difference between vertical land movement and thermal expansion). Based on the 13-GCM Ensemble using the A1FI scenario, the sea-level is projected to rise by 2100 in The Bahamas (Figure 34).

Sea Level Rise Projections (AIFI), 2100 (local, 13 GCMs)

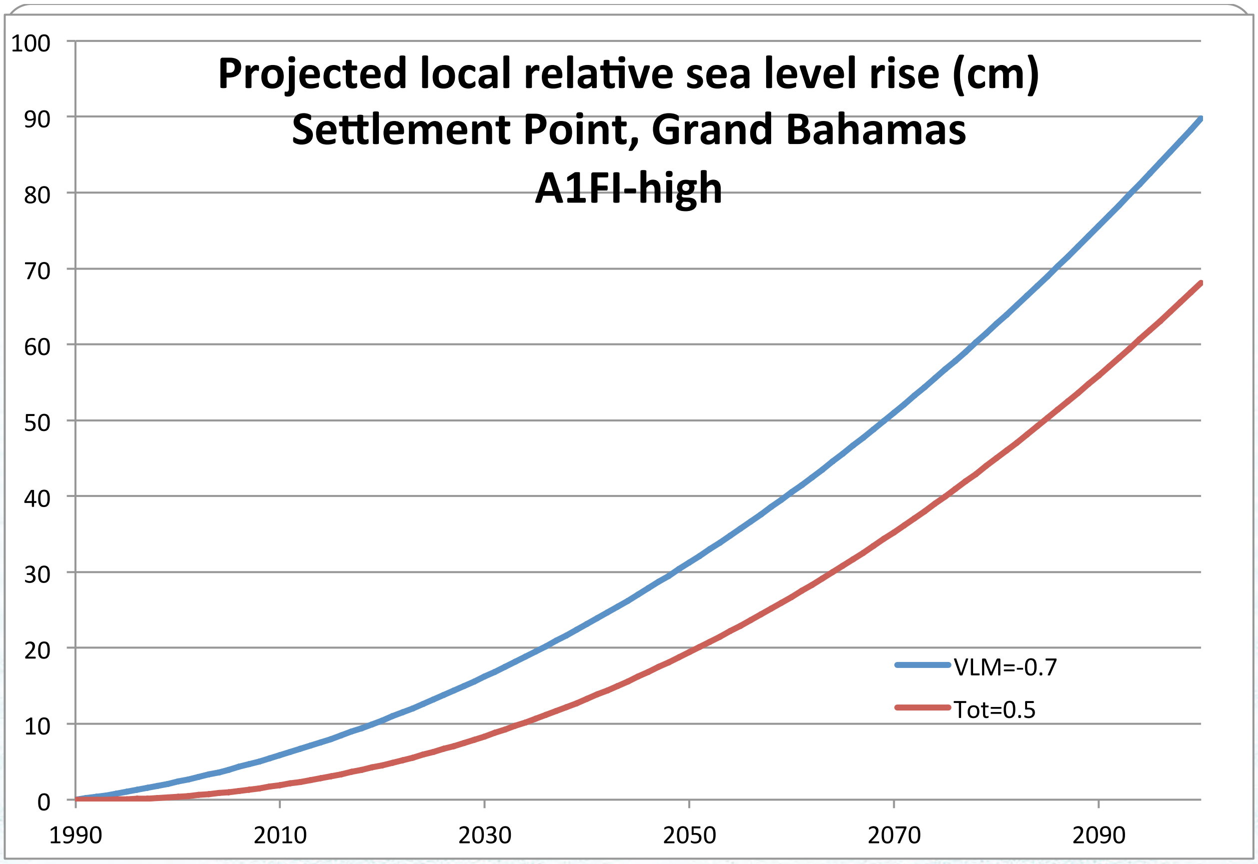


Figure 34: Sea-level rise projections (AIFI), 2100 (local, 13 GCMs). The blue line shows vertical land movement (VLM) and the red line shows total sea-level rise (Tot). The y-axis is in millimetres.

The graph above shows that by 2030 the sea level will have rise by 9.0mm, 20mm by 2050, and near 70mm by 2100. The increasing rate of sea-level rise in Grand Bahama is consistent with the global sea-level trend. However, the projection does not show the effects of local variations, and the impacts of climate-related extreme events which are likely to exacerbate the negative impacts of sea-level rise.

4.4.5 Impacts of Climate Change

The foregoing analysis of climate change in The Bahamas provides a basis for taking action as early and urgently as possible to either cope with and/or adapt to imminent changes that are likely to be expected over the coming decades. The historical analysis of rainfall and temperature strongly indicate that the average annual temperatures have increased over the last 30 years (1971-2000), and this trend is likely to continue in the near future. The mean annual temperature has increased by about 0.5^{o}C since 1960, at an average of 0.11^{o}C per decade, with the rate of increase most rapid in the warmest seasons. As for rainfall, observational record shows that the mean rainfall over The Bahamas has not changed significantly since 1960. However, since 1974 Grand Bahama has been experiencing twice the amount of rain as the island of Inagua. Spatially, more rain falls in the northwest (Grand Bahama, Eleuthera, and Abaco), Central (Andros, New Providence) and less in the southeast (Exuma, Inagua).

Projections of future climate change show that the average daily maximum temperature is likely to increase by $2.0^{o}C$ in The Bahamas by 2050. The highest increase is projected in the northernmost island of Grand Bahama and in the southernmost island of Inagua (average over $2.0^{o}C$). However, an increase of $1.93^{o}C$ to $1.97^{o}C$ is expected in the central part of The Bahamas.

The annual rainfall is likely to decrease by as much as 10% while for some seasons a 20% reduction is expected in most islands. Winter will be drier in Inagua while all islands to the northwest will have a slight increase in rainfall.

4.5 IMPACT ASSESSMENT AND KEY VULNERABILITIES

The impact and vulnerability assessment involved both top-down and bottom-up approaches. The top-down approach involved the use of information generated by the GCM-based climate change and sea-level rise scenarios, while the bottom-up approach involved consultations with relevant stakeholders and literature survey on the impacts of climate change in The Bahamas.

4.5.1 Vulnerability Analysis Key Vulnerabilities

The key vulnerabilities in The Bahamas are water resources, forests, human health, agriculture, human settlement, disaster management, energy, tourism and coastal zones. The key vulnerabilities were identified through consultative processes via expert workshops and synthesis reports[35] prepared by relevant experts. A synthesis report for each sector outlined the following: (i) the key characteristics/activities that may have direct or indirect influence on how climate change and sea-level rise have affected the sector; and (ii) how it is being dealt with or addressed in the future.

4.5.2 Storm Surge

Sea Lake and Overland Surges from Hurricanes (SLOSH) modeling as outlined below, provides the extent of vulnerability of The Bahamas to storm surge. Under the worst case climate change scenarios, and with variable intensity of hurricanes, the surge height overland in many of the islands will be up to 26ft (7m) which would render most parts of the island under water.

[35] Synthesis reports were prepared for water resources, energy, forests, human settlements and infrastructure, agriculture and tourism.

SLOSH Modeling in The Bahamas (text provided by Russell 2010). SLOSH: Sea Lake and Overland Surges from Hurricanes is a computerized model developed by Jelesnianski and Taylor (year). Rolle et al completed an atlas for the Northern and Central Bahamas including New Providence and its vicinity. The model was used with GIS information to assess vulnerable areas of The Bahamas. SLOSH is best for defining the maximum potential surge for a location. It should be used as a tool of possibility and not absolute prediction. No computer model is perfectly accurate, so there is some room of uncertainty.

SLOSH was used to run hurricane scenarios for category 1 through to 5 using the MOM functions. More specifically, scenarios were run for every island in the SLOSH grid to show what the growing intensity would be from a category 1 to 5 hurricanes. Outputs from SLOSH show that coastal areas would be heavily impacted by storm surge. Specifically, the southern coastal area of New Providence would experience severe flooding by a category 5 hurricane, and could receive a maximum of 18ft of storm surge - Eleuthera 24 ft and Exuma 26ft. Each grid cell has an accuracy of ± 20% based on the high water mark (HWM). For example, if one grid cell has a surge of 10 feet, it is accurate between 8ft and 12ft. These results show catastrophic impacts that can cause loss of life, property and a shift in local topography. Therefore, it is imperative that new measures of mitigation and adaptation be put in place to protect and prevent the coastal communities and their environments.

The scenarios have proven that adaptation needs to be implemented to protect against hurricane surges. All of the islands of The Bahamas are at risk of being severely impacted by surges from hurricanes along the coast. Therefore, more adaptation should be put in place in these areas. Some adaptive measures that can be used are as follows: rebuild natural buffer zones along the coast i.e. sand dunes and mangroves; restore the natural environment along the coast; manage coral reefs including the creation of artificial reefs that break incoming surge; restrict development along the coast; improve the building codes with construction of silted houses or retrofitted older buildings in coastal areas; and recap early warning systems (MET-office capability).

Vulnerability SLOSH mapping has been completed for the islands of New Providence, Eleuthera, South Berry Islands, The Exumas, Long Island, Cat Island, Rum Cay and San Salvador. SLOSH output shows that areas along the coast will be exposed to extreme surge from hurricanes. However, the extremity of coastal surge depends significantly on the topography of each island. Flatter narrower islands (e.g. South Berry Islands, New Providence, Eleuthera) show surge values anywhere from 16 to 23 ft ± 5%, whereas islands with higher elevation (e.g. Cat Island, Rum Cay, San Salvador, Long Island) show surge values from 2.5 to 17 ft ± 5%. Climate Change increments demonstrate high extreme values of 16.6 – 23.6 ft ± 5% and low extreme values from 3.1 – 17.6 ± %.

The storm surge values are expected to increase based on the IPCC Fourth Assessment Report (2007), which crystallizes that in the future hurricanes are expected to increase in intensity.

An assessment of all available literature was conducted to examine the adverse impacts of climate change. Stakeholder consultations through focus group meetings and workshops were also held with national experts from the government, non-government, academic and educational organisations to conduct vulnerability analysis. A number of key questions[36] were used to guide the analysis of climate change impacts and vulnerability in The Bahamas.

The Bahamas is highly vulnerable to climate change and sea-level rise due to its physical geographical characteristics. It is a low-lying archipelagic island country with 98% of its population living at or within 10ft (3m) of mean sea level. Most socio-economic activities and infrastructure development is located on the coast. Vulnerability is exacerbated by its geographic spread spanning 800mi (1,300 kilometers) in a northwesterly to southeasterly direction.

The vulnerability of The Bahamas is reinforced by a recent study of a comparative analysis of the impacts of sea-level rise and storm surges in developing countries (Dasgupta, et al. 2009). The analysis reveals that relative exposure of coastal populations will be high for The Bahamas (73.02%), with coastal GDP loss most severe (65.7%). Thus, the urban extant along the coast will be highly vulnerable to inundation from storm surges in The Bahamas (94.12%) while its coastal wetlands will be subject to 71.4% inundation risk from storm surges. This makes The Bahamas highly vulnerable to impacts of climate change and sea-level rise. Of the top ten countries most at risk to storm surges, The Bahamas is ranked first (highly vulnerable) with respect to its coastal population, loss of GDP and coastal urban areas.

4.5.3 Water Resources

The Bahamas depends almost entirely on groundwater resources, which are extremely vulnerable in the low-lying limestone islands. This vulnerability is caused by several factors:

a) Overexploitation of the water lens. This activity causes freshwater to be replaced by seawater. Salt water upcones beneath an overpumped well making it unfit for potable use. Nearly all small islands provide evidence of this in the form of abandoned or saline well fields.
b) Development of canals and waterways for boat access and the increased value of lots. Cutting canals facilitate fresh and saline water mixing, and can cause the total loss of a valuable resource. In Grand Bahama, for example, one canal system was cut right across the centre of the island where there was once a 40 ft. thick freshwater lens resulting in the direct loss of 7.5 billion gallons of freshwater held in storage and the enforced abandonment of an important wellfield (Cant et al. 1990).

[36] The questions are: (i) how would you describe The Bahamas in terms of its vulnerability to climate change? (ii) what are the key vulnerabilities?; (iii) what actions, existing or planned are being taken to address/manage key vulnerabilities?; and (iv) what are the needs and priorities for climate change adaptation?

c) Seawater inundation in low-lying limestone islands. This disturbance is caused by storm surges, or rising sea levels. Any form of saline inundation will damage a groundwater resource. When the water table continues to rise, close to or above the land surface, it results in complete evapotranspiration that will, in due course, destroy the resource. Storm surges from Hurricanes Frances and Jeanne in 2004 had major effects on the water resources of Grand Bahama. Hurricane Frances also impacted the water resources on the island of Andros. In effect, the country's two major well fields located in the centre of two of the largest Bahamian islands (W6 in Grand Bahama and the Barging Wellfield in North Andros), were inundated by several feet of seawater which caused the freshwater supplies to become brackish. Parts of the Andros wellfield still have high salinities t because saline intrusion was facilitated by the design of the conduit system used for water abstraction. Further there is abundant evidence in Grand Bahama and Andros of previous events that caused saltwater damage to the environment, but few of these, if any, are recorded anywhere.

d) Pollution threatens the water resources in The Bahamas. The islands are made up of limestone, and suitable disposal sites are scarce. Sink holes, swamps, and marshes are often used as dump sites, but these are probably the worst of all possible options. Islands of this type, have widely scattered, undeveloped communities that do not have mains sewerage. The use of septic tanks, and similar means of disposal results in widespread problems. Domestic wastes and effluents are discharged directly to the water table. Seasonal flooding is a frequent problem in low-lying islands, which affect areas with septic tanks. Other accumulations of waste affect the local water resources.

Of all the threats to water resources identified and outlined above, the most significant of all is that of the rising water table. The centre of New Providence is the lowest area (Lake Killarney and environs) on the island. So as this area becomes wetter the main freshwater lenses on the island are impacted, and important facilities such as the Lynden Pindling International Airport will be affected.

Since all the major freshwater lenses in The Bahamas are generally in the flatter low-lying areas, they are all threatened by rising water tables. For example, Cat Island has good groundwater resource areas that are not being considered appropriate as water supply sources because of flooding problems. This will apply to more and more areas in the future.

Whatever changes there may be in future rainfall patterns, they will have significant impacts on the groundwater resources of The Bahamas. For example, The Bahamas faces a future of 10-20% less rainfall by 2050. This will cause serious shortages in water supply on most low-lying islands. Unless changes are made to conserve and enhance efficiency in water resource management, water shortages will have dire economic (higher tariffs) and social (compromised livelihoods) consequences for the populations of low-lying limestone islands. Additionally, a Category 5 hurricane is likely to generate surges up to 20ft above sea level which would have a devastating effect on any island in The Bahamas.

The water resources are also going to be affected by the sea-level rise in the future. The sea-level rise projection using A1B scenario with A1FI high sensitivity indicates a 20cm rise by 2050.

This outcome will affect groundwater resources either through seawater intrusions into the freshwater lens or by up-coming due to overexploitation and seawater inundation.

4.5.4 Human Health

With an increased temperature of 2°C by 2050 in The Bahamas, it is possible that the human health of the population will be compromised. A temperature increase of 1.5°C to 2.0°C is evident for all highly populated islands of The Bahamas, and would most likely contribute to increases in vector-borne (e.g. dengue and malaria), water-borne and communicable diseases. Costs associated with treating these diseases will also increase. Signs of vector-borne diseases such as dengue are already present in The Bahamas but little is known about its introduction. Increasing temperature with little rainfall could increase dengue incidences and place additional pressure on public health resources.

Increased temperatures would result in increased incidence of respiratory and cardiovascular problems that will affect the lifestyle of the aging Bahamian population. Other health-related issues include increased risk of heat stroke particularly for the field personnel; diarrheal diseases; rodent population; and mosquitoes, including the mosquito vector for dengue and malaria.

4.5.5 Human Settlement and Infrastructure

New Providence has always been the central point of The Bahamas due to its central location within the group of islands. Since The Bahamas is a tourism destination, it provides an aesthetic setting for hotel resorts. There are several types of landscapes. Some are the result of soil topography and climate, which forms a natural setting and others are artificially conditioned and altered from planning and management of resources.

The most prominent type of landscape is rock covered by a thin layer of soil, where forests, palmetto, coconut palm trees and shrub pine are grown. Parts of The Bahamas, particularly New Providence, show decades of human alteration. Road passageways have been cut through the hills where limestone rock is directly exposed to the weather.

The main challenge of human settlement and infrastructure development is the clearing of pine forests for the development of housing and agriculture. Clearance of pine forests will affect water sources and public services. For example, there is no freshwater flowing on the island of New Providence, so the capital city, Nassau relies heavily on reverse osmosis for its water supply. With increasing population, land and infrastructure development makes the preservation of the pine forests and well fields more difficult. As the population continues to increase, groundwater sources become developed with little prospects of increased volumes.

Climate change and sea level rise will have adverse consequences on the growth of cities in The Bahamas. Land development in New Providence is extensive and closely associated with the physiographic conditions. For example, the natural harbor along the northern waterfront consistently attracts developers to initiate major developments. Therefore, much of downtown Nassau has a wide range of predominantly commercial uses such as shops, banks, high scale hotels and residential buildings. These amenities are also extended along Cable Beach and as far as Lyford Cay, (which is only a few meters above sea level).)

4.5.6 Agriculture

Agricultural production in The Bahamas focuses on four main areas: crops, poultry, livestock, and dairy. Poultry, winter vegetables and citrus fruits are the mainstay of the agricultural sector, which is concentrated in The Abacos. Exports consist mainly of grapefruits, limes, okra, papaya, pineapples and avocado. Other food crops include bananas, oranges and mangoes.

An estimated 5,000 acres of agricultural land in The Bahamas is used for citrus production. In 1993, about 14 million pounds of poultry meat was produced and valued at $15.3 million. Production of 4.15 million dozen eggs was valued at $4.85 million, and agricultural exports were estimated at 18,794 tons. Agricultural exports included honeydew, citrus, cantaloupe, watermelon and squash. The Ministry of Agriculture (Incorporation) Act of 1993 allows the Minister to authorize a lease of land for periods up to two consecutive 21-year periods. Under this policy, the government has earmarked 36,148 acres of Crown Land for agricultural use: - 13,869 acres in Andros, 11,737 acres in The Abacos and 10,542 acres in Grand Bahama. The Department of Agriculture encourages farmers to expand sweet potatoes, bananas, onions, Irish potatoes and pigeon peas acreage. The Department uses the taxes collected by the Government to subsidize the work of the farmers. This relieves farmers from the cost of acquiring a loan with the bank. The Bahamas currently has a limited capacity to grow food. However, climate change will exacerbate the problems associated with food production. Climate-related extremes such as storm surge and sea level rise would result in the loss of arable land, which can limit the capacity to produce crops. The expected changes in mean annual temperature are unlikely to have a major impact on Bahamian agriculture until the latter part of the century. However, the warming projected coupled with the CO_2 fertilization effect may increase plant growth in the short term. Extreme high temperatures and an increase in global average temperature can damage food crops thus affecting food production and yield.

The other major impact of climate change on food production in The Bahamas is the occurrence and intensity of hurricanes. Hurricanes can cause significant damage to food crops either by inundation or by salt spray. Information on the adverse impacts of hurricanes on food crops and production is scanty in The Bahamas. Despite this drawback, the government is encouraging farmers in the The Abacos, Grand Bahama and northern Andros to market their own products. Farms in these areas now represent more than two-thirds of all produce sold. In the south, where there is less rainfall, low population, poorer soil and underdeveloped infrastructure, farmers benefit from more Government support. A Disease Insect Surveillance Unit monitors the importation of fruit and vegetables into The Bahamas, to reduce the risk of pests and diseases.

4.5.7 Coastal Zones

Much of the coastline of The Bahamas, particularly in the built-up areas, is protected by seawalls. However, such infrastructure and investment is under serious threat from climate change and sea level rise including extreme events such as storm surge associated with hurricanes. Construction of harbour facilities like that at Gunpoint, Ragged Island, is necessary for getting supplies quickly and safely to the island after hurricanes or other storm events.

Globally, sea level rise is a result of melting icecaps and glaciers, and thermal expansion. The Bahamas as The Bahamas is considered the most vulnerable country to sea level rise so sea level rise is a major concern. Some 80% of the landmass is within 5 ft (1.5m) of sea level (Draft National Environmental Policy for the Commonwealth of The Bahamas). Consequently, sea level rise will have a significant impact on most hotel accommodations, marinas and cruise ship ports located in coastal areas.

Sea level rise can also have an impact on the quantity and quality of our ground water resources due to saltwater intrusion. Perhaps the most significant impact on the coastline in The Bahamas is caused by hurricane or storm generated storm surge. With the intensification of storm surges in The Bahamas, the following areas are expected to be impacted: 94.1% of The Bahamas urban coastal areas; 73% of coastal population; 71% of coastal wetlands and 65.7% of coastal GDP (S. Dasgupta, et al. 2009). Storm surges are also responsible for coastal and beach erosion.

In 2005 Hurricane Wilma passed within 150 miles (240km) of Grand Bahama, but produced storm surges as high as 20ft (7m) resulting in $100M damage and loss.

4.5.8 Tourism

Coral bleaching would not only affect the fisheries sector, which represents 5% of GDP, but also the important dive market. The Bahamas is the third most popular destination for the 43 m US dive market, 30% share. The industry supports the jobs of approximately 900 divers, and contributes 49,000 room nights annually to the accommodation sector (Bahama Dive Association). Coral bleaching can reduce the reef's ability to act as a natural defense system against storm surge, exposing our beaches to erosion. It can also have a negative impact on tourism, which contributed $365m to the economy in one year.

Vector and water-borne diseases can have an adverse impact on the tourism sector, as experienced during the summer of 2006, when the island of Exuma reported an outbreak of malaria. This resulted in a travel warning by the Center for Disease Control. Dr. Baldwin Carey, Director of Public Health, suggested that the geography of the area made it especially easy for a large influx of illegal immigrants into The Bahamas, which also contributed to the outbreak of this disease. More than 25 hurricanes impacted the region between 1970 and 2000. While the period 1990 – 1999 seem to have been the most active with some 25 hurricanes impacting the region, years 2000-2006 registered more than five category five hurricanes. The Bahamas lost 10% of its GDP due to two hurricanes (Frances and Jeanne) and a cost of USD 551m. The total loss in actual infrastructure damage resulting from Hurricanes Frances, Jeanne and Ivan was an estimated $5b for the five countries. However not calculated in the numbers is the subsequent decline in business due to the disruption in tourism arrivals during the recovery and reconstruction period. Additionally, destinations that are frequently hit by hurricanes or severe weather events suffer from the perception in the market that they are unsafe.

4.5.9 Forests

Presently, there is no information available on the potential impacts of climate change on Bahamian forests. It had been documented in other countries that the climatic variables directly influence plants and trees as a result of the increasing concentration of CO in the atmosphere. Research will have to be conducted to determine the physiological effects, as well as, the correlation of forest health, fires, storm surges, hurricanes impacts, sea-level rise and soil salinisation levels.

With the expected increase in temperature coupled with the CO_2 fertilisation effect forest growth may increase. However, this is likely to be compromised by the effects of intense hurricanes, which usually destroy large tracts of forests in The Bahamas.

4.5.10 Biodiversity

Impacts of climate change on biodiversity include - sea level rise, saltwater intrusion, coastal erosion; ocean acidification, coral bleaching, droughts, floods, fires, storm surge, hurricanes, ENSO, vector and water-borne diseases and invasive species.

4.5.11 Energy

The Energy Sector is vulnerable to changes in climate, extreme weather events and sea level rise. There are direct and indirect effects of climate change on the energy sector for The Bahamas. Other impacts include those normally associated with climate change.

Direct impacts are those that affect processes related to energy production and power generation. This also includes transportation, energy resource availability (effects of weather on shipment of energy sources), electricity generation and transmission and distribution systems.

Indirect impacts are those whose effects on other sectors have consequential impacts on the energy sector, either through competition for resources, changes in power requirements, or increases in demand. Energy, a basic commodity, is used in the production of virtually all other economic goods and services. Changes in other sectors usually have consequential effects for energy.

The indirect impacts of climate change on energy, through its effects on the residential, commercial, and transportation sectors in The Bahamas, can exceed the direct effects. For this reason they cannot be ignored in any assessment of the impacts of climate.

Salt water intrusion causes increased corrosion of electrical generating and transmission assets. The Bahamas is essentially a coastal country and is highly susceptible to the effects of corrosion on metallic structures. Salt water intrusion also causes electrical shortage events on insulators which lead to outages and loss of revenue. Coastal erosion has great impact on the facilities of The Bahamas Electricity Corporation (BEC) as most of the power generating facility is located near coasts in order to facilitate the inter-island transport of fuel. Erosion of the coast impacts the maintenance and safe handling of fuel. Hurricanes, droughts, floods, fires and storm surge also pose a serious threat to infrastructure of the energy sector.

Elevated temperatures generally reduce cooling and generating efficiencies at thermal power plants. Conversely, higher technical losses could be experienced on the transmission and distribution systems. In addition to this, there is the potential for reducing the life spans of system components, should the thermal limits be exceeded. Increased ‘line losses’ from electrical transmission and distribution systems results from elevated average temperatures and increased occurrence of blackouts caused by line sagging during heat waves. This situation is exacerbated by the increased internal resistance heating attributable to increased power flow to meet higher electricity demand for space cooling and refrigeration.

Sea level changes are a particular concern as assets of the Energy sector are typically located near the coast to facilitate shipping. Sea level rise also threatens siting options for the sector. Such impact is experienced by low-lying land during extreme weather events. The land area of The Bahamas is essentially coastal and extremely vulnerable. Any change in the frequency and intensity that make these events more prolific or more intense, will negatively impact the energy sector. Power lines, fuel pipelines, fuel stock, shipping routes and generation equipment are all vulnerable, exposed and severely affected.

4.6 ADAPTATION MEASURES, STRATEGIES AND OPTIONS

The vulnerability analysis thus far suggests that many of the issues, constraints, gaps and difficulties relating to climate change are not necessarily new. However, they will become worse if no actions are taken to address them. From the foregoing evidence of climate change, it is more than likely that temperature will increase by at least 2^{o}C in the coming decades (by 2050) in The Bahamas. This will place additional pressure on the population, human systems and natural ecosystems that provide goods and services to sustain livelihoods. Some islands will become wetter and others will become drier with more frequent extreme events in The Bahamas.

In recognition of the ongoing problems associated with sustainable development, and the greater potential for worst problems under climate change, the Government of The Bahamas developed a National Policy for the Adaptation to Climate Change (NPACC) in 2005. The NPACC sets out the goals and objectives, principles and directives for adaptation planning and action in The Bahamas. The NPACC also identifies the key vulnerable sectors to which resources would be directed to address climate change issues and concerns. The vulnerable sectors include: agriculture; coastal and marine resources; energy; the financial and insurance sector; forestry; human health; terrestrial biodiversity; tourism; transportation; and water resources. For each of these sectors, key issues relating to climate change adaptation and key actions to address each adaptation action were identified. The analysis of available information on each of the key vulnerable sectors identified indicates that only a handful of actions have been implemented including the development of policy actions for energy and forestry.

A number of factors characterize The Bahamas, which should be taken into account for the planning, development and implementation of climate change adaptation:

- The Commonwealth of The Bahamas stretches over 1,400km of ocean.
- Replication of adaptation on every inhabited island of The Bahamas would be highly resource intensive and in many cases, the cost would be prohibitive;
- From a disaster perspective, a small population can be isolated very quickly, and it is very expensive to reach them send assistance; and
- In terms of biodiversity, some islands have unique or endemic species that could be wiped out quickly by sea level rise or changes in climate.

Additionally, a number of key issues have been identified which are critical for managing climate change risks and climate change adaptation: (i) information and awareness; (ii) education and training; (iii) integration of climate change adaptation into management, planning and budgetary processes; and (iv) cooperation and collaboration.

The adaptation measures, strategies and options identified were aided and informed by the data generated through (i) vulnerability assessment; (ii) sectoral reports produced by national experts; and (iii) several expert and training workshops conducted over the course of the V&A assessment process.

The measures, strategies and options focused on the question of how to address the issues and concerns relating to the impacts of climate change and sea-level rise. In the first discussion a list of potential impacts was created, that takes into account impacts per one of eight sectors for each of the four climate change effects. In the second discussion, this list was completed with suggested adaptation options. The resulting impacts and adaptation matrices (showing potential relevant impacts and adaptations per sector) for the four major climate change effects follow below.

4.6.1 Water Resources

The reality is that there is nothing that can be done in The Bahamas to stop –(i) rising sea levels (ii) associated threat of higher water tables; or (iii) the possible increasing severity of storms that might impact the area. These are global issues that have to be addressed. Adapting to the threats and taking measures to mitigate these threats is something that can be done locally. From a Bahamian perspective, policies and measures need to be adopted or taken that will help to protect the nation's freshwater resources and related environmental concerns:

a) Enactment of laws and regulations where needed. Water Management Consultants 2003 report outlines these needs in detail;
b) Prevention of further development in low-lying areas that will be prone to flooding, now, or in the future;
c) Discouragement of the excavation of canals and waterways and any excavations below the water table where these are unnecessary;
d) Control rock and sand mining activities so that they are restricted to approved locations only;
e) Protection of beach ridge, coastal dune formations, mangroves and similar coastal features;
f) Adopting appropriate physical planning policies that will protect infrastructure from storm surges and rising water tables; and
g) Encouraging young Bahamians to seek careers in fields like Environmental Engineering, and Hydrology, and providing the necessary courses and training programs locally.

Clearly, it would very beneficial to future planning if there were accurate projections for sea level rise over the next one hundred years or so. All international efforts to improve such projections have to be supported by The Bahamas. This must include any such research that can be done in The Bahamas where the impacts of subtle changes in the environment are quickly reflected. One such project, now in the early implementation stage, is the Groundwater Resources Assessment under the Pressures of Humanity and Climate Change (GRAPHIC) initiative structured under the UNESCO-IHP program. A case study for this program is approved for the North Andros area. It includes the Barging Scheme Wellfield that has been impacted by a storm surge, and provides an ideal site for modeling environmental changes that might occur as sea level rises and climatic conditions change. The US Army Corps of Engineers have shown interest in being involved in this project, and appear willing to make significant investments in it. If it proceeds as planned, there will be scope for future expansion to map out all the water resource environments in Andros, including the inaccessible western areas, using newly developed aerial methods. Seeing exactly what changes take place over time will provide knowledge that can be applied elsewhere in The Bahamas, and in similar island environments in the world. This will aid appropriate long term planning.

With accurate sea level projections and more knowledge of future changes in climate, it is anticipated that there will be a better understanding of how groundwater conditions will change. It should become feasible to plan how long a specific water resource area can be used to provide a supply, plan for its use and final abandonment, and plan to develop alternate supply options for the future. It may be possible to protect a specific facility by elevating foundations, but this is not practicable for Bahamian groundwater resources.

If it is accepted that the sea level will continue to rise, then it must be assumed that the water supply capabilities of Bahamian natural resources will diminish. Alternative sources must be considered and the most obvious of these must be desalination. This is already accepted technology, but involves high energy usage and is costly. Alternate energy options have to be given more attention in finding ways to provide potable water at acceptable prices. Wind and solar power have been applied in the past, but more studies need to be done to see what they can offer for the future. Two other research areas of particular relevance to The Bahamas would be that of Ocean Thermal Energy Conversion (OTEC) and current power. The Bahamas has a reverse geothermal energy profile, and it may be possible to obtain the necessary cold water for OTEC use directly from deep wells. This would be a lot cheaper than obtaining cold sea water from long distance pipelines into the sea. Tidal movements across the banks create very strong reliable currents in many areas. These have flow rates that can produce enough energy to operate small reverse osmosis plants. Research needs to be carried out to see how both of these untested technologies might be used to provide the freshwater that The Bahamas will need in the future.

4.6.2 Forests

Presently, there is no information available on the potential impacts of climate change on Bahamian forests. However, it had been documented in other countries that climatic variables directly influence plants and trees as a result of the increasing concentration of carbon dioxide (CO_2) in the atmosphere. Research will have to be conducted to determine the physiological effects and the correlation of forest health to fires, storm surges, hurricanes impacts, sea-level rise and soil salinisation levels.

In order to meaningfully address the present state of affairs in the public forestry sector, the following realistic and fundamental actions are prescribed for adoption; by the Forestry Office:

i) Enact comprehensive forestry legislation, ensuring congruency with international standards and protocols;
j) Establish institutional arrangements for forestry (Forestry Unit) to effectively and efficiently undertake the mandate for sustainable forest resource management. This institution should be adequately resourced with a complement of qualified staff and a sustained budget. It should be guided by the provisions of the National Forest Policy, Forestry Law and Regulations;
k) Review and evaluate the existing forest management plans for the sustainable management of all types of forests, on Crown Lands;
l) Plan and implement a comprehensive public education and awareness program on all aspects of forestry development and conservation in partnership and concert with relevant stakeholder agencies in The Bahamas (e.g. The Bahamas National Trust, The Nature Conservancy, BEST Commission, The Ministry of Agriculture and Marine Resources, etc). The primary objective should be to sensitize the general populace on the goals and objectives of the newly constituted forestry institution, as mandated by policy and legislation;
m) Institute a program to allow for the sustainable utilization of the natural pine forest resources;
n) Actively participate on the Committee on Forestry (COFO) of the FAO, the Latin American and Caribbean Forestry Committee (LACFC) of the FAO, the Standing Committee on Commonwealth Forestry based in the United Kingdom, the Commonwealth Forestry Association and the Caribbean Foresters Association. This is

essential in seeking partnerships, co-operation and collaboration on matters pertaining to global forestry initiatives that impact The Bahamas.

o) Develop a program to recruit and train Bahamian students from high schools, who show a keen interest in forestry and conservation.

p) Provide In–Service Training Awards or Scholarships to deserving candidates for training in forestry sciences & conservation. This is paramount to allow for succession planning in the profession. Further, Forestry Resources Management and Conservation should be included on the list of areas subject to full scholarship through the Ministry of Education's Scholarship/Loan program.

4.6.3 Tourism

In response to the impact of climate change, variability and extreme events on the tourism sector the Ministry of Tourism will continue to engage in the following activities:

h) Raise the awareness of Awareness-raising of policy makers and other relevant stakeholders through workshops and symposiums to increase awareness and an appreciation of the impact of climate change on tourism and related sectors;

i) Pursue vulnerability assessments in collaboration with the Caribbean Community Center for Climate Change, Oxford University Center for the Environment and the Department of Meteorology. So far, the island of Eleuthera was surveyed to determine the vulnerability of the island and its residents to sea level rise.

j) Introduce the Foundation for Environmental Education Blue Flag certification program to marinas to assist them in developing programs that will protect the marine ecosystem;

k) Develop a hurricane preparedness and evacuation plan to assist the tourism sector to respond to and recover from any hurricane or extreme weather events in cooperation and collaboration with its partners in the public and private sectors; and

l) Assist communities through the Coastal Awareness Committee in protecting their beaches and shoreline by restoring dunes with planting sea oats, sea grapes and other native flora.

The high level of vulnerability to climate change, sea-level rise and storm surge which is exacerbated by coastal erosion and saltwater intrusion in the ground water resources, has created an urgent need to protect the vital resources on which that the tourism industry depends. Protection can be achieved with the implementation of the following steps:

a) Develop funding mechanisms and technical know-how for communities to build and re-vegetate sand dunes that will protect vulnerable areas against storm surges;

b) Educate the general public concerning the role wetlands play in the protection of our coast from storm surges and as an important habitat for fisheries and wildlife;

c) Solicit the support and buy-in from local stakeholders and the travel public that there is a need to educate persons on climate change and its impact; and

d) Establish an ICZM Unit to manage our coastal assets

4.6.4 Financial, technical and human resources

The financial, technical and human resources required are as follows:

a) the development of a national tourism plan that would include and address the issue of climate change and adaptation strategy;
b) trained personnel to monitor climate change impacts on coastal resources;
c) training of additional Department of Meteorology personnel and procurement of equipment to assist in mapping coastal areas throughout The Bahamas vulnerable to sea level rise;
d) training of additional technicians in the use of the SLOSH model to be able to assist in the forecast of hurricane landfall. This is important in helping tourism to safely evacuate guests off the island;
e) the Establishment of an integrated coastal zone management unit to effectively manage our coastal resources;
f) Workshops to bring awareness of climate change and its impacts to a broader number of stakeholders in the tourism industry; and
g) Assist communities to build and re-vegetate sand dunes to protect against sea level rise.

The table below (Table 22) provides a list of key impacts of climate change and possible adaptation measures. This was developed at a national workshop in May 2010, where representatives from government departments and civil society were in attendance.

Adverse Impacts and Adaptation Matrix

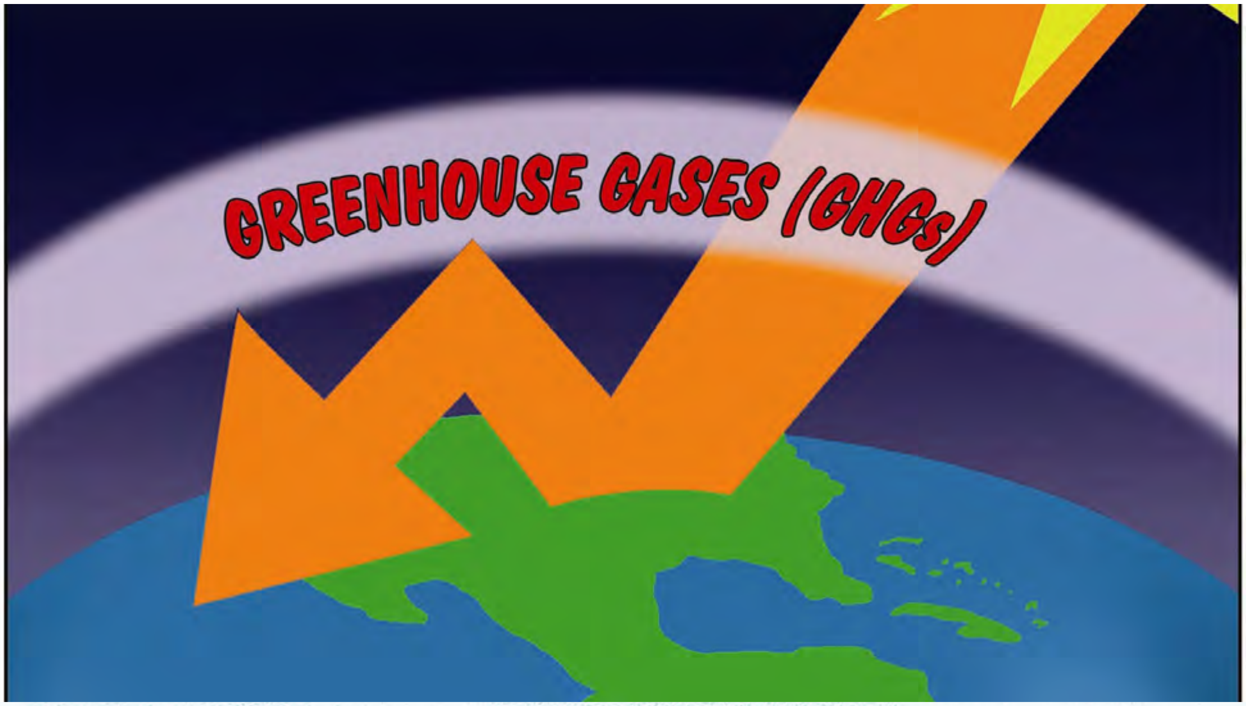
Increasing temperature	Adverse Impacts	Possible Adaptation Measures
Water Resources	Increase in evapotranspiration Fresh water lens drops/shrinkage Private wells affected Increased demand for water	Regulate use of water Education and awareness on conservation measures (government funded programs) Water catchment systems (i.e. Tanks) Maximize hotel-contribution (i.e. Supply, recycling) "green" incentives
Coastal Zones	Increase in sea surface temperature affects marine resources (e.g. sensitive to coral species leading to bleaching) Sea surface temperature increase intensity of tropical cyclone activity	Better building codes; retrofitting older building; early warning systems (MET-office capability) Protect (natural) buffer zones along the coast (i.e. sand dunes) Restricting development along the coast (zoning) Restore natural environment Coral reef management
Agriculture	Potential for increased incidence of pests Plants/crops sensitive to increasing temperature SST affecting fish species distribution	Crop rotation/seasonal crops; new ("climate") crops; reduce existing slash & burn practices; Native plants (multi-purpose: less water demanding; protection; so not only for agriculture) Natural remedies against pest
Forest	High evapotranspiration Potential high risk of forest fires Loss of native animal and plant species.	Forest legislation and enforcement; restrict burning; protect areas (20% land promise'); control "other threats" (i.e. development)
Tourism	SST increase =>fish distribution (migration) Loss of marine diversity Loss of attractiveness ("green") =>decrease in tourist arrivals (because of loss of attractiveness)	Other adaptation options will maintain/improve attractiveness Protect: marine reserves Tourist education (i.e. behaviour, type of sun-block (water-soluble), anchors); Change "tourist promotion strategy" (sun-sand-see => …)
Human Health	Respiratory/ Heart Heat stroke Vector borne diseases e.g. dengue, malaria, Food borne illness (food-poisoning)	Education; Integrated approach to vector-borne diseases (ie. stop breeding opportunities); Preventable diseases Act also dietary shifts
Settlements / Infrastructure	Road improvement needed to counter temp. increase ("road melt") Impact: uncomfortable homes Adaptation: House construction design ("Home Insulation")	Road improvements Setbacks 'Climate proofing' infrastructure Integrating alternative energy technologies in buildings Adapted house designs

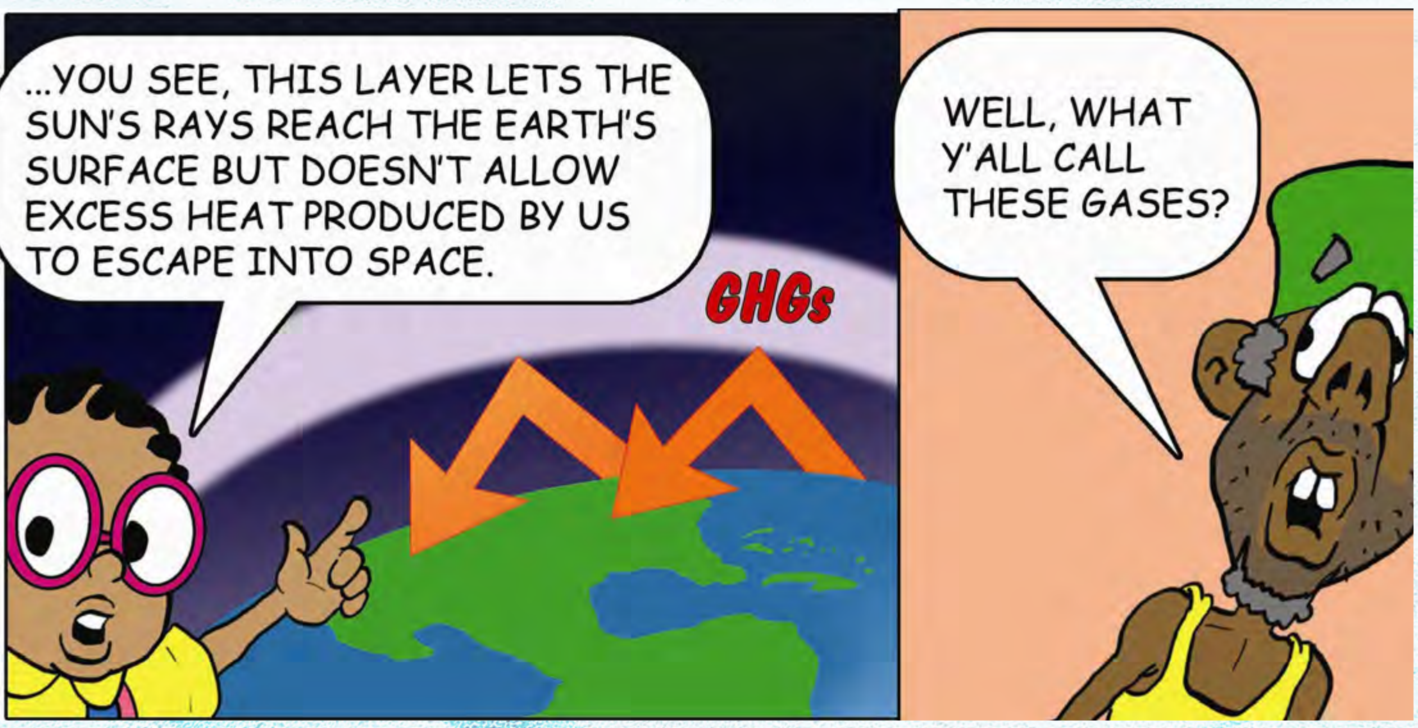
Energy	More demand for energy (e.g. air-conditioning) Increased fuel cost Decreases ability to generate energy (because of temp. constraints)	More use of renewable energy sources Alternative technologies Emission regulations/enforcement (e.g. Cars) wrt. Urban heating

Decreasing Rainfall	Adverse Impacts	Possible Adaptation Measures
Water Resources	Causes drop in groundwater table Affects the availability of water in private wells	(See temperature increase adaptation)
Coastal Zones	Salt intrusion; loss of near coast plants - specific mangroves erosion because of vegetation loss (dune plants, mangroves)	Replanting of plants Building sea walls
Agriculture	Drought; Lower cultivation; Affect size and quality of crop yield.	Irrigation (drip/improved technology); drought/salt tolerant plants; smaller scale activities; diversification (might need population preference shifts) See adaptation for temperature increase
Forest	(Shrinks forest reserve) Drought Forest Fires	More cleanups (carbide dumps); See temperature increase adaptation
Tourism	Impact on environmental quality less vegetation (loss of attractiveness) Incidence of more forest fires (pressure on water resources) Increase of air pollution	Save ‘water' initiatives; (showers, laundry) Awareness-raising; recycling & waste water-treatment/reuse
Human Health	More dust: adapt: Car Emissions Regulations; Water security => hygiene affected	
Settlements / Infrastructure	Utility water demand increase	Upgrade the network to deal with the increase in demand
Energy	More water barged or Reverse Osmosis or water production (all adaptation) permanently increase energy use (as an impact on Energy sector) Can be mitigated through “more water conservation methods”	Conserve water; conserve energy from other demands

Ocean Acidification	Adverse Impacts	Possible Adaptation Measures
Coastal Zones	-Less protection from coral reefs	See "sea level rise/coastal zones"
Agriculture and Fisheries	Affects fishing grounds Affects fish stock Ph affects organic composition of the marine life (through coral reef condition).	Remove/mitigate other pressures on fish
Tourism	Coral reefs impacted Loss in native species More invasive Native marine food source sport fishing / diving less attractive	Remove/mitigate other pressures on coral reef
Human Health	Food security (coral reef health): Reduced marine food source (protein source) More invasive pests Biodiversity loss	Education; Dietary shifts
Energy	Loss of economic stability (i.e. from tourism) impacts energy usage	None possible

Sea Level Rise	Adverse Impacts	Possible Adaptation Measures
Water Resources	Increase of salt intrusion Salt intrusion can affect well fields	Regulate water extractions from ground water (recharge areas); reroute storm water (not to sea, but to recharge areas)
Coastal Zones	Coastal erosion; Loss of beaches and land Affects mangrove vegetation: changes location	Sea walls; enrich sand dunes, mangroves, coral reef management
Agriculture	Changes chemistry of soil, which adversely affects crop production.	See "water resources/sea level rise"; crop change; fix chemistry (?)
Forest	Affects chemistry of soil – eg. Pine forest; Displaces brackish mangroves + wetlands	Replant; sea grapes; coconut/palm trees
Tourism	Loss of beach areas Coastal inundation Coastal zone erosion Dune and sand loss	Change attraction; improve coastal management; beach nourishment; dune (re-planting; setbacks
Human Health	Salt water intrusions Decrease in fresh water supply Waterborne disease due to ground water pollution	See "water resources/sea level rise"
Settlements / Infrastructure	Subsidence Impact: increased risk of flooded docks Impact: increased flood risk; Sewage system Cemeteries flooded (close to coast!; especially outer islands) Flooding of roads => change road layouts Utilities mostly on the coasts: increased flood risk and salt spray will impact insurance	Adaptation: Increase in dock height Adaptation: Improved drainage systems Adaptation: Building code upgrade Adaptation: Building code upgrade Change road lay-out Relocation; protection (nb: Vapor/moisture barriers for floors/walls)
Energy	Persons move inland (new houses) More sea wall construction More dam constructions = constructions necessary to adapt to loss of coastal area = 1 time more energy	Relocate utilities (part of refurbishing schemes) Construction of sea walls /dams


GREENHOUSE GASES (GHGs)


...YOU SEE, THIS LAYER LETS THE SUN'S RAYS REACH THE EARTH'S SURFACE BUT DOESN'T ALLOW EXCESS HEAT PRODUCED BY US TO ESCAPE INTO SPACE.
GHGs
WELL, WHAT Y'ALL CALL THESE GASES?

CHAPTER 5: OTHER INFORMATION CONSIDERED RELEVANT FOR THE ACHIEVEMENT OF THE OBJECTIVES OF THE CONVENTION

5.1 INTRODUCTION

5.1.1 Integration of Climate Change into National Policies

The Bahamas has a National Policy for the Adaptation to Climate Change. The National Policy identifies Government as the major facilitator of the implementation of the policy directives. It also provides a framework for advancing the capacity and capability of The Bahamas to effectively adapt to climate change impacts, and contributes significantly to the conservation and preservation of The Bahamas' natural resources for present and future generations of Bahamians.

Policy goals and objectives involve the following steps:

- Develop plans, processes and strategies to adapt to climate change and to avoid, minimize or mitigate the negative impacts of climate change on ecosystems, biological resources, land, water, economic activities, human settlements, and infrastructure;
- Encourage efficient use of energy and renewable energy while reducing dependency on imported fossil fuels;
- Conduct systematic research and observation on climate change;
- Explore and access mitigation and adaptation technologies;
- Enact legislative and regulatory instruments to promote effective implementation of this policy;
- Set up appropriate institutional systems and management mechanisms to ensure effective planning and responses to climate change; and
- Devise appropriate economic incentives to encourage public and private sector investment in adaptation measures.

Integration of such a policy and other aspects of climate change would vary across agencies.

5.2 Department of Meteorology

The Department of Meteorology has no existing policies. They operate with focus given to the National Emergency Management Agency (NEMA) Plan of Action. The Department is involved in the Global Climate System (GCOS) program, and is looking at being involved in the Global Earth Observation System of Systems (GEOSS).

The priorities of the department include improving Family Island stations to garner information on temperature and evapotranspiration. They are engaged in a coupon insurance scheme with Ministry of Agriculture and Marine Resources to assist farmers who may lose funds from impacts of tropical cyclones.

Climate change is not specifically considered in agency planning, but work with NEMA is related to climate change in terms of the early warning system. Impacts will include an increase in the intensity of storms that will be measured by the modification of instruments. Presently instruments are only designed to measure a certain wind speed (up to 120 miles) and will not work beyond that measurement. The Department will need additional instruments to read up to 200 mph. Changes in technology, such as utilization of air quality measurements are required to aid effective monitoring.

Information needs include GIS data to help monitor the decrease in vegetation. More research is needed to determine the impacts certain events will have on agencies and present statistics.

5.3 Bahamas Environment, Science and Technology (BEST) Commission

BEST has been the lead agency on development of national policies related to climate change, invasive species, wetlands and marinas. Policies planned for the future include those related to issues such as land-based sources of marine pollution and persistent organic pollutants.

Programs include the Integrated Watershed and Coastal Area Management project and the GEF Sustainability of Marine Protected Areas Full-Sized Project.

BEST's priorities include improving national policy development and legislation for the environment, and helping the country to pursue initiatives that would facilitate adaptation to climate change. BEST officers do consider climate change in planning. They encourage developers to go after greener alternatives such as minimal land clearing to preserve carbon sinks.

5.4 Bahamas Electricity Corporation (BEC)

The policies of BEC involve making a contribution to the national energy policy and participation in the National Climate Change Committee. Planned policies include exploring renewable energy options.

One of the priorities of BEC is the reduction of the amount of electrical power produced from fossil fuels (this will lead to reduction in fuel costs).

BEC is the largest emitter of GHG. BEC is charged with providing power to all Bahamians, and it is a challenge to provide power in the Family Islands at the same cost as the more populated and developed island of New Providence.

Climate change is not considered in agency planning. There is no imperative to address this issue. If BEC was to seriously consider impacts of emissions, it would change the way it uses energy to generate power. It would be helpful to view a Government agency's report on BEC's emissions. Information on mitigation of measures to reduce emissions would be useful. The information can be produced in any format as long as it is on Government letterhead. (Air conditioning load is the largest load they have; BEC uses less power when it is cooler. BEC emissions will increase the hotter it gets.)

A draft national energy policy has been developed, but is not yet approved by the Government. BEC looks at energy production from a financial perspective, not an economical one. The power company is looking at solar, wind, waste-to-energy, Ocean Thermal Energy Conversion and plasma energy generation as alternatives.

5.5 Water and Sewerage Corporation (WSC)

Policies of the Water and Sewerage Corporation include working with the World Health Organization and abiding by their standards. They also work with Global Water Partnership and Caribbean Water and Wastewater Association. WSC has financial and customer service policies. Planned policies include an Integrated Water Resources Management Plan which they are presently pursuing. The agency is trying to develop a master strategy for the water and sewerage service sector.

Priorities include developing adequate service standards throughout the country. This is very difficult to do without vast economic resources.

Agency issues include providing the populace with potable water and collecting their waste effluents. The latter is not being done adequately anywhere in the country.

5.6 Ministry of Education

Education policies include educating as many as possible on climate change. Climate change is incorporated in the national secondary school curriculum with more details provided at Grades 10 through 12. While climate change is not specifically referenced in the national primary school curriculum, aspects of it are addressed in science and social studies. Topics such as earth's atmosphere, hurricanes and how they happen and other climate phenomenon may include these aspects.

5.7 The College of The Bahamas

The College of the Bahamas (COB) has educational policies and programs for science, science majors and teachers.

Issues include strategic planning associated with trying to have campuses all over the country. What is the carbon footprint of teachers and students having to move around? Is COB's growth being done in a sustainable manner? COB is transitioning to a university. Therefore, it will take a larger role in research and be more involved in national issues.

COB now has a Small Island Sustainability programme, which includes a curriculum, related to climate change. The programme looks at other aspects of sustainable development including alternative means of crop production and renewable energy technologies.

5.8 Department of Lands and Surveys

The LUPAP (land use policy and administration project) is an attempt to create a base map of all the islands of The Bahamas starting with Grand Bahama, New Providence and Abaco. It would be a land parcels map including all the surveys that have been done in the country.

Sea level change may impact LUPAP. GIS maps or statistics would be best formatted for relaying information.

5.9 Department of Agriculture

The Department of Agriculture has no specific policies, but is looking to develop policies on land use and tenure, water use and management, and pesticide use. They are having discussions to review the availability of land for farmers especially those in low-lying areas. The Department wants to have some land conveyed to move farmers to higher ground and is meeting with the Office of the Prime Minister and Department of Lands and Surveys on this matter.

The Department is encouraging farmers to use greenhouses to start seedlings and grow crops with improved seed varieties. The Department is also encouraging the use of drip irrigation instead of rain fed agriculture. Slash and burn is still a practice amongst subsistence farmers. The Department does have a system of land clearing available to farmers at a cost, but some farmers prefer not to use it.

The Department wants to implement agricultural coupon insurance, which is agreeable with the majority of farmers. However, the high premium farmers would have to pay is an obstacle, but the Department is working to eliminate this concern.

Some of the issues for the Department of Agriculture include animal and plant health, food security and production, wildlife conservation and research, import control, and rural planning. Climate change will affect all aspects of agriculture, including marketing or transporting produce to different islands. Land use and clearing, land availability, wildlife management, genetic selection related to pest control and resistance will also be impacted.

5.10 Department of Environmental Health Services (DEHS)

It was noted that the Environmental Health Services Act speaks to the issue of burning and makes it illegal to emit any pollutant into the environment.

5.11 Ministry of Finance

Existing policies include a reduction in duty on solar panel and other equipment related to solar energy. She noted that the issue of climate change is on the agenda for Finance Ministers.

5.12 Bahamas National Trust (BNT)

Existing policies do not include climate change, but the BNT is planning to review them to see how they can include this issue. Its priorities are biodiversity and wetland conservation.

5.13 Ministry of Tourism

The Ministry of Tourism has no existing policies, but it does support the national climate change policy. The organization has a programme that involves coastal awareness. Priorities include doing whatever is eco-friendly, conserving the natural resources of The Bahamas and making tourism thrive. Wherever possible, the Ministry tries to influence touristic developments to be eco-friendly like building on the coast. Sustainable tourism guidelines exist, and are provided to developers when new developments are presented to the Ministry for comment.

5.14 Environmentally Sound Technologies – Transfer and Access

The Initial National Communication (INC) of The Bahamas presented to the UNFCCC in 2001 identified a number of potential projects and activities that The Bahamas could implement to contribute positively to its response to climate change. Areas and sectors covered include agriculture, energy (including renewable), health, transportation, water conservation, land use and forestry and tourism. The technologies and practices required for the above can also contribute to economic and social development for The Bahamas. To achieve sustainable development objectives, it is crucial to have the following: (i) technologies for mitigation such as in energy and transportation; (ii) adaptation technologies in the areas of water conservation; (iii) improvement and sustainability of agricultural and livestock production; (iv) reduced incidences of malaria and upper respiratory diseases; and (v) the management and conservation of biodiversity, including forestry..

Technology for implementation of activities in the above-mentioned areas and sectors vary in appropriateness and cost. In order to use scarce and valuable resources, as efficiently as possible, there is a need to conduct an assessment of available technology and cost of transfer and adaptation. This is also consistent with decision 4/CP.4 of the UNFCCC requiring non-Annex I countries to submit their technology needs for addressing climate change in a prioritized manner.

The Bahamas National Climate Change Committee (NCCC), chaired by the BEST Commission of the Ministry of the Environment, with the support of the United Nations Development Program requires the services of a consultant, an institution or consortium to conduct an assessment of the available technologies that could support economic development while meeting the climate change obligations and responses of The Bahamas. The Bahamas intends to pursue GEF Enabling Activities funding in order to complete a technology needs assessment within the GEF-5 cycle.

5.15 Climate Change Research and Systematic Observations

The Bahamas is a part of WMO and the Global Climate Observing System (GCOS).

Weather observations in The Bahamas have been made since the arrival of Christopher Columbus in 1492, and have continued to the present day. Historically, these observations were reported in locations across The Bahamas by numerous private and untrained individuals, on both land and at sea. These records were often incomplete with numerous gaps.

In 1935, a network of observing stations was organized by The Bahamas Telecommunications Department in conjunction with the United States Weather Bureau. The Bureau provided the instrumentation and forms for recording the information, with necessary instructions.

Annual tours were arranged to inspect and maintain the instruments. The information collected was disseminated in accordance with international standards and practices to well inhabited islands.

The formation of the British Caribbean Meteorological Service in 1951 resulted in the formulation of a more systematic manner of making observations. Hydro meteorological and climatological observations became the responsibility of The Bahamas Department of Meteorology on its creation in 1973, while under the Ministry of Tourism.

Systematic observations are made from a network of 21 automatic weather observing stations on 15 well inhabited islands. These stations provided data continuously at frequent intervals and for observation time. Parameters measured include wind direction and speed, precipitation, air temperature and solar radiation. The network forms part of the Global Climate Observing System and the Global Earth Observation.

A cooperative upper air observing station with the United States has been maintained since 1978. The unit provides upper-air analyses and products to users who are monitoring or conducting research in climate change, for short or long periods of time.

A Doppler weather radar, satellite data from the National Oceanic Atmospheric Administration (NOAA) and a lightning detection network are tools that are used for the early warning system of The Bahamas.

The impact of radiation on health is measured with a UV-B 501 biometer. Measurements have been made since 1999. The data will be used for plant, marine, climatological ozone or other biological impact studies that require continuous field measurements over long periods of time.

5.16 Hydrological Observations

A data well waverider buoy for the study of waves is used in marine forecasting. The data from the buoy also provides useful information for coastal management and planning.

Sea level is monitored by three tidal gauges installed in Nassau Harbour, Lee Stocking Island and Inagua. The tidal gauges were granted under the Caribbean: Planning for Adaptation to Climate Change (CPACC) Project of the Organization of American States (OAS). Data strings for Inagua and Lee Stocking Island have been shortened due to monitoring disruptions caused by tropical cyclones. A tidal gauge has been maintained and operated by the National Oceanographic and Atmospheric Administration (of the United States) as part of the GLOSS (Global Sea Level Observing System) network, at Settlement Point, Grand Bahama, since 1978.

Additional observations have been made by the Perry Institute for Marine Sciences, at Lee Stocking Island in the Exuma Cays, to include records of the physical processes controlling water temperature, water level and circulation. Some of the observations are in-situ, and are made in the shelf waters of Exuma Sound, the adjacent shallow waters of the Great Bahama Bank to the west, and in the connecting tidal channels. Sea level recordings have been made by various entities over the past century, but no long-term records exist for any individual site across The Bahamas.

For comparative purposes, there is a need to install at least two more such recorders, one in the central and the other in the southeast Bahamas.

Constraints and gaps related to RSO include the need for personnel, observation stations in remote Family Islands, development of a rainfall network and telecommunications infrastructure to support a system.

5.17 Research Programmes

Research programmes are widely ranged and encompass regional and international initiatives, with meteorological and socio-economic elements.

Two stations are equipped with meteorological sensors to monitor precipitable water (PW). The project is part of the COSMIC program recently funded by the National Science Foundation to expand SuomiNet into the Caribbean. SuomiNet is an international network of GPS receivers, configured and managed to generate near real-time estimates of precipitable water vapor in the atmosphere, total electron content in the ionosphere, and other meteorological and geodetic information. The objective of this expansion is to improve the forecasts of hurricane track and intensity using continuous observations of integrated water vapor. We will install and operate a network of up to 15 GPS stations in the Caribbean. They will all be equipped with meteorological sensors and the data will be analyzed to retrieve precipitable water vapor (PW). The derived PW data will then be assimilated into the Weather Research and Forecasting (WRF) model to evaluate what impact they have on hurricane forecasts.

Seasonal Forecasts are made by the Caribbean Institute for Meteorology and Hydrology (CIMH) and the products used by the Department of Meteorology to warn of drought.

Research activities coordinated by The Bahamas Meteorological Service include PRECIS modeling at a scale of 25km resolution using two Global Climate Models (GCMs) to downscale to regional level to be able to interpret outputs that would show changes in climate. BahamasSimClim model is used to give more site specific outputs.

Vulnerability mapping using the Sea Lake and Overland Surges from Hurricanes (SLOSH) model has been completed for the islands of New Providence, Eleuthera, South Berry Islands, the Exumas, Long Island, Cat Island, Rum Cay and San Salvador. The outputs show surge values of 16 to 23 feet in the flatter, narrower islands (New Providence, Berry Islands and Eleuthera).

5.18 Regional Research

The Caribbean Community Climate Change Centre (CCCCC), in collaboration with the Oxford University Centre for Environment (OUCE), has been implementing a pilot phase of one component of a more holistic proposal, CARIBSAVE. CARIBSAVE addresses the vulnerability of the regional tourism sector to climate change, and seeks to develop adaptation/mitigation responses to build a more climate resilient tourism sector in the region. The component being addressed, on a pilot scale in Negril in Jamaica and Eleuthera, in The Bahamas seeks to develop a Destinational Climate Change Risk Map that will form the basis of integrating climate risks into the sectoral (tourism in this instance) planning process.

In June 1999, the Government of The Bahamas, through the National Climate Change Committee (NCCC) of the BEST Commission, contracted Global Change Strategies International (GCSI) of Canada to undertake a study of climate change in The Bahamas. The study (Martin and Bruce, 1999, 2000) formed part of the effort of the Government of The Bahamas to develop a National Action Plan on Climate Change, and a First National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). The study follows earlier GCSI contributions to a workshop, and the provision of consultancy services to The Bahamas.

The GEF FSP on Sustainability of Marine Protected Areas in The Bahamas involves a research project on how increasing resilience of coral reefs to climate change can be improved by restoring mangrove areas adjacent to reef areas. This project is scheduled for completion in 2013.

5.19 El Nino-Southern Oscillation

The El Nino episodes of 1995 and 1998 were, in part, responsible for the Feasibility Study referred to in 4.1.3.1 above. It was during these events that Bahamian coral reefs experienced significant bleaching. Coral reefs are regarded as excellent indicators of climate change, since they respond to changes in the temperature and turbidity of the water, and to solar radiation. The general objective of the Project is to design feasible regional early warning systems to ameliorate the impacts of the El Nino Southern Oscillation (ENSO). The Study will include some case studies on ENSO in the Caribbean.

5.20 Vulnerability

The degree of resolution of Global Circulation Models (GCM) is generally inadequate to depict the regional climates in areas consisting of small and narrow landmass, such as The Bahamas. Examination of these models, nevertheless, indicate that the Geophysical Fluid Dynamics Laboratory (GFDL) Model, the Canadian Climate Centre (CCC) Model, and the United Kingdom Meteorological Office (UKMO) Model all predict an increase in mean air temperature of about 2° degrees Centigrade in the Caribbean region. All the models simulated the future climate in an atmosphere with a doubled carbon dioxide concentration within 75 years. No signals could be had for rainfall from the simulation exercises. However, for research purposes, it was decided that a 1° to 2° degree Centigrade temperature increase should be used, along with a 10 to 20% variation in rainfall.

The study examined human health, hydro-meteorological and land-based issues. The overriding question addressed was: what changes have occurred in the Bahamian climate to date, and what impacts have been identified? Using data provided by the Bahamian government, the study examined, analyzed and reported on, the following:

- hydro-meteorological data for The Bahamas;

- historical review of tropical storms, storm processes and storm surge inundations;
- the occurrences of drought periods and heavy rains, focusing on the increase in intensity of rainfall events;
- changes in vegetation and sedimentary processes throughout The Bahamas;
- mean air temperature changes;
- changes in mean groundwater levels in freshwater lenses in The Bahamas; and
- possible health impacts, to date, as indicated by hospital admissions data are incidences of malaria, respiratory disease and heat stress.

A comparison with nearby countries and similar regions will be attempted if data is available. In general, the availability of appropriate databases will influence the level of detail produced in the final report. The study will not produce new databases nor undertake supplementary measurements.

The study contributed to a subsequent assessment of the vulnerability and adaptation of The Bahamas to the future impacts of climate change by:

- identifying data gaps in the hydro-meteorological monitoring system, and proposing method(s) of filling these gaps;
- proposing climate change scenarios that might be used to predict future change;
- providing a relative assessment of the vulnerability of The Bahamas to the effects of climate change; and
- commenting on possible adaptation strategies for The Bahamas.

The study report will form a background paper on the hydro-meteorological and land-based effects of climate change in The Bahamas. It is intended to be the basis for a national workshop on vulnerability and adaptation, to be held at the completion of the study. To this end, the report will make specific reference to questions posed, and to discussion points that may be raised by workshop participants.

These models projected sea level rises of 1.6 in (4 cm), 12 in (30 cm) and 20 in (50 cm) over the next 25, 50 and 100 years respectively. Observations in The Bahamas reveal that storm surge produces most of the flood damage and drowning associated with tropical storms that make landfall, or that closely approach a coastline. Recognizing this fact, and the vulnerability of the Bahamian archipelago to storm surges, the Government of the Commonwealth of The Bahamas, the World Meteorological Organization (WMO) and the United States Government, applied the Sea Lake and Overland Surges from Hurricanes (SLOSH) computer model developed by Jelesnianski (1967), to The Bahamas. On the basis of observations by forecasters of the Department of Meteorology of The Bahamas and of the National Hurricane Center in Miami, Florida, thirteen storm-track headings were selected as representative of storm behavior in this region. Rolle (1990) has produced an atlas that provides maps of SLOSH modeled heights of storm surge and the extent of flood inundation for various combinations of hurricane strength and direction of storm motion.

This project, an example of bilateral assistance, was done with the assistance of the Storm Surge Group of the National Hurricane Center, National Oceanic and Atmospheric

Administration. The model has so far been applied only to the northern and central Bahamas (i.e., to the islands of New Providence, Eleuthera, Cat Island, San Salvador, Rum Cay, Long Island, Exuma and the Cays, southern Abaco and the Berry Islands). "Ground-truthing" of the model came in 1992 with the passage of Hurricane Andrew over the island of Eleuthera. Consultants recommended that, for further assessments, the SLOSH model be run with a 20 cm sea level rise, and Geographic Information Systems (GIS) data generated by this model be used. The work now needs to be expanded to include the remaining islands of The Bahamas, which are also frequently threatened by hurricanes. The findings should undoubtedly guide development in those areas vulnerable to severe flooding.

5.21 Education, Training and Public Awareness

The Bahamas Environment, Science and Technology (or BEST) Commission manages the implementation of multilateral environment agreements in The Bahamas, including the UNFCCC. The National Climate Change Committee (or NCCC), under the auspices of the BEST Commission, has tasked a public education and outreach subcommittee (or PEO subcommittee) with drafting and implementing a public education and outreach strategy on climate change in The Bahamas.

The PEO subcommittee has adopted a strategy document on public education and outreach with a three-year duration. The strategy adopts the overall goal of informing the various stakeholder groups on the effects and threats of climate change for The Bahamas. It also encourages public action and involvement in national mitigation and adaptation efforts to promote sustainable development and poverty reduction.

The strategy document sets out various stakeholder groups to be targeted, in order of priority, as follows:

- youth and education through school level general educational materials, student competitions and teacher workshops;
- the media through workshops;
- civil society (including the private sector and community groups) through targeted meetings and workshops; and
- politicians and the public sector through targeted workshops.

5.22 Education

The national primary school level curriculum currently includes general environmental education components, but no specific content on climate change. The national secondary school level curriculum currently includes specific components on climate change. Based on meetings with the Ministry of Education, the subcommittee has determined that by providing educational materials and workshops for teachers, climate change can be more effectively integrated into both the primary and secondary level school curriculum. To this end, the first short term project of the PEO subcommittee is to develop a nationally appropriate comic booklet on climate change as an educational tool. Workshops have been held with the subject officers, the writing unit of the Ministry of Education, a selection of teachers, and the Coastal Awareness Committee to review the draft comic booklet. Further funding will be required to print the booklet in large numbers for schools.

The national higher education institution, The College of The Bahamas, launched a new programme in Small Island Sustainability (SIS) in September of 2009. The SIS programme offers a Bachelors of Arts in Small Island Sustainability with a focus in either policy studies or eco-tourism and development. It also offers a Bachelors of Science in Small Island Sustainability with a focus in either environmental and ecosystems management or integrated sustainable development planning. Although there is presently no specialization in climate change available in the SIS programme, the required courses for students in the SIS programme include climate change content. The SIS programme held a series of public town hall meetings at The College of The Bahamas in 2009-2011 on various environmental issues such as geotourism, sustainable development and environmental governance.

Current climate change education (school and college level) challenges include a lack of -

- educational materials;
- familiarity with the subject matter;
- methodological courses in primary and secondary schools;
- advanced training for qualified people.

5.23 Media

There has been an increase in public awareness through both the national and international media. On a national level, a climate change workshop for media and policy makers was held on May 3, 2010. This segment was part of a workshop prepared for the Second National Communication. A new show, The Bahamas Naturally, airs monthly and focuses on the eco-systems of The Bahamas.

There are no specialist environmental journals or newspapers, and there is limited national scholarship on the issue.

5.24 Non-governmental Organizations

The Bahamas National Trust (BNT) developed many educational programs and collateral material that aid in teaching the effects of climate change in the ecosystems of The Bahamas. One such resource is the Treasures in the Sea Teacher Resource Manual around which a Teacher Professional Development workshop is built. The workshop focuses on issues of pollution, marine life and reef health, specifically, coral bleaching and ocean acidification. Another vital aspect of the BNT education program is the Wondrous Wetland Workshop and teacher’s resource that highlights the importance of mangroves in acting as barriers for hurricanes and storm surges.

In 2010 during its annual summer camp, the BNT designated a full day for conducting climate change lessons and activities. Other aspects of the camp featured various topics that relate to climate change. These include topics such as Reduce, Reuse, Recycle, Water Conservation, Pollution and various ecosystems that would have a direct negative impact from climate change. The Discovery Club, the BNT's youth environmental program, has a weather badge where climate change is among the topics discussed over a 6 week period. The BNT hopes to continue to integrate climate change in its education programs in order to facilitate a better understanding of climate change - its causes and effects.

The Bahamas Reef Environmental Education Foundation (BREEF) conducts an annual summer Marine Conservation Teacher Training Workshop at the Gerace Research Center on San Salvador. The objective of the workshop is to provide Bahamian primary and secondary level educators with hands-on experiences in the marine environment that they could subsequently share with their students. To date, approximately 280 Bahamian educators have participated in the workshops. Since 2008, the workshop has contained a component on climate change education. In 2010, the workshop will produce a series of Public Service Announcements under the theme "Conservation makes Cent$," linking environmental issues with economic development. One of the public service announcements will focus on climate change in The Bahamas.

The National Coastal Awareness Committee is a group of stakeholders from the private and public sectors formed to heighten awareness of the importance of protecting and preserving the coastline of The Bahamas. Its members are: the Ministry of Tourism, Bahamas Reef Environmental Education Foundation, the BEST Commission, Bahamas Hotel Association, Bahamas National Trust, the College of The Bahamas, Department of Environmental Health Services, Department of Marine Resources, Stuart Cove's Dive Bahamas, Dolphin Encounters Ltd., the Nature Conservancy and the Ministry of Education. The Committee has launched the National Coastal Awareness 2011 School Competitions. These include a design competition to produce a climate change banner for students Grades 7-9, and a public service announcement competition on climate change for high school students Grades 10-12 and high school graduates up to age 25.

The Fifth National Exhibition of the National Gallery of The Bahamas will take place under the theme 'The Carbon Footprint: Bahamian Artists' 21st Century Response to the Environment.' The themed national exhibit is designed to explore ideas and narratives from a selection of Bahamian artists on issues relating to the 21st century global question on carbon footprint and climate change. The exhibition is scheduled to open in August 2010 and end in January 2011.

5.25 Public Sector

Public addresses by senior government officials have included the impacts of climate change and government's effort to build capacity, and to report on the national involvement in the UNFCCC process. Additionally, experiences with tropical cyclones, public debate and the increased national and international media attention to climate change continues to be used to increase awareness on the subject.

Specific workshops on climate change have been held to train experts in preparation for the Second National Communication, namely long-range alternative energy planning system from 15th - 18th March 2010, and BahamasSimCLIM from 3rd – 7th May 2010. Both workshops focused on using and inputting data into climate modeling systems.

A strategy on public education and outreach on climate change in The Bahamas was recently adopted.

5.26 Public Participation and Access

The Bahamas is not a signatory to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters. However, the government plans to enact a Freedom of Information Act, and recently enacted a Planning and Sub-division Act 2010, which includes components involving public participation on planning decisions.

5.27 Sub-regional, Regional and International Cooperation

The PEO subcommittee recently entered into conversations with the University of South Florida to participate in a project for the development of a regional partnership on climate change. the project will include the identification of best practices in climate change education and the piloting of innovative climate change education practices.

The PEO subcommittee has also made contact with the Caribbean Community Climate Change Centre in Belize.

5.28 Gaps, Needs and Priorities

Educational materials combined with workshops for teachers on climate change are required at every level throughout the national education system. A lack of familiarity with the subject matter, combined with a lack of educational materials, means that the subject matter is not fully integrated in the national curriculum as taught.

In addition, there is a lack of:

- national data collection and distribution initiatives;
- policy interactions; and
- prioritization of climate change at the institutional and executive level which further reduces the efficacy of any educational and outreach impetus.

In order to address these gaps and needs, further funding will be required to implement the public education and outreach strategy.

5.29 Capacity Building

The intergovernmental negotiation process that ultimately led to the Earth Summit in 1992, served as a mechanism for highlighting global concerns for the environment, including climate change, and to achieve heightened awareness of these issues in The Bahamas and throughout the Caribbean region. The process in The Bahamas, of coordinating the national effort to prepare a national report for UNCED (Ministry of Foreign Affairs, 1992), led to the formation of a National Inter-Ministerial Committee on Science and Technology (NIMCOST). This Committee received approval from the Cabinet of The Bahamas, and was charged with coordinating the national effort to prepare the country report to UNCED under the aegis of the Ministry of Foreign Affairs. The UNCED county report represented the first national statement on climate change and served, within the public service, as an initial assessment of the potential impacts of climate change on The Bahamas. Awareness within the public sector was also heightened, and the stage was set for efforts to develop the technical capacity, and the advocacy needed to develop a national strategy responsive to the global problem of climate change.

The members of the Caribbean Community (CARICOM) are primarily low-lying coastal states and islands with fragile coastal ecosystems. Tourism and agriculture are the principal sources of employment and of foreign exchange earnings. Coastal areas, holding the vast majority of the population and economic activity, are vital to the prosperity and well being of these countries. They are also the most productive areas, supporting a wealth of living marine resources and high biological diversity. In recent years, these resources have come under increasing stress. This problem may well be compounded by the anticipated global warming, which will result in rise in sea level, increases in sea surface temperatures and changes in wind and ocean currents. The vulnerability of coastal resources, human settlements and infrastructure to sea level rise underscores the urgent need for an integrated framework to address these issues. The scarcity of reliable data, lack of suitable information systems and coordinated institutional structures to manage coastal resources, aggravate the difficulties. National governments in the Caribbean came to the realization that the coastal environments in the region were under stress because of increasing human activities, tourism-related infrastructure, environmentally inadequate disposal of liquid and solid waste, decaying drainage infrastructure, uncontrolled development schemes, severe weather events, mismanagement of coastal ecosystems, and increased sedimentation due to poor watershed management. Further, there was the realization that the potential impacts of sea-level rise on small island developing states of the Caribbean, included but were not limited to, salt water intrusion, increased coastal erosion, permanent flooding or inundation, and increased vulnerability to the impacts of tropical storms.

5.30 CPACC Capacity Building

The active participation of The Bahamas in the 1994 Global Conference on Sustainable Development of Small Island Developing States, held in Barbados (United Nations, 1994), resulted in the CARICOM countries approaching the OAS for technical assistance to assess the potential impacts of climate change in the Caribbean region. This dialogue resulted in the CPACC Project. The OAS and Global Environment Facility (GEF) Project Development Faculty supported the preparation of a project proposal. It became effective in April 1997, when the

Board of Directors of the World Bank, one of the Global Environment Facility (GEF) implementing agencies, approved a US$6.5 million grant, and designated the OAS as the executing agency. A Regional Project Implementing Unit (RPIU) has been established at the Barbados campus of the University of the West Indies. CPACC constitutes an enabling activity of the United Nations Framework Convention on Climate Change. The overall purpose of the CPACC project is to support Caribbean countries in preparing to cope with the adverse effects of global climate change, particularly sea-level rise, on coastal areas through vulnerability assessment, adaptation planning, and capacity building. The project follows a regional approach and is being executed through the cooperative efforts of all twelve participating countries, the University of the West Indies Centre for Environment and Development (UWICED), and several regional institutions. The CPACC project is a combination of national projects, pilot and demonstration activities, and regional training and technology transfer workshops. This approach seeks to strengthen regional cooperation and institutions, and provides a cost-effective means for adaptation planning, data collection, sharing of information skills, and project benefits.

5.31 Need, Options and Priorities

There have been a number of workshops held to enhance capacity. The Department of Meteorology is currently conducting flood plain mapping with the aid of The Bahamas National Geographical Information Service (BNGIS). The data has been integrated in the SLOSH model. It will be analyzed and transformed by NOAA, which is donating time and equipment to the process.

CHAPTER 6: CONSTRAINTS, GAPS AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

One of the principles of The Bahamas National Policy for Adaptation to Climate Change is to develop national human and institutional capacity in all aspects of climate change research, response and planning. Procuring and allocating adequate financial and other resources to ensure that climate change issues are effectively addressed is also a policy principle. Specific actions recommended by the policy include:

- continue, expand and strengthen coastal monitoring and data collection so as to facilitate decision-making;
- develop the basis for sound decision-making by further developing the capacity to undertake research into relevant climate change processes which may affect coastal human settlements;
- implement fiscal and financial measures in order to achieve equitable distribution of the economic burden between stakeholders;
- encourage the financial and insurance sectors to develop mechanisms aimed at assisting human settlements affected by climate change; and
- undertake a comprehensive assessment of human settlements and related infrastructure at risk from the effects of climate change, using risk mapping, and incorporation of the findings into the National Land Use Management Plan, and into the planning processes of the National Emergency Management Agency (NEMA) of the Cabinet Office.

6.1 Financial and Technical Resources

Financial and technical resources dedicated to climate change and addressing its impacts are significantly limited in The Bahamas. Agencies that have other tasks as their priority functions, such as Department of Meteorology, Department of Agriculture, Water and Sewerage Corporation and Bahamas Electricity Corporation, can only commit few resources to climate change.

The 2005 National Capacity Needs Self-Assessment (NCSA) Report confirmed that "current levels of government funding are insufficient to adequately support the implementation of four international environmental conventions" including the UNFCCC. The NCSA report outlined the following additional staffing needs to build capacity for improved environmental management and addressing climate change:

- 7 forecasters for the Department of Meteorology;
- 68 technical staff members for the BEST Commission (now under the Ministry of the Environment);
- 3 staff members for the Water Resources Management Unit of the Water and Sewerage Corporation;
- 400 staff members for the Department of Environmental Health Services; and
- 15 staff members for the Department of Marine Resources.

A lack of financial resources at the systemic and institutional levels was identified as a key obstacle to staff training. Furthermore, permission for involvement in training, in particular international workshops, are most often granted at the ministerial level, and not at the institutional level, where training needs are best assessed. As a result, the process of approving staff involvement in training can be very onerous and lengthy. In some instances, approval is granted after key dates for registration and payments have elapsed, thus effectively eliminating the opportunity for the staff to participate in training.

Since many of the government institutions are understaffed, and individuals are often responsible for a multiplicity of tasks, managers have expressed a reluctance to “lose” staff time through training. Managers have indicated that in some cases staffing levels are so low that they require the full complement of their staff in order to meet the most basic responsibilities of their departments. There is also a lack of learning plans and a specific environmental management training program.

The inability to effectively participate in training results in the following lost opportunities:

- to improve skills through exposure to new technologies, procedures, research, etc.;
- for networking with professional peers; and
- for gaining recognition by sharing expertise through presentation of and participation in training activities both locally and internationally.

The 2005 National Environmental Management and Action Plan (NEMAP) recommended that stable additional financial resources be made available for training. The assessment of training needs and approval for training should be completed at the institutional level and not at the ministerial level. Immediate managers and supervisors are best placed to assess the training needs of their staff. It is also recommended that learning plans be developed and a competency-based environmental management training program be developed and implemented about a two-year period. This will include the development of a training module and pilot test. E-Learning could be utilized to reduce cost. The estimated cost per module is between $US 25,000 – 40,000, thus 6-8 modules will cost about $US 150,000 – 250,000 per year or $US 300,000 – 500,000 for two years. An additional $US 50,000 or so will be required for maintenance and delivery of the training modules.

Government contribution to the preparation of the second national communication and activities relating to the implementation of the Convention

Project Proposals – Emissions Reduction and Sink Enhancement

Under GEF-5, The Bahamas intends to pursue funding for the following projects related to emissions reduction and sink enhancement:

Transformation of the public transport system through low-carbon technologies - This project would involve completion of a comparative study of the public bus transport system before and after the introduction of low-carbon technologies. It will require building on the reform of this sector, which is currently underway. It will involve policy, legislative and institutional reform to facilitate the introduction of these technologies and capacity building for staff involved in operation and maintenance of the system.

Energy efficiency market penetration in the tourism sector - Approval of the National Energy Policy would facilitate implementation of this project in the largest economic sector in The Bahamas. The project would involve the introduction of energy efficient technologies and systems into major and small hotels throughout The Bahamas. It includes training and certification for line staff in monitoring and maintenance of these systems. The project would also have a public education and outreach component.

Renewable energy (RE) technologies - Possible technologies may include waste-to-energy, biodiesel for vehicles and Ocean Thermal Energy Conversion (OTEC). Changes to facilitate the introduction of RE technologies may include modifications to the Building Code. These will need to be framed in the context of the new electricity sector framework proposed under the IDB energy projects.

6.2 Adaptation Projects

The GEF Full-Sized Project on Sustainability of Marine Protected Areas in The Bahamas includes a pilot project entitled “Incorporating Climate Change and Mangrove Restoration into Conservation Planning.” The demonstration project has implications for the entire Bahamas, but is specifically focused on the Exuma Cays Land and Sea Park (ECLSP). The project is being led by the Northern Caribbean Office of The Nature Conservancy in conjunction with the University of Queensland.

Coral reefs in The Bahamas were seriously damaged by coral bleaching in 1998 when sea temperatures rose to anomalously high levels. With sea temperature continuing to rise throughout this century, coral bleaching events are likely to become regular problems. Added to the bleaching threat to corals are the routine disturbances from hurricanes. However, recent work funded by the GEF Coral Reef Targeted Research Project and Living Oceans Foundation has shown that sea temperatures warm predictably in parts of The Bahamas. The research, led by the University of Exeter, clearly shows that some reefs will experience more intense climatic disturbance than others.

The first part of this pilot project will use a combination of historical sea surface temperature records, historical hurricane tracks (as far back as the year 1851), and climate models to locate those reefs of The Bahamas that are likely to have the greatest resistance and resilience to climate change. These predictions will be made possible by using a validated ecological model of Bahamian reefs that was developed by the University of Exeter and published in the journal *Nature*. The model will be calibrated locally by undertaking field studies of different levels of algal growth across the Bahamian archipelago. Other parameters will be obtained from existing satellite imagery (habitat maps, hurricane tracks, and sea surface temperature patterns). The final output will be a map of expected reef futures under a ‘business-as-usual’ approach to conservation. This will be complemented with another map that shows the potential impact on reef health of implementing marine reserves in each part of The Bahamas. These maps will then be combined with state-of-the-art information on patterns of larval dispersal across The Bahamas, provided by the University of Miami, to identify priority sites for conservation from a biophysical perspective. This information will assist the strategic planning of new marine reserves and provide simple tools to local stakeholders that can be used to help them select local sites for conservation.

Reefs with prolific mangrove access have a greater supply of several commercially important fishes and increased levels of grazing that are thought to improve the reef's recovery from hurricanes and bleaching events. Priority sites for mangrove reforestation will be identified using a computer algorithm to determine which sites, if restored, would offer the greatest value to the reef ecosystem, as a whole. Such an algorithm has been developed by the University of Exeter. The pilot will include a historical analysis of sites that have lost mangrove forest, thereby identifying those former mangrove sites that would offer the greatest value to reef fisheries if restored. Restoration activities will occur in the Exuma Cays Land and Sea Park as a demonstration to be scaled up at other sites in the future. Modeling will be complemented by field data collection for identification of critical areas of mangrove seeds and mangrove restoration sites. There will also be resilience monitoring for mangroves restored and development of threat abatement strategies for critical areas identified within ECLSP.

Key indicators of the project will be the following:

- maps of climate change impacts on coral reefs in The Bahamas;
- maps indicating potential impact of implementing marine reserves on reef health;
- number of sites identified as being relatively resistant to future climate change;
- number of management plans that take account of climate change impacts on reefs;
- number of sites identified for mangrove reforestation;
- production of map of mangrove contribution to reef fisheries;
- quantification of the loss of mangroves in The Bahamas over the last 20 years;
- amount of mangrove reforested; and
- health of mangroves reforested following restoration.

6.3 Technology Transfer

The Technology Needs Assessment that is scheduled to occur within the next 3 years will provide the basis for technology transfer to The Bahamas.

6.4 Other Capacity Building Needs

The NCSA Report also identified the need for the following:

- Regulations related to climate change and estimated the cost of drafting such regulations as US$15,000;
- Environmental Impact Assessment guidelines with respect to extractive processing, energy industries, industrial operations and manufacturing which should have considerations for climate change as an integral part. The estimated cost for developing the guidelines was in excess of US$63,000; and
- Funding for a fully staffed Ministry of the Environment of 274 persons with necessary infrastructure and equipment needs of US$6.2 Million.

ANNEX I: LIST OF SCIENTIFIC NAMES OF MARINE AND TERRESTRIAL FAUNA AND FLORA

LIST OF SCIENTIFIC NAMES OF MARINE AND TERRESTRIAL FAUNA AND FLORA		
Birds	Bahama parrot	*Amazona leucocephala bahamensis*
	Bobwhite	*Colinus virginianus*
	Chukar	*Margarops fuscatus*
	Cuban grass-quit	*Tiaris olivacea*
	Kirtland's Warbler	*Dendroica kirtlandii*
	Northern mockingbird	*Mimus polyglottos*
	Ring-necked pheasant	*Phasianus colchicus*
	West Indian flamingo	*Phoenicopterus ruber*
	Whistling duck	*Dendrocygna aborea*
	White crown pigeon	*Columba leucocephala*
Terrestrial mammals	Bahama hutia	*Geocapromys ingrahamii*
	Raccoon	*Procyon lotor*
Iguanas	Iguana	*Cyclura* spp. *(including C. baelopha, C. carinata, C. cychlura, C. rileyi)*
Scale fish of commercial importance	Amberjack	*Seriola dumerili*
	Bonefish	*Albula vulpes*
	Blue marlin	*Makaira nigricans*
	Dolphin	*Coryphaena hippurus*
	Jacks	*Caranx* spp.
	Lane snapper	*Lutjanus syngaris*
	Nassau grouper	*Epinephelus striatus*
	Sail fish	*Istiophorus platypterus*
	Swordfish	*Xiphias gladius*
	Tuna	*Thunnus thynnus*
	Wahoo	*Acanthocybium solanderi*
	White marlin	*Tetrapturus albidus*
Other marine species of commercial importance	Spiny lobster	*Panuluris argus*
	Queen conch	*Strombus gigas*
Turtles	Cat Island freshwater turtle	*Trachemys terrapin*
	Green turtle	*Chelonia midas*
	Hawksbill turtle	*Eretmochelys imbricata*
	Inagua freshwater turtle	*Trachemys stejnegeri*
	Leatherback turtle	*Dermochelys coriacea*
	Loggerhead turtle	*Caretta caretta*
Dolphins	Bottlenose dolphin	*Tursiops truncatus*
	Atlantic spotted dolphin	*Stenella longirostris*
	Spinner dolphin	*Stenella plagiodon*
Whales (migratory)	Beaked shortfin whale	*Globicephala macrohynchus*
	Humpback whale	*Megaptera novaeangliae*
	Minke whale	*Balaenoptera acutorostrata*
	Sperm whale	*Pyseter caodon*
Sharks	Hammerhead shark	*Sphyrna mokarran*
	Tiger shark	*Galeocerdo cuvieri*
	Nurse shark	*Ginglymostoma cirratum*
	Mako shark	*Isurus oxyrinchus*
	Lemon shark	*Negaprion brevirostris*
	Bull shark	
	Caribbean reef shark	
Native and naturalized plants	Black mangrove	*Avicennia germinans*
	Buttonwood	*Conocarpus erectus*
	Caribbean pine	*Pinus caribea*
	Horseflesh	*Lysiloma sabicu*
	Lignum vitae	*Guaicum sanctum*
	Mahogany	*Swietenia mahagoni*
	Poisonwood	*Metopium toxiferum*
	Red mangrove	*Rhizophora mangle*

	Turtle grass	*Thalassia* sp.
	White mangrove	*Laguncularia racemosa*
	Wild fig	*Ficus* spp.
	Wild tamarind	*Lysiloma latisiliquum*
Introduced crop species	Avocado	*Persea americana*
	Beans	*Phaseolus* spp.
	Breadfruit	*Artocarpus communis*
	Cassava	*Manihot esculenta*
	Corn	*Zea mais*
	Guava	*Psidium guajava*
	Gooseberry	*Phyllanthus acidus*
	Guinep	*Melicocca bijuga*
	Hog plums	*Spondias mombin*
	Hot pepper	*Capsicum* spp.
	Mamey	*Mammea americana*
	Mango	*Mangifera indica*
	Melon	*Cucumis melo*
	Pigeon pea	*Cajanus cajan*
	Pineapple	*Ananas comosus*
	Sapodilla	*Manilkara zapota*
	Scarlet plum	*Spondias purpurea*
	Soursop	*Annona muricata*
	Sweet potato	*Ipomoea batatas*
	Sugar apple	*Annona squamosa*
	Watermelon	*Citrullus vulgaris*

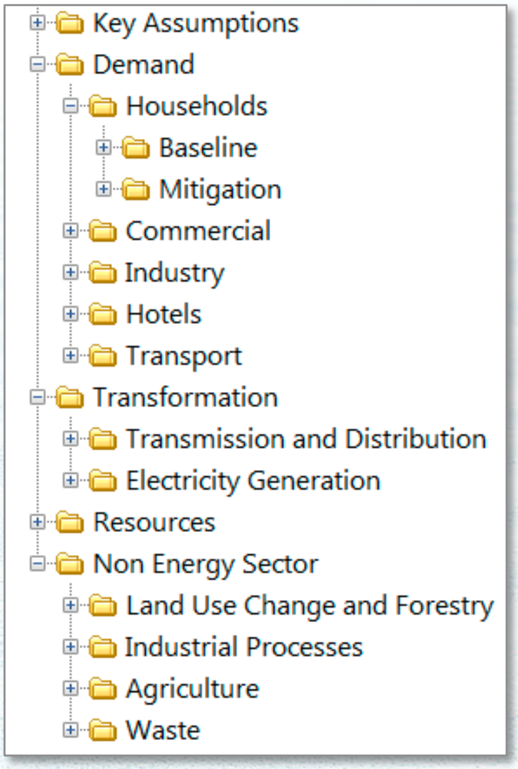
ANNEX II: ASSUMPTIONS FOR LEAP MODELING

2.1.1 Introduction

Included in this annex is an explanation of the structure and assumptions behind the baseline and mitigation scenarios used in the mitigation analysis for The Bahamas Second National Communication. The baseline and mitigation scenarios were modeled in LEAP: the Long-range Energy Alternatives Planning System, a widely-used software tool for energy policy analysis and climate change mitigation assessment.[37]

The baseline scenario was developed by the Stockholm Environment Institute (SEI)[38] with the help of Mr. Robert Hall from The Bahamas Electricity Company (BEC) and Ms. Chantel Nesbitt from the Grand Bahama Power Company (GBPC). The mitigation scenario was compiled by SEI using assumptions from the Fichtner Reports[39,40] and The Bahamas National Energy Policy report[41].

This data set includes a comprehensive picture of historical energy demand and supply in The Bahamas from 2000 to 2009 based mainly on the in-country data, but supplemented with international data sources as needed. The energy data includes information on energy use by fuel in each major demand sector (households, commercial, industry, hotels and transport). On the supply side the data sets include information on transmission and distribution losses in addition to electricity production.



The data set also includes one baseline scenario which tells a story of how The Bahamas energy system could develop over the time period of 2010 to 2030. In addition, the data set includes a comprehensive mitigation scenario which includes the various policies and measures reported in the mitigation chapter and documented in this annex.

Energy information is supplemented with the IPCC's standard Tier 1 emission factors to provide estimates of greenhouse gas emissions from the energy sector. The data sets also include simple estimates of non-energy sector GHG emissions taken from the 1990, 1994 and 2000 national inventories.

Energy consumption and production data are supplemented by macroeconomic and demographic data from The Bahamas Statistics Office and Central Bank.

2.1.2 Key Assumptions

Population

Current Accounts: Population estimates were collected from The Bahamas Department of Statistics. This data is based on historical national censuses for years 1990 and 2000, and based on preliminary census data for 2010. Data was interpolated between known data points. No digital copies of this data were available.

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[37] LEAP, distributed through www.energycommunity.org

[38] Stockholm Environment Institute, www.sei-international.org, 11 Curtis Ave. Somerville, MA 02144

[39] Fichtner, Explore Alternatives for BEC's Expansion Plan, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, September 2010.

[40] Fichtner, Promoting Sustainable Energy in The Bahamas, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, June 2010.

[41] National Energy Policy Committee, Second Report of the National Energy Policy Committee, The Bahamas National Energy Policy. Available online: http://www.best.bs/

Baseline Scenario: Population projections for years 2020 and 2030 also come from The Bahamas Department of Statistics. Data was interpolated between known data points. No digital copies of this data were available.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

Population is used to calculate the key assumption in households.

Urban Population

Current Accounts: The percent of urban population data comes from the World Bank World Development Indicators (WDI 2010) database and is available for 1990-2007. This data was acquired from the World Bank's WDI online database.

Baseline Scenario: The baseline has no projections of this variable.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

This variable is not used in LEAP's energy calculations in this data set.

Household Size

Current Accounts: Household size, or the average number of people per household in The Bahamas, is assumed to be 3.4, a representative number based on data from The Bahamas Department of Statistics.

Baseline Scenario: The baseline has no projections of this variable.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

This variable is used to calculate the number of households in The Bahamas.

Households

Current Accounts: The total number of households in The Bahamas is calculated as the total population divided by the number of people per households.

Baseline Scenario: The baseline has no projections of these variables.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

This variable is used as the activity level for the households demand sector.

GDP

Current Accounts: Historical GDP data in units of Million. In 2006 Bahamian Dollars were taken from The Bahamas central bank (raw data found in the "Bahamas Central Bank GDP data.xls" spreadsheet file in the worksheet titled "tab1"). Historical data was available from 1997 to 2007, and was extrapolated to 2009 using the historical growth rate (calculated from 1997 to 2007).

Baseline Scenario: Local GDP projections could not be found, so the baseline includes a simple growth forecast for GDP to 2030 based on a projection of historical growth from local GDP data.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

This variable is used together with the value added key assumptions and calculated with the activity level for the commercial, industry, hotels and transport sectors.

Income

Current Accounts: In current accounts, the Income variable is calculated by dividing GDP by the population of the country in units of $/person.

Baseline Scenario: The baseline scenario assumes no change in the calculation used in current accounts.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

This variable is not used in LEAP's energy calculations in this data set.

Electricity Correction Factor

Current Accounts: This variable is only used in the current accounts scenario. This factor corrects for the historical discrepancy between electricity generation and electricity consumption. In years 2000 through 2009, electric utility data reported that generation was approximately 1.25% higher than consumption. This is likely to be due to the difficulty of reporting exact consumption numbers. In order to recognize that the generation values are most accurate, we calculated a correction factor as the proportion of 2009 generation data to 2010 predicted consumption. This correction factor is multiplied by historical final energy intensities to ensure that historical generation matches consumption.

Baseline Scenario: All electricity final energy intensities are projected normally in the baseline scenario.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

This variable is used to calculate final energy intensities for electricity consumption in the households, commercial industry and hotels sectors.

Value Added

Current Accounts: Historical value added data (i.e. percent of GDP by sector) for Industry, Commercial, Hotels and Transport sectors are taken from The Bahamas central bank (raw data found in the "Bahamas Central Bank GDP data.xls" spreadsheet file in the worksheet titled "tab4"). Industrial data includes value added from industry and construction. Commercial data includes value added from wholesale and retail activity, health services, education, public administration and defense, real estate, financial intermediaries, communications and storage. Historical data was available from 1997 to 2006, and was extrapolated to 2009 using the historical growth rate (calculated from 1997 to 2006).

Baseline Scenario: All value added variables are assumed to grow at their historical growth rate (calculated from 2000 to 2009) over the time period of 2010 to 2030. This assumes that total GDP for industry, hotels and transport increase over the 20-year time frame, but total GDP for commerce decreases.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

This variable is used together with the GDP key assumption to calculate the activity level for the commercial, industry, hotels and transport sectors.

Transport

Current Accounts: Under the Transportation branches, you will find historical indicators for both passenger and freight air transport. This data comes from the World Bank World Development Indicators (WDI 2010) database and is available for 1990-2007.

Baseline Scenario: The baseline has no projections of these variables.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

These variables are not used in LEAP's energy calculations in this data set.

2.1.3 Demand

Current Accounts: Demand data for current accounts was taken from varied sources. Electricity consumption data was provided by sales reports from each electric utility. The source of data for consumption of petroleum products is the Central Bank report on oil imports ("Value of Oil Imports for Local Consumption - Central Bank.pdf"). No local level data sources were found for fuel wood, natural gas or other fuels. Assumptions for each are explained in more detail below.

Electric utilities and oil imports are reported in units of total energy consumption, not energy intensity, which means that the LEAP data set calculates historical energy intensities in each sector for its Current Accounts data. In the household, commercial, industry, hotels and transport sectors these intensities are calculated for the sector as a whole.

All historical demand data can be found in the "Bahamas Consumption History 2000 to 2009.xlsx" spreadsheet.

Energy intensities are calculated using the following formula in each historical year:

EIy = Ey /Ay

Where:
EIy = Final Energy Intensity in year y
Ey = Total Energy in year y
Ay = Total Activity Level in year y.

Different activity levels are used in each sector to calculate energy intensities as shown in Table 1. For example in the industry sector the activity level is specified as the product of GDP and the percentage value added from the industry sector, both of which are stored as data in the Key Assumptions branches. The equation in LEAP is written as:

Key\GDP[Million Bahamian Dollars]*Key\Value Added\Industry[% of GDP]/100

Table 1: Activity Level Drivers Used in the dataset

Sector	Activity Level Variable
Households	Number of Households
Commercial	Commercial Value Added
Industry	Industry Value Added
Hotels	Hotels Value Added
Transport	Transport Value Added

Historical energy consumption data is stored in a user-defined variable (initially defined in the General: User Variables screen) labeled **Total Energy** with units of Millions of British Thermal Units (BTUs). Total energy and fuel share data are extracted from electric utility reports and petroleum imports data from the central bank. Oil import reports did not specify where fuels were used. Please see **Table 2** for a list of assumptions used for this analysis. Total Energy data is stored as the total for all sectors.

Table 2: Assumptions for Petroleum Product Consumption

Assumption	Source
Diesel - 1/8 used for road transport, 7/8 used for electricity generation	2000 GHG inventory assumptions
Kerosene - 1/12 used for local use (households) 7/12 used for air transport	2000 GHG inventory assumptions
LPG/Propane - all used in households	SEI
Residual Fuel Oil - all used for power generation	SEI
Motor Gasoline - all used for transport	SEI
Aviation Gasoline - all used for transport	SEI
Lubricants - all used for transport	SEI

In addition to total energy consumption, LEAP also stores data on the fuel shares (% shares of BTU) for each fuel consumed within these sectors. Fuel share data is also derived directly from electric utility reports and petroleum import records.

Energy intensities are simply calculated as the total energy consumption divided by total activity level for each sector using the following type of equation in LEAP:

Final Energy Intensity = Total Energy [Million BTU]/ Total Activity

NB: All electricity energy intensities are multiplied by the electricity correction factor, explained in the key assumptions section.

Baseline Scenario: In the baseline scenario, the Total Energy variable is not used. Instead we have made separate projections of the activity level, energy intensity and fuel share variables and LEAP will then automatically use these to calculate the energy consumption for each fuel in each sector in each year of the scenario. This calculation is shown below.

$FC_y = A_y * EI_y$

Where:
FC_y = Final Energy Consumption in year y.
Ay = Total Activity Level in year y.

EIy = Final Energy Intensity in year y

The changes in the baseline scenario Activity Level is defined in the respective key assumptions branch. For example, the formula for the activity level variable at the Households demand branch has no new equation for the total number of households, but growth can be seen under the Key Assumptions\Households branch.

In the households, commercial and transport sectors we have assumed the historical growth rate for final energy intensity over the time period for which there is historical data. In the industry and hotels sectors we assumed zero growth because of a lack of consistent trend in historical data.

In all sectors we have assumed that fuel shares have not changed in the baseline scenario, instead fuel shares remain constant at their 2009 value.

Mitigation Scenario: In the mitigation scenario, energy savings from different policies are modeled for each sector using the total energy variable. As with the Current Accounts historical data, energy intensities are calculated as the total energy divided by the total activity level. In the case of each demand-side mitigation option, an assumption was made about the potential electricity savings in the year 2030 Below is a list of mitigation options, and their respective electricity savings in 2030.

Households - Rooftop Solar Water Heating: Based on Component II of the Fichtner reports, it was assumed that 75 GWh of electric demand could be displaced by rooftop solar hot water heaters by 2030.[42] It was assumed that potential would ramp up gradually from 2010 to 2030.

Households – Solar PV: Fichtner documents that there is a total of 99 GWh of electricity potential from PV generation and that approximately 70% of this capacity lies in household generation.[43] Based on this research, it was assumed that 69.3 GWh of electricity savings could be expected in a mitigation scenario. It was assumed that potential would ramp up gradually from 2010 to 2030.

Households, Commercial, Industry, Hotels – Energy Efficiency: Component II of the Fichtner reports proposes that a combination of energy efficiency measures can yield 15% electricity savings by 2020 and 30% savings by 2030.[44] For the purposes of this mitigation scenario it was assumed that efficiency measures could reduce baseline electricity demands by 15% in 2020 and by 30% in 2030. This mitigation potential was assumed to ramp up gradually starting in 2010.

No transport mitigation measures were modeled due to a lack of data.

2.1.4 Transformation

Transmission and Distribution

Current Accounts: Electric transmission and distribution losses are assumed based GBPC system losses provided in the “GBPC SYSTEM LOSSES 03-10.ppt” document.

Baseline Scenario: The baseline assumes no change in electricity losses after 2009. This assumes T&D losses of 9.5% over the period of 2010 to 2030.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

[42] Fichtner, Explore Alternatives for BEC’s Expansion Plan, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, September 2010. P. 4-1.
[43] Ibid. P. 4-1, 4-11.
[44] Ibid. P. 4-9.

Electricity Generation

The current representation of the electric generation module is based on electric utility capacity data that is dispatched in proportion to the available capacity. Electricity generation looks at five technologies based on the data provided by the BEC and GBPC utilities. Those technologies are as follows:

Diesel Steam Turbine, using no.2 diesel oil;

Diesel Gas Combustion Turbine, using no.2 diesel oil;

Diesel Gas Combined Cycle, using no.2 diesel oil;

Diesel Medium Speed Alternator, using no.2 diesel oil; and

Residual Fuel Oil Slow Speed Alternator, using no. 6 heavy fuel oil (or residual fuel oil, RFO).

In the mitigation scenario, new technologies are also considered. Those technologies are as follows:

Biomass;

Waste to Energy;

Solar PV;

Onshore Wind; and

Ocean Thermal Energy Conversion (OTEC).

Historical Generation data has been pieced together from both electric utilities. The final spreadsheet used for LEAP inputs is titled "Historical Generation Data.xlsx" which logged inputs from many individual source files, all documented in the previously mentioned file. To keep the file size down, none of the smaller files have been included in this analysis. A few things to note:

- BEC was unable to provide data for years 2000, 2001 and 2003. For the purposes of this analysis, historical generation from year 2003 was interpolated as the average of generation in 2002 and 2004. Data for years 2000 and 2001 were extrapolated assuming generation was proportional to electric consumption in those years.
- GBPC was unable to provide complete data for the year 2005. This data was interpolated as the average of generation in years 2004 and 2006.
- GBPC data was compiled from three separate utility sources, which may provide for inconsistencies. Data from 2000 to 2003 was taken from PRDREP reports, 2004 data was taken from the 2004 Production Report and 2006-2009 data was taken from the GADS database.
- The historical generation variable is only used in the current accounts scenario. Electricity generation starting in 2010 is calculated based on the variables below.

This variable is not used in baseline or mitigation scenarios.

Exogenous Capacity: Known current and future capacity was compiled both for GBPC and BEC through direct communication with Ms. Chantel Nesbit, Mr. Robert Hall and annual utility information. The final spreadsheet of input information to LEAP is "Electric Capacity Expansion import.xlsx."

Current Accounts: Current capacity was compiled for year 2009 with additional information from the following files:

Historical Capacity from GBPC : "Generator Name Plate – Rev 2.pptx"

Historical Capacity from BEC: "BEC Bahamas Generation Data.xls"

Baseline: Future additions and retirements from GBPC were assumed based on direct communication with Ms. Chantel Nesbit. Future additions for all of The Bahamas were assumed based on the following Ficthner Report: "Strengthening the Energy Sector in The Bahamas, Component II: Explore Alternatives for BEC's Expansion Plan."

Mitigation: Component II of the Fichtner reports includes 2 mitigation scenarios. The mitigation scenario in LEAP is adapted from the second option from Fichtner – a plan including both energy efficiency and renewable energy supply options.[45] Fichtner provides a capacity expansion plan for this scenario for BEC only, which is used as a basis for the exogenous capacity variable in the mitigation scenario.[46] To supplement this plan, the following were also assumed:

- All Family Island and GBEC baseline plans remain the same in the mitigation scenario;
- 17MW of Solar PV capacity is achieved by 2030 at a rate of 1MW/year starting in year 2014;
- 20MW of Wind capacity is built in 2015;
- 60MW of Biomass capacity is added to the system. 20 MW are added in 2015, 20MW in 2020 and 20MW in 2025; and
- Refurbished thermal power plants were not modeled in LEAP as assumptions were not available to quantify those improvements.

The above assumptions ensure that the scenario is able to achieve 15% and 30% renewable generation by 2015 and 2030, respectively. These assumptions are documented further in the file "Electric Capacity Expansion import (w mitigation).xlsx."

Endogenous Capacity: This is capacity added to meet a planning reserve margin in addition to capacity specified under the exogenous capacity variable. Neither the baseline nor the mitigation scenario requires any additional capacity to meet demand.

Dispatch Rules: Dispatch rules are only used in scenarios.

Current Accounts: In all historical years, power is dispatched according to the historical generation variable.

Baseline: All technologies are dispatched in proportion to available capacity. With this rule, processes are dispatched to try and meet electricity requirements. If the available capacity exceeds the amount needed to meet requirements, then each process will be dispatched in proportion to its available capacity (Capacity * Maximum Availability). For example, if two plants are defined and one is rated at twice the available capacity of the other, then they will run to produce outputs in a ratio of 2:1.

Please note that this assumption about dispatch causes a discrepancy in generation from residual fuel oil alternators between the years 2009 and 2010. For transparency of modeling approach, it was decided to dispatch in proportion to available capacity. The discrepancy represents that in historical years residual fuel oil alternators were dispatched at a higher rate than other technologies.

Mitigation: All thermal generation is dispatched in proportion to available capacity, the same as in the baseline scenario. New renewable generation is assumed to run to full capacity.

Maximum Availability values for thermal generation were taken from values provided by Mr. Robert Hall at BEC in the spreadsheet "Power Plant Availability BEC.xls" with the exception of the diesel steam turbine generator. Steam turbine availability was calculated from the GBPC GADS database spreadsheet "GenSummary2006-2010.xls" as an average of the two steam turbine units over the time period of 2006 to 2009. Steam turbine availability was calculated as follows:

Annual Availability [%] = Available Service Hours [hrs] / 8760 [hrs/yr] *100

[45] Fichtner, Explore Alternatives for BEC's Expansion Plan, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, September 2010. P. 4-7.
[46] Ibid. P. A-6, oil at $100/barrel.

Availability values for renewable generation were calculated based on available hours when given by Fichtner[47], and assumed based on SEI expertise when no data was available.

Table 3: Electric Generator Availability Assumptions

Technology	Availability [%]
Diesel Gas Turbine	90.4
Diesel Gas Combined Cycle	94.1
Diesel Gas Alternator Med Speed	86.2
RFO Alternator Slow Speed	78.9
Diesel Steam Turbine	63.2
Biomass	80.0
Waste to Energy	85.6
Solar PV	25.0
Wind	25.0
OTEC	80.0

No changes in availability were assumed for the baseline or mitigation scenarios. Note that performance parameters are included in current accounts for mitigation technologies. This does not mean that those technologies generate electricity in historical years or the baseline scenario.

Efficiency values for thermal generation were taken from values provided by Mr. Robert Hall at BEC in the spreadsheet "Power Plant Efficiency BEC.xls" with the exception of the diesel steam turbine generator. Steam turbine efficiency was calculated using the average monthly heat rates provided in PRDREP reports from GBPC.

Process Efficiency [%] = Conversion [3412 btu/kWh]/ Heat Rate [btu/kWh]

Renewable generation efficiencies were assumed based on SEI expertise.

[47] Fichtner, Explore Alternatives for BEC's Expansion Plan, Preliminary Report II, Strengthening the Energy Sector in The Bahamas, September 2010. P. 4-9 – 4-10.

Table 4: Electric Generator Efficiency Assumptions

Technology	Efficiency [%]
Diesel Gas Turbine	25.6
Diesel Gas Combined Cycle	30.9
Diesel Gas Alternator Med Speed	33.2
RFO Alternator Slow Speed	39.5
Diesel Steam Turbine	21.4
Biomass	35.0
Waste to Energy	35.0
Solar PV	100.0
Wind	100.0
OTEC	35.0

No changes in efficiency were assumed for the baseline scenario.

Capacity Credit values represent the amount of rated capacity that contributes towards the reserve margin. This is an indicator of intermittent renewables and therefore only has significance for Wind and Solar PV in the mitigation scenario. All other technologies are assumed to have a capacity credit of 100%. Values in the mitigation scenario are listed below and are based on SEI expertise.

Table 5: Intermittent Electric Generator Capacity Credit Assumptions

Technology	Capacity Credit[%]
Solar PV	35.0
Wind	35.0

2.1.5 Resources

This model does not include a resource analysis.

2.1.6 Non-Energy Sector

The non-energy sector modeling is very simple. Data was provided for the following areas based on past Bahamian GHG inventories:

- Land Use Change and Forestry;
    - changes in forest and biomass stocks; and
    - abandonment of managed lands;

- Industrial Processes;
    - o road surface paving;
- Agriculture;
    - o enteric fermentation and manure management;
- Waste;
    - o wastewater; and
    - o sewage.

Current Accounts: Non-energy sector data was used from past Bahamian GHG inventories from IPCC spreadsheets. Data points were used from 1990, 1994 and 2000 and interpolated to provide data from 1990-2000.

Baseline Scenario: The baseline scenario assumes no change in the year 2000 values.

Mitigation Scenario: No changes have been made in the Mitigation Scenario. All data and expressions are inherited from the Baseline Scenario.

ANNEX III: COMPLETE LIST OF POLICY TARGETS AND OBJECTIVES

3.1 Policy Targets and Objectives

Short term Targets (1-5 years)[48]

- Complete data gap analysis;
- Complete phase-out of incandescent light bulbs and their replacement with reduced mercury compact fluorescent light bulbs (CFL);
- Investigate and implement waste-to-energy technology for New Providence;
- Investigate combined head and power and cogeneration technologies;
- Explore use of biofuels;
- Develop a common basis to measure and compare the average annual unit cost of each form of energy consumed by sector and geographic area ($/gallon, $/kWh, $/bbl);
- Develop a means to measure and track the annual national energy bill and the impact on the economy;
- Develop a regulatory framework to monitor and assess fossil fuel leakage, reduce losses of imported products and conserve resources of products imported for domestic consumption;
- Develop a means to measure the economic impact of the annual national expenditure on fossil sources of energy;;
- Initiate public buildings energy usage reduction strategies;
- Explore interconnections between islands to enhance efficiency and promote the potential for renewable energy;
- Assess the Commonwealth's wind potential as well as identify potential sites for pilot and or demonstration facilities;
- Assess the feasibility of compressed natural gas as a fuel source in The Bahamas;
- Develop a means to measure the economic impact of the annual national expenditure on renewable sources of energy; and
- Initiate energy efficiency activities in public and private utilities.

Medium-Term Targets (5-10 years)

- Increase the penetration of renewable energy sources in the Commonwealth to 15% of supplies;
- Deploy renewable energy technologies in several small communities, aiming towards >50% of power from renewable sources;
- Reduce dependence on imported fuel oils by: -
  - Increased building energy efficiency by introducing standards in public buildings for cooling public spaces, heating water, lighting and the deployment of the highest energy star ratings of equipment;
  - Increased use of solar hot water systems to 20 to 30% of all households;
  - Increased efficiency of cooling systems and increasing seasonal energy efficiency ratings (SEER);
  - Increased deployment and usage of energy efficient lighting systems and fenestration systems (windows) in public buildings;
  - Increased public awareness and education on renewable energy potential and usage; and
  - New requirements for all government financed homes and buildings to use, install, operate and maintain solar water systems;
- Develop pilot and demonstration systems for residential cooling using reverse thermal gradient in low cost housing estates;
- Initiate a pilot demonstration project for ocean thermal energy conversion potential starting with taking measurements at Clifton, New Providence and North Eleuthera;
- Assess wave and tide potential of The Bahamas, as well as, identify potential sites for pilot or demonstration facilities;
- Develop a means to estimate the average annual unit cost of renewable sources of energy;

[48] NEPC report p.27 (exact text)

- Develop filters to achieve the optimum level of local participation in any energy entity that should be pursued during a period of ownership transition.

Long-Term Targets (10-20 years)

- All installations of water heaters are solar water heaters
- Develop a programme to pursue cost-effective opportunities in reducing energy consumption
- Develop a programme to minimize greenhouse gas emissions
- Establish a funding mechanism, sources of energy use and constant technology innovations and the engagement of the private sector through private and public partnerships in the expansion, upgrade and renewal of energy services infrastructure; and
- Develop extended targets for changes in the energy mix based on extended unit cost and economic impact estimates by energy source, informed by local experiences and historical data.

Short-Term Objectives

- Energy Conservation
    - Develop and implement a public sector energy conservation programme and marketing campaign. This programme must be an aggressive campaign that includes a comprehensive energy audit of the various government agencies and holdings, with the goal of achieving energy-consumption reduction targets. This programme must be transparent and will require a marketing scheme to promote the programme, to lead both the private sector and the public by example, to encourage and influence private sector participation (starting with government vendors and service providers) and competition;
    - Develop and implement a consumer-oriented energy conservation campaign. Such a campaign should include consumer education on “wise” energy use and conservation (and consequently monetary saving) tips, and an outreach component to advise the public of its role in strengthening national self-sufficiency and energy security. In order to maintain enthusiasm and reinforce the importance of consumer energy conservation, the campaign also requires a marketing component that demonstrates the consumer savings achieved through the various tips promoted in the overall campaign;
    - Develop and execute an implementation strategy for the economic incentives announced in the 2008/09 budget cycle. This includes working with The Bahamas Customs Department to ensure customs officers are able to identify energy saving goods subject to tax-rate reduction or exemption. Consumers should also be advised of these goods. (This may be a component of the consumer-oriented energy conservation campaign).
- Energy production management
    - Review and establish a guideline for independent power producers; and
    - Explore the option of combining heat and power and cogeneration technologies to support the ongoing effort of capacity deferment.
- Assess renewable potential
    - Identify the data gaps, then formulate and implement solutions for closing the gaps and setting realistic targets; and
    - Investigate the potential exploitability of various renewable energy sources and technologies, including waste to energy, wave, tidal, wind, photovoltaic systems and solar water heating units.

Mid-Term Objectives

- Renewable energy implementation plan
    - Develop and implement a renewable energy programme. This programme should encourage the private sector to develop projects to produce electricity using renewable sources (e.g. solar, wind, ocean-thermal) for possible exploitation by The Bahamas Electricity Corporation. The programme can be used to establish targets for renewable electricity sales;
- Energy Commission

- Establish a permanent energy commission, responsible for overseeing the implementation of select national energy initiatives, stemming from the national energy policy;

- Full data gaps
    - Identify data gaps, and then formulate and implement solutions for closing the gaps and setting realistic targets;
- Develop energy efficiency standards
    - Establish energy efficiency standards (e.g. building standards) for incorporation into the existing regulatory regimes. Stakeholder consultation on the proposed standards should be done, as well as, compliance promotion and enforcement.

<u>Long-Term Objectives</u>

- Reduce the rise in energy consumption and reduce use on a per capita basis
    - Develop and implement a programme to pursue cost-effective opportunities to reduce further energy consumption by various target sectors and individual consumers;
    - Develop and implement a programme to minimize greenhouse gas emissions; and
    - Establish funding mechanisms for identifying, implementing and promoting sustainable energy use and technology innovation that support efforts to achieve the targets outlined in the national energy action plan.

3.2 Transport Sector Policy Agenda

<u>Short-Term Targets</u>

- Introduce an integrated traffic management system and public transport system:
    - Reduce average commute times on New Providence by 20%;
    - Increase ridership of public transport to 10-20%;
    - Employ advanced energy efficient lighting systems in public spaces supported by signage and traffic management systems;
- Conduct a gap analysis to generate consistent datasets;
- Conduct national market and consumer research to secure data on pricing and other socioeconomic and market trends affecting the sector.

<u>Mid-Term Targets</u>

- Increase fuel efficiency for motor vehicles to 30-35 mpg for 70% of licensed vehicles through the application of incentives to import and use more efficient vehicles in private and public sector transport.

<u>Short-Term Objectives</u>

- Complete a study of the sector energy demand and consumption:
    - Identify the data gaps, and then formulate and implement solutions for closing the gaps and setting realistic targets; and
    - Investigate the potential exploitability of various options for improving the sector.

Mid-Term Objectives

- Fuel economy transport
    - Develop and implement a programme to increase the average fuel economy of vehicles. This program could include periodic vehicle emission testing as a part of the vehicle registration process, a ban on the import of vehicles older than five years, or improved enforcement of road traffic and safety legislation;
    - Improve the quality of diesel oils imported for local consumption to reduce particulate emissions in order to improve air quality in urban centers; and

- Develop and implement a national strategy for integrated traffic and transportation system management.


The Commonwealth Of The Bahamas

Annex 4

COMMONWEALTH OF THE BAHAMAS

Human Rights 75 High-Level Climate and Environment Roundtable

The Future of Human Rights, the Environment and Climate: Advancing the right to a healthy environment, including a safe and stable climate for all.

Access to justice and accountability for environmental harm

Presented by

Senator The Honourable L. Ryan Pinder K.C.
Attorney General and Minister of Legal Affairs
on
Tuesday 12th December 2023
Geneva, Switzerland

Roundtable Question

What in your view can help those whose human rights have been violated as a result of environmental degradation, to access to remedy and reparation or compensation?

Response

I wish to address this question in three parts: firstly, the responsibility of affected States, secondly that of private industry and thirdly that of industrialized nations and the largest emitting countries.

The Bahamas is a small island developing state, but also a Big Ocean country, an archipelago of over 700 islands and cays. These characteristics result in significant exposure to the effects of climate change, causing a material threat to our people's basic human rights, including a right to a healthy environment; right to life; right to development; right to water, and right to self-determination. The Bahamas holds the philosophy that the polluter must pay for the adverse impact of their actions on the climate.

Vulnerable people do not have a means to pursue recourse for the breaches of their human rights and tangible losses incurred because of climate change. Climate Justice requires that vulnerable populations, who have historically contributed the least to the unfolding climate calamity and who are disproportionately affected, have access to justice and be compensated for their loss. **The governments of vulnerable countries are therefore obligated to make climate justice representations in support and protection of their populations.**

In The Bahamas, we have legislated in our Environmental Planning and Protection Act, the concept that the polluter must pay. An important component of this regime is the creation of the Environmental Administration Fund which ensures that fees and fines collected because of environmental crimes, will go to benefit communities impacted and build the country's capacity to respond to and prevent crimes in the future.

Private industry should be held liable for their continuous and direct contribution to the generation of greenhouse gasses that cause climate change and whose effects have directly and adversely affected countries like The Bahamas. Our tangible losses are enormous, impacted by rising sea levels and rising ocean temperatures.

We also **believe industrialized countries owe an obligation to vulnerable, non-emitting states for their contribution to the climate crisis.** The Bahamas supports the United Nations (UN) Resolution requesting an advisory opinion from the International Court of Justice (ICJ) on the obligations of States in respect of climate change. We view the Resolution as a significant milestone in our decades-long struggle for climate justice. The Bahamas will be submitting a written statement in support of the advisory opinion calling for differentiated responsibilities based on proportional contribution to global greenhouse gas emissions.

The fundamental basis of a sovereign's advocacy on the effects of climate change on its vulnerable population is that the benefits must accrue to the people. I mentioned the Environmental Administration Fund under our domestic law. We also believe obligations of private industry and polluting states should contribute to schemes for the direct benefit of those whose human rights have been violated.

The Bahamas is taking a proactive approach. The effects of the climate crisis have caused for catastrophic property insurance to either be unavailable or beyond the reach of many in The Bahamas. The Bahamas has therefore committed to develop an insurance product that will be funded from the aforementioned liabilities of private industry and industrialized states. We are therefore not only fighting to *achieve* climate justice but also working to ensure that its *reparations* accrue to the benefit of the most vulnerable.