INTERNATIONAL COURT OF JUSTICE

DISPUTE CONCERNING THE CONSTRUCTION OF A ROAD IN COSTA RICA ALONG THE SAN JUAN RIVER

NICARAGUA *v.* COSTA RICA

REJOINDER OF COSTA RICA

VOLUME I

2 FEBRUARY 2015

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Chapter 1

Introduction

Overview of the matters for response

1.1. In its Reply, Nicaragua has persisted in its attempt to portray the construction of the 1856 Road ("the Road") in Costa Rica´s sovereign territory as a misconceived mega-project, leading to an environmental catastrophe. Thus the Road is depicted as "a project of immense proportions",[1] by which "Costa Rica has laid waste to a vast stretch of the border area for no comprehensible reason",[2] "to the great detriment of Nicaragua and the environment".[3]

1.2. It is for Nicaragua, as Claimant, to make good these allegations of fact which are central to its claim and occupy the foreground of this dispute. By contrast, the issues that divide the Parties so far as concerns the applicable principles of international law on transboundary harm are relatively confined. The focus of this Rejoinder is thus largely on completing the evidence before the Court, and responding to the case on the facts as now put by Nicaragua.

1.3. As to that case, Costa Rica makes five introductory observations.

1.4. *First*, given that the Road is being constructed solely within Costa Rican territory, the central issue is whether any sediment reaching the San Juan River from the construction works has resulted in significant harm *to Nicaragua*. Despite Nicaragua's colourful references to large quantities of dump-trucks,[4] the

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1 NR, para. 1.5.

2 NR, para. 1.13.

3 NR, para. 1.12.

4 E.g. NR, para. 1.18.

answer to that question is in the negative because any such sediment is inevitably insignificant when compared to the sediment load that the River already carries. Nicaragua's experts have been unable to rebut this critical fact, which is further confirmed by the scientific evidence and data presented with this Rejoinder.

1.5. *Secondly*, while Nicaragua wishes to portray the construction of the Road as a mega-project, its own experts have focused on a length of approximately 41 km of road, of which just a few stretches form the pivot of Nicaragua's allegation of significant harm. These stretches appear again and again in the photographic and other evidence deployed by Nicaragua. They are in no sense illustrative of the Road as a whole. Nicaragua has been unable to make out a case to the contrary, and it has likewise been unable to make out a case that the construction works on even these limited stretches have caused anything approaching significant harm to its territory.

1.6. Indeed, with respect to the extreme nature of the claims that Nicaragua makes as to the scale of the construction works, and the harm engendered, it is recalled that the greater part of the Road is along terrain that is completely flat, and/or through land that has been farmed for decades generating no risk of additional sediment entering the River. Further, this is a narrow road, averaging less than 10 m in width, not a motorway or highway.

1.7. Costa Rica considers it very important that, in light of Nicaragua's claims (see e.g. paragraph 1.1 above), the Court has the best possible understanding of the real scale of the works on the Road, and of the alleged scope for harm to Nicaragua. To this end, in the letter accompanying this Rejoinder, Costa Rica has proposed that a delegation of the Court could take advantage of the postponement of the oral hearing (scheduled, until recently, for March 2015) to conduct a site visit. The Court could then see for itself whether this is indeed "a project of immense proportions", whether "Costa Rica has laid waste to a vast stretch of the border area",[5] and it will be better-placed to assess the allegations of significant environmental harm to Nicaragua.

1.8. *Thirdly*, in light of its failure to sustain the case it initially pleaded, in its Reply Nicaragua seeks to bring an entirely new case. It is now said that Costa Rica is to be held responsible for the pre-existing heavy sediment load in the San Juan River, with the alleged legal consequence that Costa Rica is not permitted to argue that the sediment from the Road is insignificant in comparison to the existing sediment load.[6] Thus, Costa Rica is somehow expected to respond in its Rejoinder to a case on the alleged impacts of deforestation and other land use activities over (i) a vast area and (ii) dating back to the 1940s. The obvious difficulty with this is that it seeks to transform the case on the Road to a far broader case to do with the causes of, and State responsibility for, long term sedimentation – a case that depends on different and extensive evidence, and which has not been brought or pleaded by Nicaragua with any sufficient particularity, albeit that at the same time it apparently seeks to call into question the long-established recognition of the San Juan, as well as other rivers of the region, as naturally sediment laden rivers.[7]

1.9. The current case is and remains the *Dispute concerning Construction of a Road in Costa Rica along the San Juan River*, not the Dispute concerning "alleged

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5 NR, paras. 1.5 and 1.13.

6 NR, paras. 1.25-1.29.

7 See Professor Colin Thorne: *Assessment of the Impact of the Construction of the Border Road in Costa Rica on the San Juan River: Reply Report*, February 2015, **Appendix A to Costa Rica's Rejoinder** (the ***2015 Thorne Report***), para. 4.140; see also **Vol. III, Annex 10**, Allan Astorga, *Extraordinary sediment inputs due to exceptional events on the San Juan River*, 2014 (the ***Astorga Report***), pp. 9-17.

massive and uncontrolled deforestation in Costa Rica", as Nicaragua now evidently wishes to re-cast it.[8] The causes of sedimentation in the San Juan River are many and complex and, as the Court is aware from the *Certain Activities* case, the high sediment load long pre-dates the deforestation that Nicaragua now wishes to bring to the fore. In fact, the high sediment load in the San Juan River is principally the result of the geology of the region, in particular the tectonic and volcanic activity in the area drained by the San Juan River and its tributaries.[9]

1.10. This is not, however, a matter for the Court to resolve in this case. The central question here is, and must remain, whether sedimentation from the construction of the Road has led to significant harm to Nicaragua, alongside whether alleged risks from the Road led to notification and EIA obligations on the part of Costa Rica with which it failed to comply. Nicaragua's belated attempt to change the tenor of its case merely serves to highlight its inability to make good its contentions on significant adverse impact on which its Application was founded.

1.11. *Fourthly*, in the Introduction to its Reply, Nicaragua seeks to weigh up and to reject Costa Rica's reasons for the construction of the Road, suggesting that Costa Rica should have responded differently or not at all to the acts of Nicaragua that precipitated construction.[10] Nicaragua's central point here is to contend that it did nothing to cause a perception of emergency on the part of Costa Rica.

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8 NR, para. 1.28.

9 **Appendix A**, 2015 Thorne Report, para. 4.140. Moreover, Nicaragua obscures the fact that its own territory contributes in great proportion to the sediment load of the San Juan River see the photographs in Figure 4.26 of the Thorne Report, reproduced for the Court's convenience in Chapter 2 below.

10 NR, paras. 1.7-1.12.

1.12. That, of course, is not accepted, and the Court now has the facts and competing positions of the Parties before it. Costa Rica's response was in no sense one of "states' taking matters into their own hands after bringing the relevant dispute [i.e. the *Certain Activities* case] before [the Court]":[11] the Road does not extend to, let alone enter, the area under dispute in the *Certain Activities* case.[12] The central point is that, in constructing the Road (solely within its territory), Costa Rica was responding to acts perceived in good faith as demonstrating a risk of further violations by Nicaragua of Costa Rica's sovereignty and territorial integrity, assessing that there was an emergency justifying urgent infrastructure works to improve access to its border areas.

1.13. *Finally*, it is noted that Nicaragua – despite its sovereignty over the waters of the San Juan River and despite the ample time available – has chosen not carry out direct flow and sediment measurement on the River (or at least not to provide these in these proceedings). Such data would evidently have been of value, whether in terms of supporting Nicaragua's contentions on a harmful increase in sediment load, or in showing those contentions to be untenable, as Costa Rica considers them to be. This omission is all the more striking given that Nicaragua has prevented attempts made by Costa Rica to carry out such measurements, whether alone or jointly with Nicaragua[13].

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11 NR, para. 1.10.

12 Curiously, this is a point that is also taken against Costa Rica: cf. NR, para. 1.9, where it is said that "the ostensible connection between events at and around what Costa Rica calls Isla Portillos and the new road are amply disproved by the fact that the road stops well short of that area". The argument appears to be that if State A invades or is perceived as invading State B at point X (which had not previously been in dispute), State B has no basis for considering that its territorial integrity is at risk other than specifically at point X.

13 See Chapter 2, paras. 2.28-2.33.

1.14. While not bearing the burden of the proof, Costa Rica has sought to provide scientifically reliable estimates of water flows and sediment loads of the San Juan River, as well as other evidence, which demonstrate that no significant harm has been, or risks being, caused to the river by the Road. The evidence that Nicaragua has submitted in its Reply has focused on attempting to cast doubt (unsuccessfully) on Costa Rica's scientific reports, but surprisingly it has not provided the basic measurements that would be expected to be the central plank of its case on the facts.

The Structure of this Rejoinder

1.15. This Rejoinder is filed in accordance with the Court's Order of 3 February 2014 setting the date for submission of Costa Rica's Rejoinder as 2 February 2015.

1.16. The issues are presented as follows.

1.17. In Chapter 2, Costa Rica responds to the evidence on alleged significant harm that has been submitted by Nicaragua with its Reply. It is shown that Nicaragua greatly overestimates the amount of sediment that has come from construction of the Road, but is anyway unable to make out a case that even its own estimated quantities of sediment have caused, or have risked causing, significant harm to the San Juan River (as to which, as noted above, no flow or sediment measurements have been provided). Indeed, it is unable to show any discernible impact to the pre-existing sediment load or bed load of the River. It is likewise unable to show any other environmental or otherwise adverse impact or risk of significant harm to Nicaragua.

1.18. In Chapter 3, Costa Rica considers the residual legal issues, including Nicaragua's case that there has been an infringement of its territorial integrity in breach of the 1858 Treaty of Limits. As Chapter 3 further explains, that Treaty has no application on the alleged facts of the present case (by contrast, it is of critical importance in the *Certain Activities* case). Costa Rica also responds on the outstanding issues on the threshold and requirements for Environmental Impact Assessment (EIA) and notification, and on Nicaragua's contentions on breach of the Convention on Biological Diversity and other treaties said to apply on the facts.[14] It is shown that no obligation under any of these treaties has been breached.

1.19. In Chapter 4, Costa Rica makes brief further submissions on the remedies sought by Nicaragua. This Rejoinder concludes with a brief summary and Costa Rica's submissions.

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14 Namely, the Ramsar Convention, the Central American Convention for the Protection of the Environment and other regional instruments, as well as the bilateral "SI-A-PAZ" agreement. See NR, Chapter 6, Section F; cf. CRCM, Chapter 5, Section E.

Chapter 2

The Absence of Adverse Impact of the Road on the San Juan River

A. Nicaragua's Case

2.1. In these proceedings, Nicaragua claims that, as a result of the construction of the road in Costa Rica, "large amounts of sediment are eroding into the River in amounts sufficient to cause significant environmental harm."[15] It argues that "Costa Rica has caused, and is continuing to cause, significant harm to Nicaragua's San Juan River and its natural environment."[16] It further argues that Costa Rica's construction of the road "has placed Nicaragua at grave risk of continued harm, and nothing Costa Rica has done has mitigated this risk."[17] It requests the Court to declare that Costa has breached its "obligation not to damage Nicaraguan territory" and its "obligations under general international law and the relevant environmental conventions".[18]

2.2. Nicaragua's claims of significant harm rest on its case that the Road is contributing sediment to the River in quantities which cause harm. In its Memorial, Nicaragua claimed that the volumes of sediment had a negative impact upon (a) water quality; (b) morphology of the River; (c) navigation; and (d) the ecosystem (including aquatic life and fishing), tourism and health.[19] Nicaragua

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15 NR, para. 2.1. See also NM, paras. 3.3, 3.60 and 5.58.

16 NR, para. 2.137.

17 NR, para 3.59.

18 NR, Submissions, paras. 1(ii) and (iii).

19 NM, para. 3.81.

did not however produce any evidence with its Memorial as to the existing sediment load of the San Juan River. It merely asserted that the contribution of additional sediment – which it estimates based on the opinion expressed by Dr Kondolf (opinion in turn based on his visual observations of the Road from the River and from the air) – had an adverse impact on the River.

2.3. In its Counter-Memorial, Costa Rica produced evidence demonstrating that the Road was not contributing sediment to the River in quantities which cause or could cause harm. This evidence consisted of comprehensive scientific and technical reports relating to the impact of the Road on the San Juan River, which squarely addressed the question whether the Road is contributing sediment to the River, and if so, how much sediment, and they also considered the relative impact of this sediment in the context of the existing sediment load of the River.[20] These reports were assessed in the independent expert report of Professor Colin Thorne.[21]

2.4. In its Reply, Nicaragua submitted several reports responding to Costa Rica's evidence concerning the absence of adverse impact on the River. These are:

(a) Dr G. Mathias Kondolf, "Erosion and Sediment Delivery to the Rio San Juan from Route 1856", July 2014, Annex 1 to Nicaragua's Reply (the ***2014 Kondolf Report***);

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20 See CRCM, Chapter 3.

21 See Professor Thorne, *Assessment of the Impact of the Construction of the Border Road in Costa Rica on the San Juan River*, November 2013, **Appendix A** to Costa Rica's Counter-Memorial (the ***2013 Thorne Report***).

(b) Mr Danny Hagans and Dr Bill Weaver, "Evaluation of Eorsion, Environmental Impacts and Road Repair Efforts at Selected Sites along Juan Rafael Mora Route 1856 in Costa Rica, Adjacent the Rio San Juan, Nicaragua", July 2014, Annex 2 to Nicaragua's Reply (the ***Hagans and Weaver Report***);

(c) Dr Edmund D. Andrews, "An Evaluation of the Methods, Calculations, and Conclusions Provided by Costa Rica Regarding the Yield and Transport of Sediment in the Rio San Juan Basin", July 2014, Annex 3 to Nicaragua's Reply (the ***Andrews Report***);

(d) Dr Blanca Ríos Touma, "Ecological Impacts of the Route 1856 on the San Juan River, Nicaragua", July 2014, Annex 4 to Nicaragua's Reply (the ***2014 Ríos Report***); and

(e) Golder Associates Inc., "The Requirements of Impact Assessment for Large-Scale Road Construction Project in Costa Rica Along the San Juan River, Nicaragua", July 2014, Annex 6 to Nicaragua's Report (the ***Golder Report***).

2.5. There are four preliminary points to be made by reference to this evidence and Nicaragua's case on harm as it has developed in its Reply.

2.6. First, as explained in Chapter 1 above, Nicaragua has attempted to distract the Court from the central issue of whether sediment reaching the San Juan River from the works has resulted in significant adverse impact to Nicaragua: it has sought to bring a new case, raising allegations that Costa Rica has contributed to the very heavy sediment load in the San Juan River over a 50-60 year period that predates the construction of the Road, and thereby radically altering the scope of the dispute before the Court. Insofar as Costa Rica's experts have been able to deal with this matter in the time available, they simply do not agree with the late allegations made by Nicaragua.[22] However, this matter is not a focus in this Chapter because Costa Rica does not consider it to be properly within the scope of the dispute before the Court, which concerns the construction of a Road in Costa Rica.

2.7. Secondly, Nicaragua has persisted in its misplaced emphasis on the question whether the Road was constructed with strict adherence to engineering standards. It asserts that Costa Rica has "violated 'the most basic, well accepted road engineering and road maintenance principles normally applied during road construction'"[23] and that Costa Rica has "disregarded the simple but critical principle that a highway construction project must be planned and designed"[24] as though these "principles" reflect international law obligations binding on Costa Rica. They do not.

2.8. Nicaragua nonetheless persists in its references to a May 2012 report of the National Laboratory of the University of Costa Rica (in its Spanish acronym, ***LANAMME***)[25] and a June 2012 report of the Costa Rican Federated Association of Engineers and Architects (the ***CFIA***),[26] which, as Costa Rica explained in its Counter-Memorial, do not evidence that environmental harm has or will be caused

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22 See, e.g, **Appendix A**, 2015 Thorne Report, paras. 4.120-4.141.

23 NR, para. 3.2. See also paras. 3.3-3.15.

24 NR, para. 3.4.

25 **NM, Annex 3,** National Laboratory of Materials and Structural Models of the University of Costa Rica, "Report INF-PITRA-014-12: Report from Inspection of Route 1856 - Juan Rafael Mora Porras Border Road," May 2012.

26 **NM, Annex 4**, Federated Association of Engineers and Architects of Costa Rica, "Report on Inspection of the on the Border Road, Northern Area Parallel to the San Juan River CFIA Report", 8 June 2012.

to the San Juan River.[27] As Costa Rica explained in Chapter 2 of its Counter-Memorial, the Road was constructed under emergency circumstances. Since April 2012, Costa Rica has been carrying out work to protect the Road and to mitigate the effects of the Road, primarily in Costa Rican territory. That work has been effective, it is continuing, and Costa Rica is committed to completing the Road to the highest environmental and engineering standards. Whether or not the Road was initially constructed to such standards is beside the point: Nicaragua's claim is that Costa Rica has breached its international obligations because the Road is causing environmental harm to Nicaragua's territory. For that claim, Nicaragua bears the burden of proof to show environmental harm. In the absence of any evidence of adverse impact to the River, it has failed to discharge that burden.

2.9. Thirdly, Nicaragua seeks to portray the Road in the worst possible light by reference to a very few limited stretches, which appear repeatedly in the photographs submitted with Nicaragua's Reply and its technical reports, and which are relied upon in support of Nicaragua's claim of adverse impact by reference to thousands of dumper trucks. Before one considers the detail of the expert evidence, it is necessary to step back and consider the scale of what is under discussion here. The part of the Road which Nicaragua considers to be problematic is not 108 km, but in fact a small number of stretches where remediation works are now complete or underway (and have been completed and/or advanced in the time since Nicaragua submitted its Reply). When Nicaragua's claims are considered in their context, even on their inflated figures

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27 Both LANAMME and CFIA have confirmed that their reports do not address the impacts of the Road on the San Juan River. They furthermore indicate that their reports have been misrepresented by Nicaragua: see **CRCM**, **Annex 63**, Letter from the President of the CFIA to the Minister of Foreign Affairs of Costa Rica, Reference 034-2012-2013-PRES, 28 August 2013; and **CRCM**, **Annex 61**, Letter from LANAMME to the Minister of Foreign Affairs of Costa Rica, Reference LM-IC-0914-2013, 14 August 2013.

of sediment eroded from the Road to the River, what is in dispute is the addition of sediment in the range of a very small – even imperceptible – increase in the sediment load of a River which is naturally adapted to a sediment load that is "very heavy".[28] Nicaragua implicitly accepts that the impact of the Road is very small, as is demonstrated by its belated attempt to depict the existing sediment load as "excessive" and unnatural, and that the existing sediment load is the responsibility of Costa Rica.[29] Ultimately, the issue for the Court to decide is whether the Road – which in large part is a track built on existing paths – is having a significant impact on the San Juan River.

2.10. This leads to a fourth preliminary point. Even accepting the estimates of sediment eroding from the Road to the River put forward by Nicaragua's experts in 2013 (which Costa Rica does not), this sediment would represent only 1% to 2% of the total annual sediment load of the River.[30] A contribution of sediment in this proportion is obviously too small to have any adverse impact on the River, either in respect of water quality or aggradation of the bed. The new estimates of sediment eroding from the Road put forward with Nicaragua's Reply would indicate an addition of less than 3% to the total annual sediment load of the

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28 *Navigational Rights*, NCM, para 1.1.8: "The sediment load that the San Juan River receives from rivers originating in Costa Rica is very heavy. Thus, the sediment load immediately downstream from the Sarapiqui River, measured at the beginning of the seventies, was 10.2 million metric tons per year" (footnote omitted).

29 NR, paras. 2.75-2.79.

30 See CRCM, para. 3.33. As the Court noted in its Order of 13 December 2013 rejecting Nicaragua's Request for Provisional Measures in this case, a contribution of sediment in the order of 1 to 2 per cent of the total sediment load in the San Juan River "seems too small a proportion to have a significant impact on the river in the immediate future": see *Construction of a Road in Costa Rica Along the San Juan River (Nicaragua v Costa Rica), Request presented by Nicaragua for the Indication of Provisional Measures, Order*, 13 December 2013, para. 34.

River.[31] On this basis, while there remain a number of issues in dispute between the Parties' experts in terms of the extent of any impact of the Road, ultimately these disputes are immaterial, because *even on Nicaragua's own estimates, the Road is having no adverse impact on the River*.

2.11. In response to the reports submitted with Nicaragua's Reply, Costa Rica has produced a series of further expert reports with its Rejoinder. It has done so because it wishes to meet Nicaragua's case head on and because it takes protection of the environment very seriously. It is nonetheless reiterated that Nicaragua is seeking to magnify insignificant impact, portraying very limited stretches of the Road as if they were typical of the entirety of its length. To respond to Nicaragua's Reply, Costa Rica submits evidence which is assimilated and assessed in a further report prepared by Professor Colin Thorne: *Assessment of the Impact of the Construction of the Border Road in Costa Rica on the San Juan River: Reply Report*, February 2015, **Appendix A to this Rejoinder** (the ***2015 Thorne Report***). The 2015 Thorne Report is supported by a number of reports addressing specific issues, which include the following:

(a) issues of sediment contribution to and transport on the River: Costa Rican Institute of Electricity (ICE), SBU Projects and Associated Services, Centre for Basic Engineering Studies, Department of Hydrology, *Second Report on Hydrology and Sediments for the Costa Rican River Basins draining to the San Juan River,* December 2014 (the ***2014 ICE Report***) (**Annex 5**); University of Costa Rica Centre for Research in Sustainable Development, Department of Civil Engineering, *Second Report on Systematic Field monitoring of Erosion and Sediment Yield along Route*

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31 **Appendix A**, 2015 Thorne Report, para. 8.9.

1856, November 2014 (the ***2014 UCR Report***) (**Annex 4**); and Andreas Mende, *Inventory of Slopes and Water Courses related to the Border Road No 1856 between Mojón II and Delta Costa Rica: Second Report*, December 2014 (the ***2014 Mende Report***) (**Annex 3**);

(b) issues of the potential impact of extreme weather and other exceptional events: Juan Carlos Fallas Sojo, *Comments on the Report by Dr Kondolf as it pertains to Hurricanes and Tropical Storms*, 2014 (the ***Fallas Report***) (**Annex 9**); and Allan Astorga, *Extraordinary sediment inputs due to exceptional events on the San Juan River*, 2014 (the ***Astorga Report***) (**Annex 10**);

(c) issues of potential ecological impacts: Professor Ian Cowx, *Independent Expert Report concerning Evidence of Impacts on the Aquatic Ecology of the San Juan River, Nicaragua due to construction of Route 1856 in Costa Rica*, 2014 (the ***Cowx Report***) (**Annex 2**); Arturo Angulo, Fish Fauna in the San Juan River, 2014 (the ***Angulo Report***) (**Annex 7**); Bernald Pacheco, *Answers and Study Analysis, "Ecological Impacts of the Route 1856 on the San Juan River, Nicaragua", by Dr Rios Touma 2014*, 2014 (the ***Pacheco Report***) (**Annex 6**); PE Gutierrez, *Critical statistical analysis of the report "Ecological Impacts of the Route 1856 on the San Juan River, Nicaragua" by Blanca Ríos Touma*, 2014 (the ***Gutierrez Report***) (**Annex 8**); and Centro Científico Tropical (CCT) *Follow-up and Monitoring Study Route 1856 Project- EDA Ecological Component*, January 2015 (the ***2015 CCT Report***) (**Annex 14**).

(d) Costa Rica's completed and ongoing remediation works: CODEFORSA, *Consulting Services for the Development and Implementation of an*

Environmental Plan for the Juan Rafael Mora Porras Border Road, 2014 (the ***2014 CODEFORSA Report***) (**Annex 13**); CODEFORSA, *Restoration and rehabilitation of ecosystems affected by the construction of the Juan Rafael Mora Porras border road, Ruta 1856,* November 2014 (the ***CODEFORSA Quarterly Report for November 2014***) (**Annex 12**); and CONAVI, *Works on National Road N° 856: Before and After - Updated as of December 2014*, December 2014 (the ***2014 CONAVI Report***) (**Annex 11**).

2.12. Nicaragua's case rests entirely on the hypothesis that the Road is contributing massive and harmful quantities of additional sediment to the River. The true picture as to sedimentation is set out in **Section B** below. Each of the specific allegations as to adverse impact is addressed in **Section C** below. Nicaragua's misplaced reliance on the "Judgment" of the Central American Court of Justice is discussed in **Section D** and conclusions are set out in **Section E**.

B. The Contribution of Sediment from the Road to the River in its Context

2.13. As explained above, Nicaragua's allegations of adverse impact are based on the contribution of sediment from the Road to the River. To assess these allegations it is necessary first to consider the existing sediment load of the River, in order to establish the baseline from which any impact of additional sediment may be measured.

2.14. In its Reply, Nicaragua persists in its claim that sediment is a pollutant.[32] As Costa Rica explained in its Counter-Memorial, the contribution of sediment to

[32] See, eg, NR, paras. 2.75-2.76.

a river such as the San Juan is a natural process, and one which is essential to the life of the River. This process is commonly regarded as beneficial.[33] Sediment could only be regarded as a pollutant if its concentration is elevated compared to the natural sediment load carried by the River. Sediment concentrations in the San Juan River are high and highly variable, as Nicaragua accepts.[34] As Professors Thorne and Astorga explain, this is because the basin experiences extraordinary sediment yields associated with earthquakes and volcanic eruptions that are a natural consequence of its geology.[35] In this context, sediment cannot be regarded as a pollutant.

(1) Impact of the Road on the sediment load of the San Juan River: before and after construction of the Road

(i) Establishing the baseline

2.15. In order to assess the baseline of the sediment load of the San Juan River prior to the construction of Route 1856, Costa Rica's experts initially referred to the existing records, such as they are. In its Counter-Memorial, Costa Rica's experts had recourse to the only records that exist for the pre-construction period, which date from 1974-1976. The measurements of Suspended Sediment Concentration in the San Juan made during this period were recorded jointly by the two parties, and were relied upon by Nicaragua in the *Navigational Rights* case to assert that the sediment load of the San Juan River is "very heavy".[36]

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33 See, eg, **CRCM**, **Annex 81**, GM Kondolf, "Hungry water: Effects of dams and gravel mining on river channels" 21(4) (1997) *Environmental Management* 533.

34 NR, para. 2.125.

35 **Appendix A**, 2015 Thorne Report, para. 4.140; see also **Vol. III**, **Annex 10**, Astorga Report, pp. 9-17.

36 *Navigational Rights*, NCM, para 1.1.8: "The sediment load that the San Juan River receives from rivers originating in Costa Rica is very heavy. Thus, the sediment load

These records were compared with estimates of the sediment load of the River after construction of the Road, done on the basis of the only measurements available to Costa Rica, which were taken from a sediment monitoring station on the Río Colorado at Delta Colorado, immediately downstream of Delta Costa Rica, where the San Juan River bifurcates into the Lower San Juan and the Río Colorado. As explained below, they are comparable to measurements taken on the San Juan River, which suggests that they may be used as an indication of the sediment load of the San Juan.

2.16. Nicaragua however criticises Costa Rica's reliance on the measurements of Suspended Sediment Concentration from 1974-1976, while omitting to mention that it has itself relied upon them before the Court.[37] Now, relying on the evidence of Dr Andrews (Nicaragua's expert), Nicaragua suggests that the samples used by Costa Rica are too few to draw any meaningful conclusions.[38] Leaving to one side that Nicaragua already relied upon these precise measurements to make representations to the Court concerning the sediment load of the San Juan River, and while acknowledging that limited records are available (and no additional records have been provided by Nicaragua, which is sovereign over the San Juan), the fact remains that in 1974-1976, 12 measurements were made using the best field methods then available and it is undeniable that these measurements provide some indication of the suspended sediment load transported by the San Juan River during that period.[39]

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immediately downstream from the Sarapiqui River, measured at the beginning of the seventies, was 10.2 million metric tons per year [footnote omitted]".

37 *Navigational Rights*, NCM, para 1.1.8.

38 NR, para. 2.124, referring to NR, Annex 3, Andrews Report, Section V(C).

39 **Appendix A**, 2015 Thorne Report, para. 4.142.

2.17. In its Reply, Nicaragua also contends that the measurements used by Costa Rica "cannot support its conclusions because river flows and suspended sediment loads vary considerably from year to year."[40] As Costa Rica's experts explain, the sediment load in a River such as the San Juan, which drains a tectonically active basin with live volcanoes, does indeed vary widely from year to year, not only because of varying rainfall and runoff, but also because of extraordinary quantities of sediment supplied by natural events such as landslides triggered by earthquakes.[41] In order to account for this natural variability, in 2014 Costa Rica's experts conducted a thorough analysis of records of the sediment loads measured at Costa Rican hydrometric gauging stations within the San Juan basin, including taking account of uncertainties in the time series. That analysis resulted in an estimate of the Suspended Sediment Concentrations of the San Juan of approximately 12.7 million tonnes per annum.[42] This is actually lower than the approximation now put forward by Nicaragua's expert, Dr Andrews, of about 13.7 million tonnes per annum.[43] It is therefore apparent that the difference between the approximation made by Nicaragua and the estimate given by Costa Rica's experts is *de minimis*. However, adopting Costa Rica's estimate (which is lower) is conservative, because the relative contribution of sediment from the Road will necessarily be higher if the baseline sediment load against which it is compared is lower. Again, as explained in paragraph 2.10 above, because even on Nicaragua's own inflated figures of the Road-derived sediment that contribution is

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40 NR, para 2.125, referring to NR, Annex 3, Andrews Report, Sections V(D) and V(E).

41 See **Appendix A**, 2015 Thorne Report, para. 4.140; and **Vol. III, Annex 10**, Astorga Report, pp. 9-17.

42 **Appendix A**, 2015 Thorne Report, para. 4.77; and **Vol. III, Annex 5**, 2015 ICE Report, pp. 15-19.

43 NR, Annex 3, Andrews Report, p. 27.

imperceptible, these differences between the two Parties' experts are immaterial to the question of adverse impact.

2.18. The estimate of the average annual suspended sediment load of the San Juan in 1974-1976 is approximately 8 million tonnes per annum, which falls within the confidence band (accounting for uncertainty) set out in the evidence submitted with Costa Rica's Counter-Memorial.[44]

(ii) Establishing the sediment load post-construction of the Road

2.19. This estimate of the baseline sediment load of the River is then compared to the sediment load of the River after the Road was constructed. As explained in paragraph 2.15 above, the post-Road sediment load of the River was estimated on the basis of records taken from a sediment monitoring station on the Río Colorado at Delta Colorado, in Costa Rica, a few hundred metres from the San Juan. In its Reply, Nicaragua criticises Costa Rica's use of these measurements on the basis that they "cannot be easily compared" with measurements on the San Juan.[45] It was of course necessary for Costa Rica to use these measurements of the sediment load on the Río Colorado because Nicaragua did not agree to carry out joint measurements on the San Juan, as Costa Rica proposed, and because Nicaragua has chosen not to carry out any such measurements itself during the three years since it commenced this case. This omission is to be noted.

2.20. In any event, as explained in Costa Rica's Counter-Memorial, the measurements taken at Delta Colorado are comparable to those taken on the San Juan River at La Trinidad (in 1974-1976), because about 90% of the flow and sediment that passes through La Trinidad also passes through Delta Colorado.

44 **Appendix A**, 2015 Thorne Report, see Table 4.13 and para. 4.143.

45 NR, para. 2.126.

Nicaragua contends that the assumption that the sediment data from the Colorado River represents 91% of the sediment of the San Juan is not appropriate, because it is based on a comparison of records collected at one gauge over a two-year period with records collected at another gauge over another two-year period.[46] As Professor Thorne explains, "[t]he division of flows at the Delta *could* be determined with confidence if Nicaragua or its experts measured and made known the discharge of the lower Río San Juan."[47] As Nicaragua has not done so, the only basis on which Costa Rica's experts are able to estimate the division of flows is on basis of the available records, while taking due account for uncertainty.

2.21. Further, while Costa Rica maintains that its estimate of the division of sediment into the Lower San Juan and the Colorado River is reliable, in order to account for any variance in this flow, in the 2014 ICE Report calculations of the sediment loads of the San Juan and the Lower San Juan were performed assuming that 85%, 90% and 95% of the sediment load of the San Juan flows to the Colorado and 15%, 10% and 5% to the Lower San Juan, respectively.[48] As will be seen below, on any of these assumptions, any contribution of sediment from the Road to the River is having no adverse impact on the Lower San Juan, let alone causing any significant harm.

2.22. Nicaragua makes three further criticisms of Costa Rica's estimate of the post-Road sediment load of the San Juan. First, it alleges that the samples were collected improperly,[49] or may have been collected improperly.[50] These

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46 NR, para. 2.126.

47 **Appendix A**, 2015 Thorne Report, para. 4.75.

48 **Appendix A**, 2015 Thorne Report, para. 4.76.

49 NR, para. 2.127.

50 NR, para. 2.129.

allegations are unsupported. In the 2014 ICE Report, Costa Rica's experts explain that suspended sediment measurements were made at their hydrometric station on the Colorado River in the same way as at all their other hydrometric stations, and that the approaches used to measure and calculate annual suspended sediment load used generally in Costa Rica are consistent with internationally recognised approaches.[51]

2.23. Secondly, Nicaragua contends that the conclusions set out in Costa Rica's Counter-Memorial are based on "a flawed statistical analysis", causing the suspended sediment measurements before the construction of the Road to appear identical to the measurements of suspended sediment after the construction of the Road.[52] In the reports that accompanied its Counter Memorial, Costa Rica's experts used simple, linear regression to compare suspended sediment concentration records for 1974-1976 and 2011-2013. This approach was selected recognising that application of advanced mathematical transformation or manipulation of the data cannot be justified due to the limited numbers of samples. It was also entirely appropriate for the purposes of comparing the pre- and post-Road measurements of the River.[53]

2.24. As an alternative to this comparison, Dr Andrews suggests fitting linear regression lines to the data that do not pass through the origin.[54] As Professor Thorne points out in his 2015 Report,[55] this is flawed because the regression lines fitted by Dr Andrews suggest that either the San Juan River could carry a small

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[51] **Vol. III, Annex 5**, 2014 ICE Report, pp. 8-9.

[52] NR, para. 2.130.

[53] **Appendix A**, 2015 Thorne Report, paras. 4.142-4.147.

[54] NR, Annex 3, Andrews Report, p. 33.

[55] **Appendix A**, 2015 Thorne Report, paras. 4.142-4.147.

but finite suspended sediment load even if it there were no flow whatsoever, or that the sediment load reduces to zero at low discharges, both of which are impossible.

2.25. Finally, Nicaragua seeks to challenge Costa Rica's estimate of the bed load. This estimate is necessary in order to evaluate Nicaragua's claim that coarse sediment added to the sediment load of the River (which would be transported as bed load) has resulted in aggradation in the lower San Juan River. As no measurements of bed load are available (and none were presented by Nicaragua), it was necessary for Costa Rica's experts to estimate the bed load using a bed load transport equation.

2.26. Nicaragua challenges Costa Rica's calculation of the bed load on the basis that Costa Rica's assumptions as to the slope of the River were incorrect. In simple terms, the steeper the slope, the higher the bed load will be. Dr Kondolf criticizes the slope figures given in Table 1 of the 2013 Thorne Report as being overstated.[56] As Professor Thorne explains in his 2014 Report, this criticism arises from a mis-labelling of the column headings in Table 1 of his 2013 Report, which are expressed in degrees. This minor error had no impact on the calculations made by ICE in estimating the bed load component of the total load of the San Juan River.[57]

2.27. In order to provide as robust bed load estimates as possible (in the time available), ICE has improved the bed load calculations using the "Engelund-Hansen approach", which was recommended by Dr Andrews as an alternative to

[56] **NR, Annex 1**, 2014 Kondolf Report, p. 67; see also NR, paras. 2.132-2.135.

[57] **Appendix A**, 2015 Thorne Report, para. 4.46.

the "Einstein bed load equation", used by ICE in 2013.[58] ICE also improved the way they accounted for uncertainty in the calculation of the bed load, thereby providing a more robust estimate.[59] The best estimate of the annual bed load of the San Juan derived using these calculations is 3,600,000 tonnes per year, but uncertainty in the application of bed load equations in the absence of measured data is notoriously high. Here, uncertainty also derives from the fact that the precise division of flow at the Delta is unknown. Consideration of these uncertainties means that the confidence band on the estimated bed load is very wide. This uncertainty could have been substantially reduced had Nicaragua agreed to a programme of jointly supervised measurements in the San Juan River, as Costa Rica requested.

(iii) Nicaragua's refusal to participate in a joint measurement exercise

2.28. It may be helpful at this point to recall that Nicaragua is both the claimant in this case, and as such bears the burden of proof to show significant harm, and sovereign over the San Juan River. As such, it was in a position to carry out measurements of the flow and sediment load of the San Juan (and the Lower San Juan), to provide evidence of its claim of adverse impact. It has failed to do so and also obstructed Costa Rica's efforts to carry out a joint measurement programme on the River. In the absence of both measured data and Nicaragua's agreement to measure data, Costa Rica has used the methods and data at its disposal to estimate the flow and sediment on the San Juan and the Lower San Juan, based on direct measurements of the main Costa Rican tributaries to the San Juan River, as well as the Colorado River.

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58 **Appendix A**, 2015 Thorne Report, paras. 4.50-4.51; cf. NR, Annex 3, Andrews Report, p. 27.

59 **Appendix A**, 2015 Thorne Report, paras. 4.50-4.51.

2.29. Two years ago, Costa Rica requested Nicaragua's agreement "to take discharge measurements and collect water samples from the San Juan River on a monthly basis, to establish its chemical quality and to measure the sediment load that the River carries".[60] A month later Nicaragua responded, suggesting that it would be willing to take joint measurements, provided Costa Rica suspended all Road construction works.[61] Given this unacceptable condition, Costa Rica proposed through the Court a joint monitoring programme.[62] Following a lengthy exchange of notes,[63] which caused inordinate delay, and in view of the impending deadline for submission of Costa Rica's Counter-Memorial, in September 2013 Costa Rica indicated that it would no longer pursue a joint programme, but instead would encourage Nicaragua to carry out measurements on the River itself.[64] In its Reply, Nicaragua did not present any evidence of such measurements.

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60 **CRCM, Annex 46**, Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-063-13, 6 February 2013.

61 **CRCM, Annex 48**, Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Costa Rica, Reference MRE/DM-AJ/129/03/13, 5 March 2013.

62 **CRCM, Annex 49**, Letter from the Co-Agent of Costa Rica to the Registrar of the International Court of Justice, Reference ECRPB-013-2013, 7 March 2013.

63 **CRCM, Annex 54**, Letter from the Agent of Nicaragua to the Registrar of the International Court of Justice, Reference HOL-EMB-108, 14 June 2013; **CRCM, Annex 55**, Letter from the Co-Agent of Costa Rica to the Registrar of the International Court of Justice, Reference ECRPB-036-13, 24 June 2013; **CRCM, Annex 59**, Letter from the Co-Agent of Costa Rica to the Registrar of the International Court of Justice, Reference ECRPB-052-13, 7 August 2013; **CRCM, Annex 64**, Letter from the Agent of Nicaragua to the Registrar of the International Court of Justice, Reference HOL-EMB-167, 30 August 2013; and **CRCM, Annex 65**, Letter from the Co-Agent of Costa Rica to the Registrar of the International Court of Justice, Reference ECRPB-63-2013, 27 September 2013.

64 **CRCM, Annex 65**, Letter from the Co-Agent of Costa Rica to the Registrar of the International Court of Justice, Reference ECRPB-63-2013, 27 September 2013.

2.30. During the course of the preparation of Costa Rica's Rejoinder, a new opportunity was presented to Nicaragua and Costa Rica to carry out direct measurements of the San Juan and Colorado Rivers. In accordance with the Court's Order of Provisional Measures of 22 November 2013, and following a field visit carried out on 10-13 March 2014 by technicians appointed by Ramsar to inspect the new *caños* excavated by Nicaragua in the northern sector of Isla Portillos, in August 2014 the Ramsar Secretariat issued RAM Mission Report No 77. In its Report No 77, the Ramsar Secretary recorded that it was "necessary to implement and maintain a continuous record of the volumes of flow of Colorado River (upstream and after its bifurcation with the San Juan River)."[65]

2.31. Following this recommendation, on 21 October 2014 Costa Rica proposed to Nicaragua that both countries carry out joint measurements of the volume of flow of the San Juan and Colorado rivers at specified sites, being:

(a) on the San Juan River, 500 metres upriver before the bifurcation with the Colorado River;

(b) on the Colorado River, 500 metres downstream from said bifurcation; and

(c) on the lower San Juan, 500 metres downstream from the same bifurcation.

Costa Rica also proposed that the technical teams of both countries meet on 30 October 2014 in San José, in order to coordinate the corresponding technical aspects.[66]

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65 See **Vol. IV, Annex 78**, Report Ramsar Advisory Mission No. 77 Wetland of International Importance Caribe Noreste, Costa Rica, August 2014, p. 19.

66 **Vol. IV, Annex 40**, Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-0639-10-14, 21 October 2014.

2.32. Nicaragua then engaged in a course of conduct which appears to have been intended to obstruct the carrying out of such measurements. It suggested a different date and venue for the meeting, and suggested measurements be carried out in the area of the new *caños*.[67] Costa Rica replied, accepting that measurements be carried out in that area but insisting that the sites proposed by it be maintained, because in accordance with Ramsar's request it was necessary to measure the volume and flow of the San Juan before and after the Delta of the Colorado River.[68] Nicaragua rejected these sites,[69] and despite a further exchange of diplomatic notes[70] it proved impossible to reach an agreement.

2.33. In summary, Nicaragua has refused to present measurements of water volumes and sediment loads of the San Juan of its own, and when opportunities were presented to carry out joint measurements of the San Juan and Colorado Rivers which would have greatly benefited the Court in analysing Nicaragua's claims in this case, Nicaragua successfully managed to derail them.

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2.34. As noted in paragraph 2.18 above, based on the available measurements, Costa Rica's experts estimate the average annual suspended sediment load for

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67 **Vol. IV, Annex 41,** Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference MRE/DM/AJ/439/10/14, 27 October 2014.

68 **Vol. IV, Annex 42,** Note from the Acting Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-0672-14, 28 October 2014.

69 **Vol. IV, Annex 43**, Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference MRE/DM-AJ/448/11/14, 3 November 2014.

70 **Vol. IV, Annex 45**, Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-0697-14, 5 November 2014.

1974-1976 at approximately 8 million tonnes. Considering uncertainty in the measurements Costa Rica's experts derived the confidence interval on this estimate to be approximately 5.5 to 10.6 million tonnes[71]. Measurements from 2010-2013 yielded an estimate of average annual suspended sediment load for the San Juan of approximately 6.5 million tonnes, with a confidence interval of approximately 5.2 to 8 million tonnes.[72] This suggests that the suspended sediment load of the River in the period following construction of the Road was lower than that in 1974-76. As Professor Thorne concludes, if sediment from the Road had resulted in a significant increase in the suspended sediment load in the River, one would expect to see higher load and concentration figures after the Road was constructed, and this is not the case.[73]

(2) Estimates of sediment eroded from the Road to the River

2.35. As explained in Chapter 3 of Costa Rica's Counter-Memorial, in order to confirm whether the Road has had or is having an adverse impact on the San Juan River, it is necessary to consider the extent to which the Road is contributing sediment to the River. In its Memorial, Dr Kondolf made an estimate that erosion was lowering the surface of the Road at an average rate of 1 metre per year on 40-50% of its slopes, and on the basis that 40% of this sediment was delivered to the River, he estimated that between 145,290 and 182,030 tonnes of sediment were contributed from the Road to the River each year.[74]

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71 See **CRCM, Appendix A**, 2013 Thorne Report, para. 8.11, Table 11 and Figure 27.

72 See **CRCM, Appendix A**, 2013 Thorne Report, para. 8.10, Table 11 and Figure 27.

73 See **CRCM, Appendix A**, 2013 Thorne Report, para. 8.13 and **Appendix A**, 2015 Thorne Report, para. 4.147.

74 **NM, Annex 1**, 2012 Kondolf Report, p. 46; see also Third Kondolf Report, p. 2. It was assumed that a cubic metre of sediment has a mass of approximately 1.67 tonnes: see **CRCM, Appendix A**, 2013 Thorne Report, para. 8.54.

2.36. With its Reply, Nicaragua submitted a further report from Dr Kondolf, based on his visual observations of the Road from the River and the air, and on examination of satellite images.[75] Dr Kondolf increased his estimate of the sediment delivery (from 40% to 60%, 60% being the more conservative estimate adopted by Costa Rica's experts).[76] He also added an additional 9,960 to 19,920 m^3y^{-1} for sediment delivery from "access roads" to the Road, which he opines is delivered to the River annually.[77] On this basis, Dr Kondolf estimates that sediment delivered to the River to between 116,000 and 150,000 m^3y^{-1}, which converts to 177,020 and 250,500 tonnes per year.[78] This is a substantial increase on his initial estimate of 145,290 to 182,030 tonnes per year.

2.37. With its Counter-Memorial, Costa Rica's experts considered the contribution of sediment from the Road to the River based on the following approach:

(a) Based on field measurements, experts from the Department of Civil Engineering at the University of Costa Rica estimated land surface lowering rates for (i) sheet erosion of the road bed and slopes; (ii) landslides on cut slopes; (iii) gullies on cut slopes; (iv) gullies on fill slopes; and (v) rill erosion on cut slopes.[79] Based on the results of this

75 **NR, Annex 1**, 2014 Kondolf Report, p 59; see also NR, paras. 2.5-2.6.

76 **NR, Annex 1**, 2014 Kondolf Report, p. 61. Costa Rica's experts had assumed the more conservative estimate of 60% in the evidence submitted with Costa Rica's Counter-Memorial.

77 **NR, Annex 1**, 2014 Kondolf Report, p. 62.

78 *Ibid*.

79 **CRCM, Annex No 1**, University of Costa Rica Centre for Research in Sustainable Development, Department of Civil Engineering, *Report on Systematic Field monitoring of Erosion and Sediment Yield along Route 1856*, September 2013 (the ***2013 UCR Report***); **CRCM, Appendix A**, 2013 Thorne Report, para. 8.21.

monitoring, Professor Thorne concluded that Dr Kondolf's estimate of land surface lowering of 1 m per year was probably too high by a factor of five for the stretch of Road between Marker II and Río Infiernito. With respect to the entire 108 km of the Road, it was probably too high by a factor of ten.[80]

(b) Based on the field monitoring undertaken by UCR, and taking account of the length and steepness of the road bed, and the areas of cut slopes and fill slopes along the full length of the Road,[81] ICE calculated the estimated average annual erosion rate by volume to be 101,550 tonnes per year.[82] On the basis of a 60% delivery rate to the River,[83] ICE concluded that the average input of sediment from the Road to the San Juan was 60,800 tonnes per year.[84]

Thus the data analysed by Costa Rica's experts, including Professor Thorne, indicated that Dr Kondolf had over-estimated the sediment contribution from the Road to the River by a factor of 2.4 (taking Dr Kondolf's lower end of the range) to 3 (taking the upper end of Dr Kondolf's range).[85]

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80 **CRCM, Appendix A**, 2013 Thorne Report, para. 8.34.

81 These were examined and assessed in **CRCM, Annex 6**, Andreas Mende and Allan Astorga G., *Inventory of Slopes and Water Courses related to the Border Road No 1856 between Mojón II and Delta Costa Rica*, October 2013 (the ***2013 Inventory of Slopes and Water Courses***); and **CRCM, Annex 3**, Allan Astorga G. and Andreas Mende, *Route 1856: analysis of the change in land use based on satellite images before and after the construction of the border road*, August 2013 (the ***2013 Land Use Change Report***).

82 **CRCM, Appendix A**, 2013 Thorne Report, para. 8.44 and Table 13.

83 **CRCM, Appendix A**, 2013 Thorne Report, para. 8.45.

84 **CRCM, Appendix A**, 2013 Thorne Report, para. 8.45 and Table 14.

85 **CRCM, Appendix A**, 2013 Thorne Report, para. 8.54.

(i) UCR Report: estimates of erosion rates

2.38. In its Reply, Nicaragua criticises UCR's estimates of erosion rates on two grounds. First, Nicaragua suggests that the authors of the 2013 UCR Report "ignore[d] many of the sites where erosion is the most serious".[86] The nine sites examined in the 2013 UCR Report were within the uppermost 15 km of the Road and Nicaragua claims that the next 26 km of the Road "contains numerous sites with much more serious erosion than those studied in the 15 km upriver."[87]

2.39. Secondly, Nicaragua criticizes the estimate presented in the 2013 UCR Report for applying erosion rates measured at small features to larger features.[88] Nicaragua suggests that UCR ought to have made "actual measurements at an adequate number of genuinely representative sites" instead.[89]

2.40. In 2014, UCR added additional sites to its monitoring programme and made use of more sophisticated technology in order to confirm that its estimates made in 2013 were reliable. The additional sites included several of the sites identified by Dr Kondolf as the most severely eroding sites. Their measurements confirmed that the estimates made in 2013 were reliable – indeed, these additional sites are in fact lowering the land surface at rates which are either comparable to or lower than the rates estimated by UCR in 2013. These measurements therefore confirm that Dr Kondolf's higher estimates – made on the basis of photographs and observations of the Road from the River and the air – are overstated.

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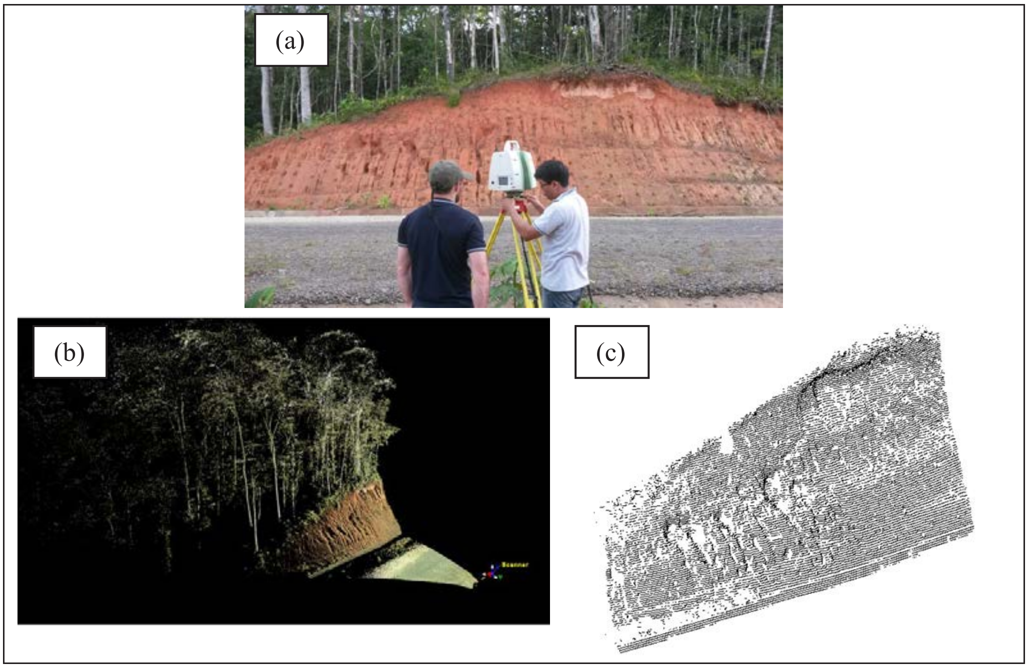
[86] NM, para 2.100.

[87] NM, para. 2.100, citing NR, Annex 1, 2014 Kondolf Report, Section 7 and Inventory of Severely Eroding Sites, Appendix A.

[88] NR, para 2.104, citing **NR, Annex 1**, 2014 Kondolf Report, Section 7.

[89] NR, para. 2.104.

2.41. In 2014, UCR used more advanced technology (terrestrial Light and Distance Range-finding – LiDAR, previously unavailable to the UCR team) to carry out measurements at their long-term monitoring sites, rather than making measurements manually.[90] UCR also used an aerial photogrammetric survey using an unmanned aerial vehicle to carry out measurements on sites which were previously inaccessible to the UCR team. This made it possible for UCR to measure an erosion rate for each erosion feature individually, rather than averaging it over the entire area of each monitored slope.[91] This use of this technology is explained in Figures 4.1 and 4.2 to the 2015 Thorne Report, reproduced below for convenience.



90 **Vol. III, Annex 4**, 2014 UCR Report, section 2.2; see also **Appendix A**, 2015 Thorne Report, para. 4.6.

91 **Vol. III, Annex 4**, 2014 UCR Report, section 2.2.

Figure 4.1 (a) Terrestrial LiDAR being set up at monitoring Site 4 on May 27, 2014 (b) LiDAR point cloud (c) contour data for use in erosion measurements and calculations.

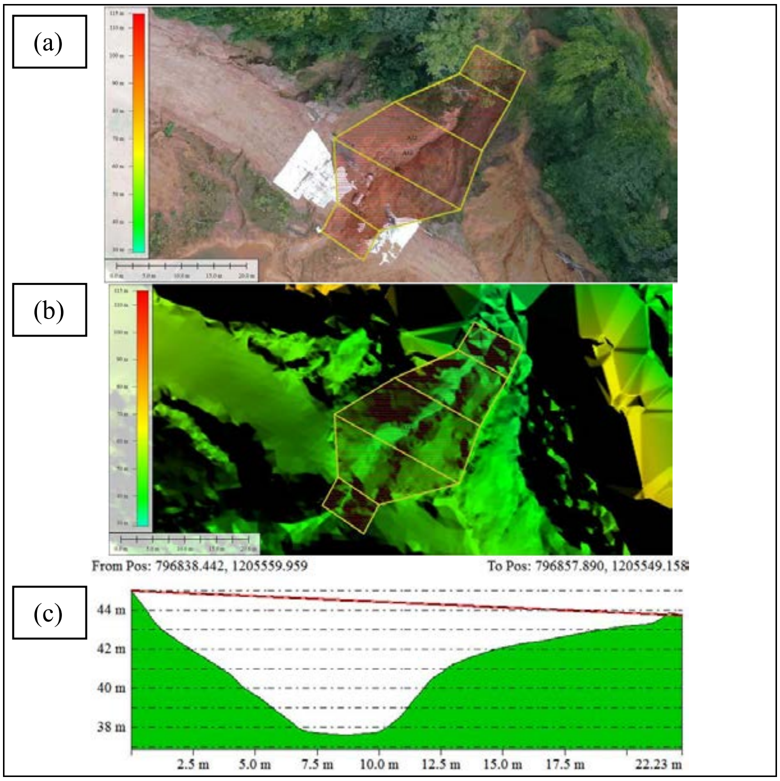


Figure 4.2 (a) Orthophoto, (b) Digital Elevation Model and (c) cross-section through gully at Site 12 (Dr Kondolf's site 9.4) derived from photogrammetric survey on October 28, 2014 and used to estimate gully planform area and eroded volume.

2.42. In addition, UCR added three new sites to its monitoring, numbered Sites 11, 12 and 13 in UCR's 2014 Report and corresponding to Sites 8.1, 9.4 and 9.5 in the 2014 Kondolf Report.[92] For these sites, Dr Kondolf and Hagans & Weaver

[92] **Vol. III, Annex 4**, 2014 UCR Report, section 2.1; see also **Appendix A**, 2015 Thorne Report, para. 4.3. Dr Kondolf's Site 9.6 was not included in UCR's study because it was being mitigated at the time of study, and UCR took the very conservative approach of omitting sites where remediation was taking place, in effect assessing the impact of the Road *before* any remediation of it was carried out: see **Vol. III, Annex 4**, 2014 UCR Report, section 2.1; see also **Appendix A**, 2015 Thorne Report, para. 4.19. As UCR explained, Dr Kondolf's Site 8.2 was not included because it did not display a single

provided estimates of the erosion, allowing a direct comparison between their estimates – based on photographs and observations of the Road from a distance – and UCR's measurements on the ground. The rates measured by UCR in 2014 for sites 8, 9 and for 11-13 (i.e. Kondolf's Sites 8.1, 9.4 and 9.5) are set out in Table 4.4 of the 2014 UCR Report, as follows:

Table 4.4 Measured data for fill slope gullies at UCR Sites 8, 9 and 11-13 (from the 2014 UCR Report)

Site	Gully area (m^2)	Volume eroded (m^3)	Annual Erosion rate (m/y)*
8	86	101.4	0.76
9	18.4	8.7	0.30
11 (8.1)	174	134.5	0.22
12 (9.4)	500	659.9	0.38
13 (9.5)	720	303.1	0.12

*note: that the annual erosion rate at Site 8 is double that at the most rapidly eroding of the Sites mentioned in the 2014 Kondolf Report.

2.43. Taking account of the additional sites monitored and using newly available technology, the annual erosion rates estimated by UCR in their 2014 Report are reproduced in Table 5.2 of the 2015 Thorne Report, reproduced here for convenience. The highest average annual erosion rate is used for each type of erosion and slope, and as Professor Thorne explains, this means that the erosion rates used by Costa Rica are conservative.[93]

dominant erosion feature, which would allow UCR to categorise it in accordance with the methodology adopted in their monitoring programme. Nevertheless, for Site 8.2 and for Dr Kondolf's Sites 10-17, UCR concluded, based on their first-hand observations of the Road, that these sites were not eroding at any rates higher than those sites included in their monitoring programme: **Vol. III, Annex 4**, 2015 UCR Report, section 2.1; see also **Appendix A**, 2015 Thorne Report, para. 4.19.

93 **Appendix A**, 2015 Thorne Report, para. 4.33.

Table 5.2 Maximum annual erosion rates from the 2014 UCR Report

Erosion type	Fill slope erosion rate (m/yr)	Cut slope erosion rate (m/yr)
Rotational landslide	0.40[a]	0.40
Gully	0.76	0.27
Rill	0.16[b]	0.16
Sheet	0.14[c]	0.07

a. As no rotational landslides were measured in fill slopes, the cut slope landslide erosion rate is recommended.
b. The 2013 report conservatively used the same erosion rate for rills in cut slopes and fill slopes and this has been repeated in this report. The estimated erosion rate for rills in fill slopes is lower (0.07 m/yr.) therefore the higher erosion rate recorded in cut slopes (0.16 m/yr.) has been conservatively recommended for both sites.
c. Recommended sheet erosion rate is estimated by doubling rate measured for a cut slope to account for uncompacted condition of soil in fill prisms.

2.44. In addition, UCR provide estimates of road surface erosion, which were subsequently adjusted by ICE for stretches of dirt and gravel road and stretches where the Road is merely a trail.[94]

2.45. As Professor Thorne explains, UCR's 2014 measurements confirm that UCR's 2013 erosion rates were not "unrepresentatively low", as Nicaragua now claims:

> "These measurements reveal that while the gullies at Dr Kondolf's sites 8.1, 9.4 and 9.5 are indeed larger and have eroded greater *volumes* of sediment than gullies formed in fill slopes monitored at UCR Sites 8 and 9, the mean annual *erosion rates* (that is their volumes eroded divided by their planform areas, divided by their age, i.e. how much they have lowered the ground surface in a year) at Dr Kondolf's sites 8.1, 9.4 and 9.5 are actually much *lower* than that measured at Site 8, and are comparable to those measured at Site 9.

94 **Appendix A**, 2015 Thorne Report, para. 4.79 and Table 4.15.

> The rates of erosion measured at Dr Kondolf's sites 8.1, 9.4 and 9.5 are also comparable to the erosion rate recommended in the 2013 UCR Report, which was 0.2 m/y (as listed in Table 4.2). Hence, Dr Kondolf's conclusion that the rates UCR reported in 2013 were unrepresentatively low is not supported by the measurements made at his sites 8.1, 9.4 and 9.5 in 2014."[95]

2.46. Moreover, as UCR explain in their 2014 Report, their monitoring programme excluded all slopes which had been mitigated or which were in the process of being mitigated.[96] As Costa Rica's remediation works have reduced erosion from the Road to the River, this means that UCR's erosion rates are highly conservative.

(ii) Mende Report: measurement of areas subject to erosion

2.47. As explained in paragraph 2.37 above, the results of the field monitoring of UCR were used together with an assessment of the length and steepness of the road bed, the areas of cut slopes and fill slopes along the full length of the Road (which were examined and assessed in the 2013 Inventory of Slopes and Water Courses Report[97] and the 2013 Land Use Change Report[98]), and the road bed surface.

2.48. In its Reply, Nicaragua criticizes the 2013 Inventory of Slopes and Water Courses Report on three grounds. First, it contends that the rates applied are not those set out in the 2013 UCR Report.[99] This is correct, although in the 2013 Inventory generally higher rates were applied than the erosion rates estimated in

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95 **Appendix A**, 2015 Thorne Report, paras. 4.16-4.17.

96 **Vol. III, Annex 4**, 2014 UCR Report, section 2.1; see also **Appendix A**, 2015 Thorne Report, para. 4.19.

97 **CRCM, Annex 6**, 2013 Inventory of Slopes and Water Courses.

98 **CRCM, Annex 3**, 2013 Land Use Change Report.

99 NR, para. 2.109.

the 2013 UCR Report, resulting in a more conservative estimate of the rate of sediment eroding from the Road to the River. In the updated analysis submitted in the 2014 UCR Report and the 2014 Mende Report, the same rates are now used, without any variance, so the discrepancy no longer exists.[100] In any event, this discrepancy was always immaterial because Costa Rica's approach in its Counter-Memorial was to show that, even on the estimates of Nicaragua's own experts of Road-derived sediment, there was no adverse impact on the River. This remains the case so far as concerns Nicaragua's latest expert evidence, as discussed further in paragraphs 2.62-2.65 below.

2.49. Secondly, Nicaragua asserts that the areas set out in the 2013 Inventory are "underestimated" and "based on visual estimates", rather than actual measurements, resulting in estimates which are unreasonably low.[101] It is correct that visual estimates were used in 2013, and it is to be noted that the process of estimating areas in the 2013 Inventory was made difficult by the fact as a result of inclement weather, making field measurements difficult, and rendering some of the stretches of the Road inaccessible by vehicle or even on foot, as Dr Mende explains.[102]

2.50. In the 2014 dry season, a new field campaign was carried out by Dr Mende. Dr Mende was able to inspect every slope and watercourse crossing between Marker II and Delta Costa Rica, which allowed him to more closely scrutinise the condition of the Road. In addition, this field work was done using more advanced technology than that which was available to Dr Mende in 2013.[103]

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100 **Vol. II, Annex 3**, 2014 Mende Report, p. 1.

101 NR, para. 2.110.

102 **Vol. II, Annex 3**, 2014 Mende Report, p. 3.

103 **Vol. II, Annex 3**, 2014 Mende Report, p. 4.

The new technology allowed distances between 10 and 100 metres to be measured with an accuracy of +/- 0.5 metres, and elevation differences to be measured to an accuracy of +/- 0.2 metres.[104] These improvements in the fieldwork have increased the accuracy of the measurements and therefore the robustness of the results.

2.51. Finally, Nicaragua identifies a calculation error in the 2013 Inventory, because of the assumption that slopes are vertical.[105] This error has been addressed in the Mende Report, resulting in a larger surface area calculation for slopes.[106] While this factor did have an impact on the estimate of Road-derived sediment given by Costa Rica's experts, it was immaterial to the question of adverse impact as assessed by Professor Thorne: even on the basis of estimates given by Nicaragua's experts, the Road was having no adverse impact on the River. This remains the case, as discussed further at paragraphs 2.62-2.65 below.

(iii) Application of erosion rates to areas subject to erosion

2.52. The erosion rates estimated in the 2014 UCR Report are applied to each of the slopes along the Road, for which measurements are set out in the 2014 Mende Report. As noted in paragraph 2.43 above, the highest average annual erosion rates are used, making the results conservative. An example of this calculation for Cut Slope T-8a is set out in Table 4.7 of the 2015 Thorne Report, set out below for convenience.

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[104] **Vol. II, Annex 3**, 2014 Mende Report, p. 4.

[105] NR, para. 2.111.

[106] **Vol. II, Annex 3**, 2014 Mende Report, p. 2.

Table 4.7 Example calculation of annual erosion volume for Cut Slope T-8a.

Erosion type	Cut slope erosion rate (m/y)	Slope area affected (m^2)	Estimated annual volume of erosion (m^3/y)
Sheet erosion	0.07	185	13
Rills	0.16	554	89
Gullies	0.27	369	100
Land Slides	0.40	739	296
Totals	--	1,847	497

2.53. This calculation was performed for all 201 slopes along the Road, resulting in an estimate of slope erosion from the Road of 72,000 m^3/y, which converts to 120,000 t/y.[107] As Professor Thorne explains, this estimate is more accurate because it was made using more advanced technology, and it is also very conservative because it uses the highest average erosion rates for all four possible erosion processes:

> "This volume is based on a scenario in which all four erosion processes operate at their upper bound rates, simultaneously at every slope along the entire length of the Road. For erosion of 72,000 m^3 actually to occur in one year, it would require rainfall sufficiently heavy, frequent and widespread to maximize annual erosion rates along the entire length of the Road, which is improbable for the meteorological reasons explained in Section 4*D*, below. Hence, I believe this to be a 'worst case' rainfall scenario for slope erosion along the Road and one that is actually very unlikely to occur, making it a highly conservative estimate. Also, no account is taken of reductions in slope erosion resulting from the programme of erosion mitigation performed by CONAVI and CODEFORSA, which has progressed significantly since 2013 (see Section 7, below). It follows that the annual slope erosion volume of 72,000 m^3/y produced by Dr Mende is very much a 'worst case' value, not a mean annual average value.
>
> The slope erosion volume estimated in 2014 is nearly double that estimated in 2013, which was 36,590 m^3/y (or 61,100 t/y). The increase results from

107 **Vol. II, Annex 3**, 2014 Mende Report, p. 30; see also **Appendix A**, 2015 Thorne Report, para. 4.37.

> Dr Mende's underestimation of slope surface areas in 2013. Use of improved instrumentation in the 2014 field campaign allowed him to measure slope dimensions precisely instead of estimating them, to produce more accurate results, especially for those fill slopes where the road is situated at the top of the slope. Applying the same conversion rate for cubic metres of sediment to metric tonnes of 1.67 t/m^3 used in 2013, 72,000 m^3/y converts to almost exactly 120,000 t/y."[108]

2.54. As Professor Thorne explains, these estimates of slope erosion are to be preferred to estimates made by Dr Kondolf on the basis of visual observations. Professor Thorne concludes:

> "I am confident that the revised estimate of 72,000 m^3/y (equivalent to 120,000 t/y) proposed in the 2014 Mende Report represents a reliable, 'worst case' estimate of the annual erosion rate for slopes along the Road between Marker II and Delta Costa Rica, because:
>
> (a) it is based on two years of field monitoring and measurements using accurate technologies;
>
> (b) upper bound, measured erosion rates are applied to all the slopes along the Road simultaneously; and
>
> (c) no reduction is made for the mitigating effects of CONAVI and CODEFORSA's slope stabilizing work (which now reduces erosion at over half of the slopes requiring mitigation).
>
> In summary, I believe this figure to be a highly conservative estimate, representative of erosion under an unlikely, 'worst case' rainfall scenario."[109]

2.55. To this estimate of slope erosion, an estimate of road surface erosion was added, based on the UCR rates. Applying the assumption that 60% of sediment eroded from the Road reaches the River, an assumption made by Costa Rica's

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108 **Appendix A**, 2015 Thorne Report, para. 4.36-4.37.

109 **Appendix A**, 2015 Thorne Report, para. 4.40.

experts in 2013 and adopted by Dr Kondolf as reasonable in his 2014 Report,[110] the resulting estimate of Road-derived sediment delivered to the River on a worst case conservative basis is 74,949 tonnes (or 44,880 m^3) per year.[111] This is represented in Table 4.16 and Figure 4.16 of the 2015 Thorne Report, reproduced below for convenience.

Table 4.16 Annual yields of Road-derived sediment from the basins of major Costa Rican tributaries between Marker II and Delta Costa Rica under a 'worst case' rainfall scenario (from the 2014 ICE Report).

Tributary Basin	Road length (km)	'Worst case' sediment yields ($m^3\ yr^{-1}$)				'Worst case' sediment yields ($t\ yr^{-1}$)
		Road bed	Cut slopes	Fill slopes	Total	
Major Costa Rican tributary basins draining directly to the Río San Juan						
Infiernito	41.0	855	12,348	19,051	32,253	53,863
San Carlos	11.1	173	253	399	825	1,378
Cureña	29.5	387	1,738	8,966	11,091	18,521
Sarapiquí	4.5	172	49	---------	221	369
Chirripó	22.8	192	190	107	489	817
Costa Rican area draining directly to the Río San Juan						
Total	108.8	1,778	14,578	28,523	**44,880**	**74,949**

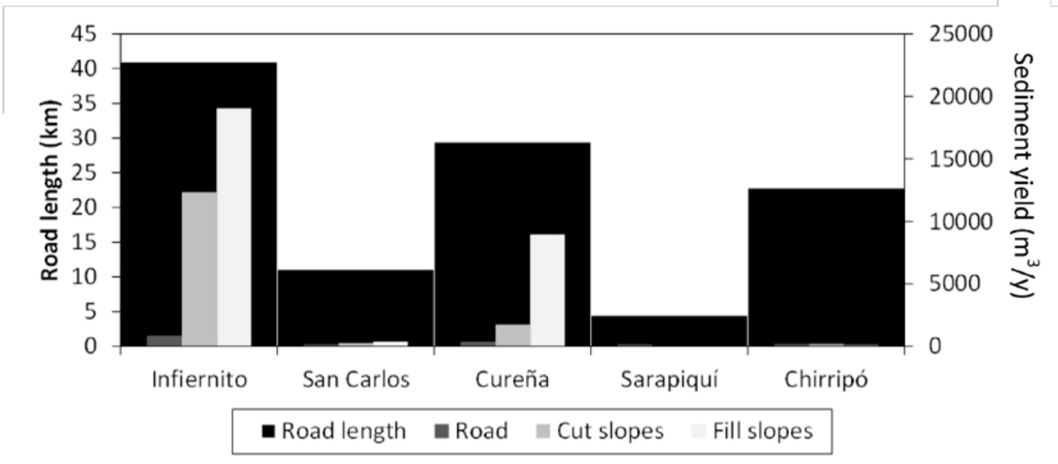

Figure 4.16 Annual yields of Road-derived sediment from the basins of major Costa Rican tributaries between Marker II and Delta Costa Rica under a 'worst case' rainfall scenario (from the 2014 ICE Report).

110 **Appendix A**, 2015 Thorne Report, para. 4.80.

111 **Appendix A**, 2015 Thorne Report, para. 4.80 and Table 4.16.

2.56. As noted in paragraph 2.46 above, Costa Rica's estimates of erosion on the Road are based on monitoring of sites that have not been remediated. Thus, Costa Rica's estimates are highly conservative, because the remediation works are being effective in reducing erosion from the Road, as detailed in Section C(5) below.

2.57. Dr Kondolf's estimate of Road-derived sediment is further inflated by the addition of sediment said to be eroding from "access roads" to the River.[112] Again, these estimates are based on visual observations of the Road (and possibly, the access roads). As Professor Thorne explains, in August 2014 he drove along some of these Roads, observing that most pre-existed the construction of the Road and were practically unchanged. Some representative photographs of these are included in Figure 7.1 of Professor Thorne's Report, and are reproduced for convenience below.

Figure 7.1 Typical views of access roads traversed during the field visit on 29 August 2014. Photographs by author [Professor Thorne].

112 **NR, Annex 1**, 2014 Kondolf Report, pp. 58 and 61; and NR, paras. 2.4 and 2.66.

2.58. Concerning Dr Kondolf's suggestion that these access roads are contributing significant amounts of sediment to the River, Professor Thorne concludes as follows:

> "Bearing in mind the stable condition of the access roads, their remoteness from the River and the scarcity of streams linking them to the River, in my opinion it is highly unlikely that sediment from these access roads reaches the Río San Juan in any appreciable quantities."[113]

2.59. Nicaragua also criticises Costa Rica's estimates of erosion on the ground that they do not take into account additional erosion from "failed stream crossings".[114] As Professor Thorne explains, a high proportion of these sites have been remediated or are in the process of or scheduled to be remediated, and on that basis UCR excluded them from their monitoring programme. In any event, given the very limited nature of these inputs, Professor Thorne explains that they cannot have any significant or long-lasting effect on the River:

> "These yields of Road-derived sediment do not consider erosion from areas disturbed during construction in 2011. This is because those areas have subsequently revegetated, either naturally or due to vegetation planting by CODEFORSA and CONAVI. Neither do the estimates consider erosion at failed watercourses. This was criticised in relation to the 2013 estimates in paragraph 2.119 of Nicaragua's Reply. To explain why it was decided not to attempt to estimate erosion at failed crossings in 2014, it is only necessary to examine a typical example, as illustrated by Dr Kondolf in Figure 24, on page 36 of his 2014 Report, which shows the point where the Road intersects a small ditch draining an area of pasture. The width of the ditch is not specified, but as the Road has an average width of 10 m and the ditch is clearly much narrower than this, it is perhaps 2 m wide. In the vicinity of the ditch, the channel of the Río San Juan is about 200 m wide. The River in this reach conveys an average annual discharge of the order of 500 m^3/s and an annual sediment load of several millions of tonnes. It follows that volume of

113 **Appendix A**, 2015 Thorne Report, para. 7.32.

114 NR, para. 2.119.

sediment from a ditch that is only 2 m wide could erode from a failed crossing that extends along that ditch for about 10 m is insufficient to have any impact on the Río San Juan or the lower Río San Juan that could be either significant or long-lasting. In any case, of 127 watercourse crossings surveyed in the updated inventory of crossings in the 2014 Mende Report, erosion has already been mitigated or is in progress at 40% and is unnecessary at 36% because these crossings are either stable (19%) or the Road is just a trail (17%). Mitigation is scheduled at the remaining 24% of crossings where it is needed."[115]

2.60. In a final attempt to make out its claim of adverse impact, Nicaragua asserts that Costa Rica's erosion estimate "does not account for additional construction of the Road" – i.e. new sections of the Road that Costa Rica may construct in the future.[116] This speculative assertion is of course no proof of significant adverse impact on the River; nor has Nicaragua established that there is any significant risk of adverse impact.

2.61. In summary, Nicaragua's estimate of erosion from the Road to the River – based on visual approximations – is significantly overstated for the reasons explained above. Costa Rica's experts have put forward a robust estimate of erosion in the range of 75,000 tonnes (or 45,000 m^3) per year, which is insignificant when considered in the context of the sediment load of the River, as explained further below.

(3) Impact of the sediment eroded from the Road on the total sediment load of the River

2.62. As explained in paragraph 2.13 above, in order to assess Nicaragua's allegations of adverse impact (which are based on the contribution of sediment from the Road to the River), it is necessary to consider the contribution of

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115 **Appendix A**, 2015 Thorne Report, para. 4.81.

116 NR, para. 2.118.

sediment eroded from the Road in the context of the existing sediment load of the River.

2.63. As explained in subsection (1) above, the best estimate of the average annual total load in the San Juan being revised to 12,678,000 t/y, comprising a suspended load of 9,078,000 t/y and a bedload of 3,600,000 t/y. In the Lower San Juan, the total load is estimated to be 2,181,000 t, comprising a suspended load of 1,479,000 t plus bedload of 702,000 t.[117]

2.64. As noted in paragraph 2.61 above, the average input of sediment from the Road to the River is estimated to be approximately 75,000 t/y (ignoring the impacts of the mediation works). In the context of a sediment load of 12,678,000 t/y, this "is an indiscernible 0.6% of the total load" of the River.[118] This is obviously too small a proportion to have any impact on the River, let alone any significant impact.

2.65. As noted in paragraph 2.36 above, Dr Kondolf's estimate of a range of sediment delivered annually from the Road to the River (116,000 to 150,000 m/y, which converts to 194,000 to 250,500 t y^{-1}) is significantly overstated. But even if it were an accurate assessment, which Costa Rica does not accept, it would represent only 1% to 2% of the total annual sediment load of the River,[119] or 2% to 3% of the suspended sediment load.[120] A contribution of sediment in this range is similarly too small to have any adverse impact on the River.[121] Finally, if Dr Andrews' estimate of the average annual total load (13.7 million t y^{-1}) were

117 **Appendix A**, 2015 Thorne Report, Table 4.17(b).

118 **Appendix A**, 2015 Thorne Report, para. 4.94.

119 **Appendix A**, 2015 Thorne Report, para. 4.93.

120 **Appendix A**, 2015 Thorne Report, para. 4.114.

121 **Appendix A**, 2015 Thorne Report, para. 4.114.

applied, this percentage contribution would be lower, although still in the range of 1% to 2%.[122]

(4) Impact of the sediment eroded from the Road on the bed in the Lower San Juan

2.66. As Professor Thorne explained in his 2013 Report, even if all the Road-related sediment entering the lower San Juan River were to be deposited on the bed of the San Juan (a proposition which is unlikely for the reasons he explained), and using the estimates given by Nicaragua in its Memorial (which are likely to be significantly overstated), the increase in the rate of aggradation of the bed would be tiny.[123]

2.67. In its Reply, relying on the evidence of Dr Andrews, Nicaragua contends that "nearly all of the coarse sediment … will settle within the first three kilometres" of the Lower San Juan.[124] As Professor Thorne explains, this proposition is not credible. Although some of the coarse sediment may be deposited in the first three kilometres, the rest of the sand entering the Lower San Juan will be distributed along the channel and in in the Bay of San Juan del Norte. This is for three reasons:

(a) First, Nicaragua's own study relating to its dredging programme established that the Lower San Juan has a mobile sand bed throughout its length.[125] This casts doubt on Nicaragua's new contention that nearly all

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122 **Appendix A**, 2015 Thorne Report, para 4.96.

123 **CRCM, Appendix A**, 2013 Thorne Report, para. 8.60.

124 NR, para. 2.63, referring to **NR, Annex 3**, Andrews Report, Section V(I).

125 *Certain Activities*, **NCM, Annex 7**, *Environmental Impact Study for Improving Navigation on the San Juan de Nicaragua River (Excerpts)*, September 2006; see also **Appendix A**, 2015 Thorne Report, para. 5.26.

of the sediment will settle in the first three kilometres of the Lower San Juan.

(b) Second, growth of the micro-delta some 30 kilometres downstream of Delta Colorado indicates that the Lower San Juan has capacity to transport sand throughout its length.[126]

(c) Third, more than 20 sites where Nicaragua has carried out dredging operations on the Lower San Juan are located downstream of the first three kilometres.[127] If all or even "nearly all" of the coarse sediment entering the Lower San Juan were deposited in the first three kilometres, as Nicaragua now suggests, it is unlikely that Nicaragua would have any need to dredge in these downstream areas, including in the vicinity of the "disputed territory".

2.68. As Professor Thorne explains, even accepting the figures of Road-derived sediment put forward by Nicaragua's expert (which, for the reasons explained above, are significantly overstated), and the proposition that all of it is deposited in the first three kilometres of the Lower San Juan (which, for the reasons explained above, is an untenable proposition), this would only cause the bed of the Lower San Juan to rise by 5 to 10 mm per year. As Professor Thorne states:

> "Were I to accept Dr Kondolf's 2014 estimate that the quantity of sediment derived from the Road plus all the access roads delivered to the River annually is between 116,000 and 150,000 m^3, which I do not, and applying Dr Andrews' assumptions that 10% of that sediment is carried into the Lower Río San Juan and that 12 to 18% of it is relatively coarse, then 1,390 to 2,700 m^3 of sand from Route 1856 plus its access roads would be added

126 **Appendix A**, 2015 Thorne Report, para. 5.27.

127 See *Certain Activities*, **CRM, Sketch Map 7.1**; and **Appendix A**, 2015 Thorne Report, para. 5.28.

to the non-Road related coarse load. If all of this were to be deposited within 3 km of the Delta, which I believe to be unrealistic, this would still only cause the bed to rise by an average of 5 to 10 mm. Hence, by Dr Andrews' calculation, any change in average bed elevation would still be unmeasurable. Also, sedimentation would be time-limited because any supply of sand from the Road would decrease as mitigation takes effect, disturbed areas revegetate, and slopes relax towards equilibrium according to the geomorphological 'rate law' (Graf 1977).

In any case, as Dr Andrews points out, division of discharges (and hence division of coarse sediment load) at the Delta, '*cannot be determined with any confidence',* precluding the possibility of establishing a causal link between construction of the Road and changes in bed level in the lower Río San Juan until such time as the data necessary to determine the divisions of discharges and sediment loads at the Delta have been collected.

On this basis, while it is almost certain that coarse sediment derived from erosion of the Road *cannot* have had any discernable impact on either sediment loads or bed elevations in the lower Río San Juan immediately downstream of the Delta, it would be impossible to prove that it *has* had any such impact."[128]

2.69. Relying on the evidence of Dr Andrews, Nicaragua also claims that fine sediments carried into the Lower San Juan "will also be deposited once they reach the 'brackish' (i.e., partially salty) water that exists in the stretches of the River nearer to the Caribbean",[129] so that the "vast majority of the relatively fine sediment will be deposited within the delta and not carried into the ocean as Thorne states".[130] This is wrong. As Professor Thorne explains, the Caribbean has a micro-tidal regime, and consequently salt water does not penetrate far into the delta and the vast majority of the fine sediment carried into the Lower San Juan will be carried into the Caribbean Sea:

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128 **Appendix A**, 2015 Thorne Report, paras. 5.33-5.35.

129 NR, para. 2.67.

130 **NR, Annex 3**, Andrews Report, p. 29.

> "Dr Andrews' opinion might be correct for a delta building into a marine water body that experiences frequent *'tidal surges'*. But the Caribbean has a micro-tidal regime, with a diurnal tidal amplitude averaging only about 20 cm (Kjerfve, 1981). This explains why most of the fine sediment carried by the lower Río San Juan is not deposited within the delta but is carried into the Caribbean Sea, as I indicated in my 2013 Report and as illustrated in typical, rainy season satellite images (Figure 5.4), that show plumes of turbid river water extending into the Bay of San Juan del Norte and the littoral zone of the Caribbean Sea."[131]

Indeed, this is demonstrated by the satellite images included in Figure 5.4 to Professor Thorne's report, which show plumes of turbid river water extending into the Bay of San Juan del Norte and the littoral zone of the Caribbean Sea (reproduced below for convenience).

131 **Appendix A**, 2015 Thorne Report, para. 5.38.

Figure 5.4 Satellite images showing that flow from the lower Rio San Juan carries turbid water with a high concentration of fine sediment into both the Bay of San Juan del Norte and the littoral sediment system of the Caribbean Sea. Image dates (a) 13 December 1997 (b) 26 November 2013.

2.70. Finally, Nicaragua attempts to establish its claim of adverse impact by referring to contributions to the bed of the Lower San Juan River as a result of other sources of sediment from "Costa Rican basins" which have allegedly "experienced significant deforestation and changes in land use, increasing the amount of sediment they contribute to the River."[132] As explained in Chapter 1 above, these allegations raise issues that are beyond the scope of the case submitted to the Court in the present proceeding. They are in any event incorrect, to the extent that Costa Rica's experts have been able to address these complex matters in the time available.[133] Moreover, as these photographs of the rivers Santa Cruz and Sábalos in Figure 4.26 of the 2015 Thorne Report show, large

[132] NR, para. 2.69, referring to Andrews Report, **NR, Annex 3**, Section IV(D).

[133] **Appendix A**, 2015 Thorne Report, paras. 4.120-4.141.

amounts of sediment appear to be entering the San Juan from Nicaraguan territory.

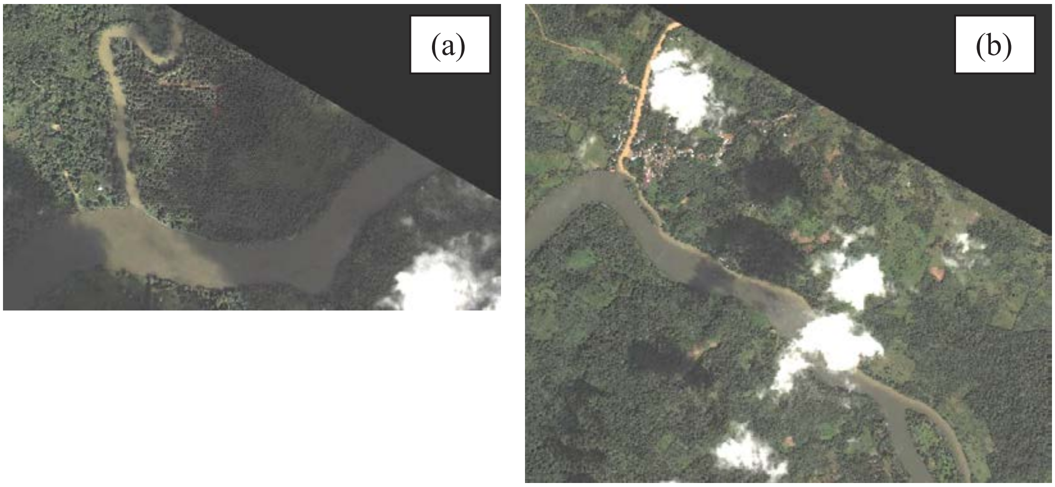

Figure 4.26 Turbid water draining to the Río San Juan from Nicaraguan tributaries on 23 December 2012 (a) Río Santa Cruz (b) Río Sábalos.

(5) Potential impact of rainfall from a hurricane or tropical storm

2.71. In its Memorial, relying on the evidence of Dr Kondolf that in the region of the road "rainfall intensities can be very high, especially during tropical storms and hurricanes",[134] Nicaragua argued that the volume of sediment being delivered from the Road to the River will "increase dramatically".[135]

2.72. As Costa Rica explained in its Counter-Memorial, the region in which the Road is located has never been directly hit by a hurricane,[136] and hurricanes

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134 **NM, Annex 1**, 2012 Kondolf Report, para. 4.7.

135 NM, para. 4.19.

136 See **CRCM, Annex 13**, United States National Oceanic and Atmospheric Administration, Map of Historical Hurricane Tracks, available at http://csc.noaa.gov/hurricanes.

passing to the north of the region have only delivered rainfalls to the region which were unexceptional and were within the natural range of rainfall in the area, which is abundant.[137]

2.73. In its Reply, relying again on the evidence of Dr Kondolf, Nicaragua asserts that Hurricane Irene-Olivia followed the north bank of the San Juan in 1971, and that "tropical storms are well-documented in the region."[138] Dr Kondolf specifically refers to a tropical storm which occurred in May 2004.[139]

2.74. With this Rejoinder, Costa Rica submits an explanatory report prepared by the Director General of the Costa Rican National Meteorological Institute, Professor Juan Carlos Fallas Sojo (who is also Professor of Physics and Meteorology at the University of Costa Rica) (the ***Fallas Report***). As Professor Fallas explains, the event which occurred in May 2004 was not a "tropical storm", but a "tropical wave". A tropical wave is a cluster of thunderstorms with little, if any, organized wind circulation. This feature differentiates them from tropical storms, tropical depressions and hurricanes which have well-organized air circulation in a counter-clockwise direction, with strong winds. In the context of Costa Rica's prominent mountain system, these counter-clockwise winds promote the "orographic effect", concentrating rainfall on the windward side of the mountains. As Professor Fallas explains, this means that rainfall associated with a hurricane or tropical storm would be much greater in catchments draining to the

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137 CRCM, paras. 3.34-3.35; see also **CRCM, Annex 68**, Letter from the General Director of the Costa Rican National Meteorological Institute to H.E. Edgar Ugalde Álvarez, 7 November 2013.

138 NR, para. 3.49, referring to 2014 Kondolf Report, Section 12.

139 **NR, Annex 1**, 2014 Kondolf Report, p. 71.

Pacific than in catchments draining to the Caribbean, such as the San Juan River.[140]

2.75. Based on Professor Fallas' expert report, Professor Thorne concludes that Nicaragua's experts have overstated both the risk of unprecedented rainfall and the potential impact on sediment loads in the San Juan River of the rainfall associated with a hurricane or tropical storm. As he states:

> "In my opinion as a geomorphologist, the risk of rapid erosion due to intense rainfall in the area around the Road is probably greater during the localised thunderstorms associated with a Tropical Wave than would be the case during a Tropical Cyclone. However, the frequency of localised downpours is high and their impacts limited because, to restate my position, *'the hydrology, sediment dynamics, morphology and environment of the River are fully adjusted to the effects of frequent and heavy rainstorms'* (2013 Thorne Report, paragraph 6.20)."[141]

2.76. In a further attempt to make out its claim of adverse impact, Nicaragua argues that "[s]evere erosion from the Road can also be expected in the event of an earthquake",[142] which Nicaragua considers to be a "very real" risk.[143] Although there have been earthquakes in the region, as Professor Thorne explains, the area of slopes on the Road is tiny in comparison to the area of which would be disturbed by landslides triggered by an earthquake.[144] In these circumstances, the additional risk associated with an earthquake in the vicinity of the Road is correspondingly tiny.

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140 **Vol. III, Annex 9**, Fallas Report, p. 3.

141 **Appendix A**, 2015 Thorne Report, para. 4.112.

142 NR, para. 3.55.

143 NR, para. 3.56.

144 **Appendix A**, 2015 Thorne Report, paras. 4.128-4.129.

(6) The Road has had no adverse impact on sediment in the River

2.77. The scientific and independent expert evidence submitted by Costa Rica demonstrates that the Road has had no adverse or significant impact on the sediment load of the River. Professor Thorne expresses his opinion as follows:

> "The Road has had no significant impact on sediment transport in the Río San Juan because the quantity of additional sediment derived from the Road is tiny compared to the heavy sediment load that was already being carried by the Río San Juan prior to construction of the Road. Also, the additional load from the Road is indiscernible due to high seasonal and inter-annual variability in sediment supplies from other sources and complexity in sediment transport processes."[145]

2.78. The same conclusion is reached even on the over-inflated estimates of Road-derived sediment put forward by Nicaragua's experts, as Professor Thorne notes:

> "Even according to Dr Kondolf's over-estimate (which I do not accept) the contribution of sediment from the Road is tiny (less than 3% of the mean annual sediment load in Río San Juan). Using the more reliable upper bound estimates reported herein the contribution is probably less than 1% of the mean annual load of the River. In either case, this contribution would in practice be indiscernible, due to uncertainty and naturally variability in quantity of sediment carried by the Río San Juan."[146]

2.79. The evidence submitted by Costa Rica further demonstrates that the Road has had no adverse or significant impact on the lower Río San Juan, including by aggradation of the bed of the River. As Professor Thorne concludes:

> "There is no scientific justification for '*active efforts, including dredging, to maintain the capacity and quantity of the river's waters*' in the lower Río San Juan on the pretext of having to remove Road-derived sediment. Coarse

[145] **Appendix A**, 2015 Thorne Report, para. 8.2.

[146] **Appendix A**, 2015 Thorne Report, para. 8.9.

> load and deposition calculations using an upper bound estimate of the amount of Road-derived coarse sediment entering the lower Río San Juan suggest that this is indiscernible compared to pre-existing coarse load, especially when allowance is made for uncertainty concerning estimation of the bedload carried by the River and the proportions in which flow and sediment are divided when flow bifurcates at the Delta.
>
> Sediment continuity dictates that even if all of the coarse Road-derived sediment supplied to the lower Río San Juan in one year according to Dr Andrew's estimate (which I do not accept) were to be deposited on the bed of the channel within the first three kilometres downstream of the Delta it would, on average, raise the bed of the river by less than 5 to 10 mm."[147]

2.80. As noted in paragraph 2.2 above, Nicaragua's claims as to the significant harm which it alleges is being caused to the River are based on the contribution of sediment from the Road to the River. In the circumstances Costa Rica's experts show that the sediment contribution is insignificant and indiscernible even using the estimates of that contribution put forward by Nicaragua's experts, Nicaragua's claims must fail.

C. There is No Risk of Any Other Adverse Impact on the San Juan River

2.81. Nicaragua claims that the Road has had an adverse impact on the San Juan River in respect of (1) water quality; (2) channel morphology; (3) navigation; and (4) ecosystem, tourism and health. It also claims that (5) Costa Rica has failed and is failing to remediate the Road's defects. Each of these claims is addressed in turn below. A follow up study (the 2015 CCT Report) from the Tropical Science Centre (CCT, in its Spanish acronym), which validates the findings made in 2013 EDA, further shows that all impacts on Costa Rican territory remain localized.[148]

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[147] **Appendix A**, 2015 Thorne Report, paras. 8.6-8.7.

[148] **Vol. III, Annex 14**, 2015 CCT Report.

(1) Water quality

2.82. In its Memorial, Nicaragua contended that the contribution of sediment from the Road to the River adversely impacted the water quality of the River,[149] and claimed compensation for the cost of restoring the water quality of the San Juan.[150] To substantiate its claim, Nicaragua relied on general statements by Dr Kondolf that increased sedimentation has affected water quality in rivers.[151]

2.83. Costa Rica demonstrated in its Counter-Memorial and this Rejoinder that the Road is not delivering additional sediment to the River in excessive concentration or any measurable quantity which would cause any harm to the River, including in respect of water quality.

2.84. In its Reply, Nicaragua has attempted to link its claim as to impact on water quality with its claim as to impact on the ecosystem. This is addressed further in subsection (4) below.

(2) Morphology

2.85. In its Memorial, Nicaragua asserted that Costa Rica's alleged failure to apply certain design and construction standards, including "international road practices intended to minimize on-site and off-site impacts to [*inter alia*] channel morphology" resulted in adverse impacts on the San Juan River.[152] In his report submitted with the Memorial, Dr Kondolf was more measured about potential

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[149] NM, paras. 3.60, 3.81, 3.89 and 3.92.

[150] NM, para. 6.33.

[151] **NM, Annex 1**, 2012 Kondolf Report, para. 1.3.2.

[152] NM, para 3.6.

impacts on morphology, making only another very general statement that sediment can impact channel morphology.[153]

2.86. In its Reply, Nicaragua asserts that the Road "has caused undeniable morphological changes to the River including, most visibly, the creation of large deltas of sediment in the River, as well as the deposit of significant quantities of sediment on the bed of the lower San Juan River."[154]

2.87. Insofar as Nicaragua's claim of harm on the basis of morphological changes is based on the deposition of sediment on the bed of the Lower San Juan, as explained in paragraph 2.68 above, any aggradation in the bed of the Lower San Juan which has been caused by Road-derived sediment is indiscernible and cannot have had any adverse impact. As Professor Thorne explains, even accepting the figures of Road-derived sediment put forward by Nicaragua's expert (which, for the reasons explained above, are significantly overstated), and the proposition that all of it is deposited in the first three kilometres of the Lower San Juan (which, for the reasons explained above, is an untenable proposition), this would cause the bed of the Lower San Juan to rise by less than 5 to 10 mm per year.[155] This is not by any measure "significant" and does not suffice to establish a claim for harm based on morphological change.

2.88. Concerning Nicaragua's claim that the Road has caused the creation of or addition to "large deltas" of sediment in the River, as Professor Thorne explains, there is no evidence as to whether the deltas which Nicaragua asserts were created as a result of the Road did or did not exist before the Road was constructed. Due

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[153] **NM, Annex 1**, 2012 Kondolf Report, p. 37, para. 4.9.

[154] NR, para. 2.2.

[155] **Appendix A**, 2015 Thorne Report, para. 5.33.

to heavy cloud cover in the region, cloud-free, high resolution satellite images are generally not available for the relevant period. However, cloud-free images are available for two of the locations identified by Dr Kondolf and those images demonstrate that the deltas pre-date the Road. They are included as Figure 5.3 to the 2015 Thorne Report and reproduced below for convenience. Professor Thorne concludes that he "cannot rule out the possibility that this is actually the case for most of [the deltas Dr Kondolf identifies as having been caused by the construction of the Road]."[156]

156 **Appendix A**, 2015 Thorne Report, para. 5.11.

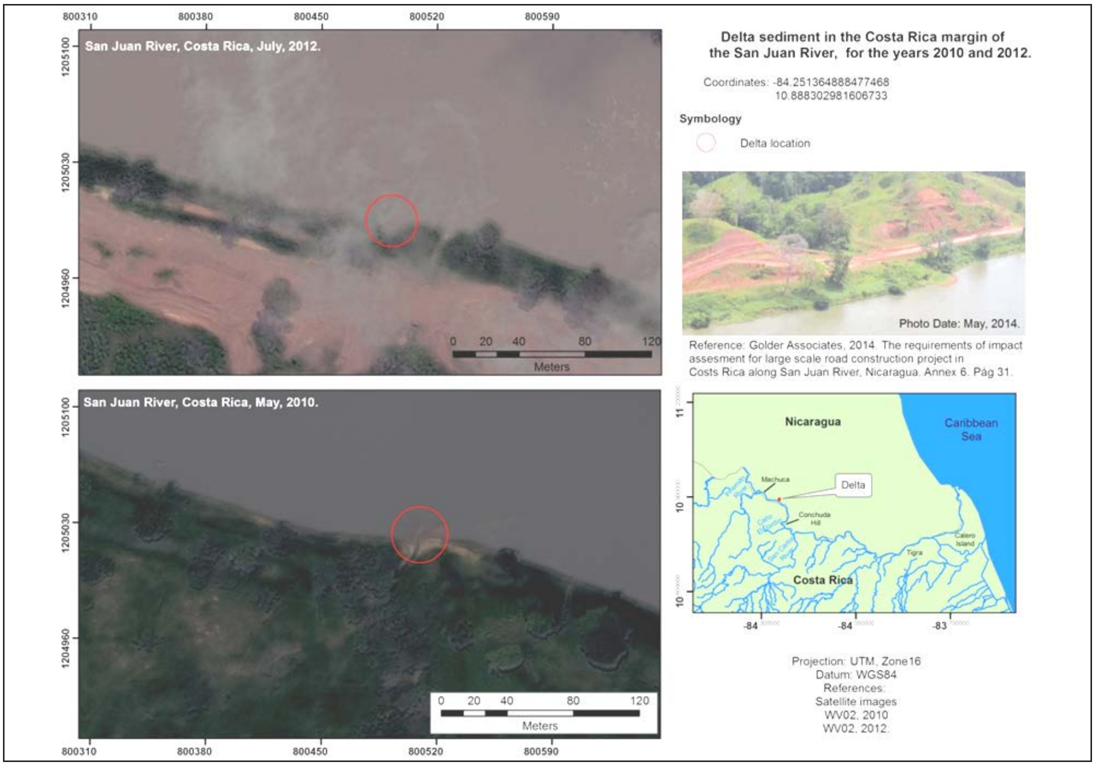

Figure 5.3 Pre- and Post-Road satellite images establishing that at least two of the eight south bank deltas identified as being formed from sediment derived from the Road were present prior to construction of the Road.

2.89. In any event, the eight deltas identified by Dr Kondolf on the southern bank are morphologically indistinguishable from those which exist on the northern bank (during an overflight in April 2014, 15 deltas were photographed in the Nicaraguan bank of the San Juan), and in fact it appears that deltas on the northern bank are larger than those on the southern bank (see Figure 5.2 to the 2015 Thorne Report, which is partially reproduced below).

Extract of Figure 5.2 Fifteen north bank deltas photographed from Costa Rican airspace in April 2014. These deltas are formed in sediment eroded from Nicaragua and some are considerably larger than any of those photographed by Dr Kondolf along the south bank. The size and morphology of these deltas should be compared to those shown in Appendix F of the 2014 Kondolf Report, which were also taken at conditions of low flow in the Río San Juan. (Partial reproduction Appendix A, 2015 Thorne Report, pp. 92-95).

2.90. Moreover, Dr Kondolf describes the composition of the sediment on the deltas adjacent to the Costa Rican bank as "angular, friable clasts" and the sediment on the deltas on the northern (i.e. Nicaraguan) bank as formed in "more rounded, competent gravels".[157] As Professor Thorne observes, the fact that sediment on the deltas on the Costa Rican bank are friable "indicates that they will quickly weather down to rounded, gravel-sized particles similar to those forming deltas at the south bank of the Rio San Juan",[158] such that "the half-life of their residence on deltas will be measured in months rather than years" and they will be "easily absorbed within the existing load of the Rio San Juan."[159] This process will be further accelerated by Costa Rica's mitigation works, which will cut off the supply of new clasts.[160] In contrast, the deltas on the north bank are formed in less crumbly gravels which indicates that they "are formed from stream bed material that has been transported considerable distances from its eroding source, that these grains do not crumble, and that they will remain too large for the Rio San Juan to transport away for years or decades".[161] Professor Thorne concludes that any impacts of the deltas built or enlarged by Road-derived clasts is local and transitory: "that any contribution they make to morphological features in the River is insignificant due to their spatially restricted extent and because their existence in the channel will be short lived."[162] In the absence of any significant impact on the morphology of the River, Nicaragua's claim to adverse impact based on the creation of deltas must be dismissed.

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157 **NR, Annex 1**, 2014 Kondolf Report, p. 70.

158 **Appendix A**, 2015 Thorne Report, para. 5.12.

159 **Appendix A**, 2015 Thorne Report, para. 5.14.

160 **Appendix A**, 2015 Thorne Report, para. 5.16.

161 **Appendix A**, 2015 Thorne Report, para. 5.12.

162 **Appendix A**, 2015 Thorne Report, para. 5.17.

(3) Navigation

2.91. Nicaragua claims that Costa Rica has breached Nicaragua's right of navigation on the San Juan River. Having relied in its Memorial on a bare statement by Dr Kondolf that his photographs "document … impacts to navigation",[163] and on an assertion by Nicaragua's Foreign Minister that dumping of trees and soil "into the river flow, difficulting [*sic*] and risking the navigation in its waters",[164] in its Reply Nicaragua asserts its claim by reference to (a) the so-called "Road-derived deltas", which Nicaragua says "have a clear negative impact on navigation, as it is no longer possible to navigate the River in the locations the deltas have come to occupy";[165] and (b) sand bars and sediment accumulation in the Lower San Juan.[166]

2.92. Concerning the deltas relied upon by Nicaragua, for the reasons explained in paragraph 2.90 above, these features are very small and they will have only a temporary existence. Consequently, there is no impact on navigation along the River, let alone any long-standing impact.

2.93. Concerning accumulation of coarse, Road-related sediment in the Lower San Juan, for the reasons explained in paragraph 2.68 above, any aggradation of the bed would be, even according to Nicaragua's experts, be less than 5 to 10 mm per year. This could have no impact on navigation on the San Juan.[167] It follows

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163 **NM, Annex 1**, 2012 Kondolf Report, Appendix B, p 1, referred to in NM, para. 3.6, footnote 112.

164 **NM, Annex 16**, Diplomatic note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs of Costa Rica, Reference MRE/DVS/VJW/0685/12/11, Managua, 10 December 2011, p .404, referred to in NM, para. 2.31.

165 NR, para 5.24.

166 NR, para. 2.66.

167 **Appendix A**, 2015 Thorne Report, paras. 6.55-6.56.

that Nicaragua's claim of adverse impact based on navigation on the River must be dismissed.

(4) Ecosystem, Tourism and Health

2.94. Nicaragua makes further claims as to the impact of the road infrastructure works on the San Juan River, as to adverse effects on the ecosystem (in particular, fish, algae and macroinvertebrates) and tourism. In its Memorial, Nicaragua also claimed that the construction of the Road has impacted upon the health of the riparians of the River. In its Request for Provisional Measures, Nicaragua made a similar assertion,[168] but it was not substantiated in any way, and it appeared to abandon it.[169] Nicaragua now appears to have abandoned it in this proceeding entirely, as it is not referred to in its Reply.

2.95. Concerning impact on the ecosystem, in its Memorial, Nicaragua alleged harm to the ecosystem of the River,[170] and claimed compensation for losses allegedly suffered in respect of fishing.[171] Having failed to substantiate this claim for the reasons explained in Costa Rica's Counter-Memorial, in its Reply, Nicaragua has articulated its claim as one for damage caused to aquatic organisms.[172] Its claim appears to have two aspects: first, the impact of Road-

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168 **Vol. IV, Annex 24,** Letter from Nicaragua to the Registrar of the International Court of Justice, Reference HOL-EMB-196, 11 October 2013, p. 3.

169 See CR 2013/31, p. 16, para. 3 (Wordsworth) and p. 33, para. 30 (Wordsworth); see also CR 2013/29, p. 42, para. 21 (Wordsworth). None of Nicaragua's counsel mentioned the word "health" in their oral submissions.

170 NM, para. 3.93. See also paras. 1.9-1.10, 5.61 (referring to Nicaragua's report to the Court dated 23 July 2012 in the *Certain Activities* case), and 5.67.

171 NM, para. 6.33.

172 NR, para. 2.78.

related sediment on fish;[173] and second, the impact of Road-related sediment on algae and macroinvertebrates, in particular on deltas which Nicaragua alleges have been caused by the construction of the Road.[174] In addition, in its Reply Nicaragua alleges that there is an additional risk of adverse impact on the ecosystem as a consequence of the transport of hazardous substances on the Road.[175] Each of these is addressed in turn below.

2.96. As Professor Thorne explained in his 2013 Report, fish and other aquatic organisms in the San Juan River are "fully adapted" to high levels of sediment,[176] given that the sediment load of the River is "very heavy", as Nicaragua has stated.[177] Dr Kondolf contends, however, that "some of the most prevalent fish known to exist in the Rio San Juan … such as Cichlids, members of the family Mugiliidae, and Poecilids, are vulnerable to increases in turbidity and suspended sediment."[178]

2.97. Dr Kondolf's opinion has been reviewed by Professor Cowx, an internationally-recognized expert in the management of inland fisheries and aquatic resources. Professor Cowx concludes that Dr Kondolf's statements relating to the impacts of sediment on fish in the San Juan are both unsupported by empirical evidence from the River and are based on academic sources that are taken out of context. As Professor Cowx explains, Dr Kondolf has identified families of fishes, at a more general level than species. While some species within

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173 NR, para. 2.78.

174 NR, paras. 2.86-2.87.

175 See NR, paras. 3.34-3.42.

176 **CRCM, Appendix A**, 2013 Thorne Report, p. 50.

177 See *Navigational Rights*, NCM, para. 1.1.8.

178 **NR, Annex 1**, 2014 Kondolf Report, p. 64.

these families may be vulnerable to high loads of sediment, other species are adapted to high loads. After reviewing the available data and literature, Professor Cowx concludes that "there is no evidence that the fish and fisheries of the San Juan have or will be impacted by construction of Route 1856."[179] He notes:

> "What the literature actually demonstrates is that Dr Kondolf's statement is a gross over-generalisation. While some members of the families of fishes he names are vulnerable to increased in turbidity and suspended sediment, other members of those families are adapted to high sediment loading and this is illustrated through the species specific review summarised herein and reported in detail in the references cited.
>
> Empirical data on the species impacted with specific reference to the San Juan River are required to justify and substantiate claims of any long-term impact of construction of Route 1856 on the fish and fisheries of the river. No such data have been provided by Nicaragua's experts. The examples used as evidence are general and unspecific to the San Juan River and the species that inhabit it."[180]

2.98. The second aspect of Nicaragua's claim concerning impact of the Road on the ecosystem of the San Juan concerns algae and macroinvertebrates. During the hearing on Nicaragua's Request for Provisional Measures, Dr Kondolf reported results of sampling of periphyton done by Dr Ríos in May 2013.[181] Dr Ríos has submitted a separate report with Nicaragua's Rejoinder, in which she seeks to compare deltas on the southern bank which Nicaragua alleges are composed of Road-derived sediment with deltas on the northern bank of the River.[182] She

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179 **Vol. II, Annex 2**, Cowx Report, p. 13.

180 **Vol. II, Annex 2**, Cowx Report, p. 13. These conclusions are also confirmed by a report produced by a Costa Rican fish expert, Arturo Angulo Sibaja, which concludes that the relevant species of fish are well adapted to high levels of sediment: see **Vol. III, Annex 7**, A Angulo, *Fish Fauna in the San Juan River*, 2014.

181 Third Kondolf Report, p. 13.

182 **NR, Annex 4**, Dr Blanca Ríos Touma, "Ecological Impacts of the Route 1856 on the San Juan River, Nicaragua", July 2014, (the ***2014 Ríos Report***).

concludes that the deltas on the southern bank have significantly lower periphyton biomass values and degraded levels of species richness and abundance, and that these indicate "that the sediments eroded from the road are having negative effects on the aquatic communities of the deltas affected by the sediments."[183] Based on the impacts on these deltas (which, as explained above, are very small and are temporary), Nicaragua concludes that sediment from the Road is causing significant harm to aquatic organisms in the River.[184]

2.99. At the outset, it can be noted that the environmental impact study on which Nicaragua relies in the *Certain Activities* case reported that the San Juan contains planktonic and benthonic organisms in the San Juan of species "that are tolerant and adapted to adverse conditions".[185] This of itself is sufficient to cast very significant doubt on Nicaragua's current contentions.

2.100. Moreover, as noted above, any aggradation to existing deltas, or newly-created deltas, will be temporary. In such circumstances, a claim to significant harm could not be made out.

2.101. In any event, the evidence put forward by Nicaragua does not establish that the Road has adversely impacted the aquatic ecology of the River, even on some very temporary basis. As Professor Cowx explains, the findings of Dr Ríos are compromised by the use of inappropriate methods and do not substantiate Nicaragua's claim. The deficiencies in the 2014 Ríos Report are set out in Professor Thorne's report, and in summary include the following:

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183 **NR, Annex 4**, 2014 Ríos Report, Section 4(a).

184 NR, para. 2.92.

185 *Certain Activities*, **NCM, Annex 7**, p. 67.

(a) failure to take into account the comparative size of the drainage areas on the deltas on the northern and southern banks, which could explain any differences in ecological health on those deltas;

(b) failure to control for differences in the areas, natural vegetation and land use in the catchments draining to the deltas, which could give rise to the differences allegedly found by Ríos in the ecological health of the deltas;

(c) significant deficiencies in the statistical analysis applied to the data collected, resulting in unreliable conclusions; and

(d) the family level identification of invertebrates sampled in the River, which does not account for the fact that different species in the same family may have higher adaptability to adverse conditions, including in respect of sediment levels.[186]

2.102. On the basis of these and other factors, Professor Cowx concludes that:

> "Evidence provided in the Ríos Report that compares environmental bio-indicators for deltas on the northern and southern banks is largely inconclusive and fails to provide the robust empirical data necessary to prove that sediment eroded from the Road has adversely impacted the aquatic ecology of the San Juan River."[187]

And:

> "It is therefore unsound for Dr Kondolf to conclude that Road-derived sediment has had negative effects [on] invertebrate communities in the San Juan River."[188]

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[186] **Vol. II, Annex 2**, Cowx Report; and **Appendix A**, 2015 Thorne Report, paras. 6.22-6.35.

[187] **Vol. II, Annex 2**, Cowx Report, p. 19.

[188] **Vol. II, Annex 2**, Cowx Report, p. 18.

2.103. In their follow-up study on the impact of the Road, CCT consider the impact of sediment eroding to Costa Rican basins on the aquatic ecology of those basins, and conclude that there have been no significant adverse effects. They also note that from their visual observations of the Road, it appears that most of the Road does not present a threat to aquatic environments.[189] In these circumstances, and in the absence of any reliable evidence from Nicaragua to the contrary, Nicaragua's claim of adverse impact on the ecosystem of the San Juan River must be dismissed.

2.104. In its Reply, Nicaragua argues that there is a "risk that a hazardous substance, transported along the Road, will spill into the River following an accident."[190] It argues that the impact of such a spill "could be devastating" to the ecology of the River, in particular to fish and macroinvertebrate populations.[191]

2.105. Nicaragua's argument is based entirely on speculation, and it is speculation of a risk without basis. Costa Rica's 1995 Regulations for the Ground Transportation of Hazardous Materials provide effective regulation of the movement of hazardous substances.[192] Such substances can only be carried on

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189 **Vol. III, Annex 14**, 2015 CCT Report, para. 7.1.2.

190 NR, para. 3.34.

191 NR, para. 3.40.

192 **Vol. IV, Annex 15**, Costa Rica, Executive Decree No 24715-MOPT-MEIC-S, 6 October 1995, published in the Official Gazette number 207, 1 November 1995. In contrast, Nicaragua has failed to provide effective regulation of hazardous substances: see, for example, **Vol. IV, Annex 74**, Report by the Director General on the Status of Implementation of Article VII of the Chemical Weapons Convention as at 31 July 2014; Additional Measures for states parties that possess industrial Facilities which are declarable under the Convention. Reference EC-77.7, C-19/DG.8, 13 May 2014; and **Vol. IV, Annex 75**, Report by the Director-General on the Status of Implementation of Article VII of the Chemical Weapons Convention as at 31 July 2014: Article VII- Initial Measures, Reference EC-77/DG.6, C-19/ DG.7, 13 May 2014.

authorized roads,[193] and those authorized roads do not include the Road.[194] In the circumstances, there is no risk of adverse impact to the ecology of the River on the basis that hazardous substances will be transported on the Road.

2.106. Secondly, Nicaragua claims the Road has adversely impacted on tourism in Nicaragua and claims compensation for such harm. This claim is entirely unsupported by evidence of actual impact, and in any event lacks any sensible legal foundation.

2.107. As to evidence, Nicaragua relies on the Golder Report, arguing that the area's tourism potential has been "significantly impaired by the Road", and given that "tourism in the area 'is mostly associated with the natural beauty of this remote and non-highly commercialized region', the only reasonable conclusion is that Costa Rica's project detrimentally impacts tourism in Nicaragua."[195] The Golder Report refers to the 2013 CCT Report, which identified "landscape alteration" as an impact of the Road and recommended reforestation in areas visible to the San Juan River.[196] The Golder Report does not directly address the conclusion set out in the 2013 CCT Report that "[t]he effect of the construction of

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193 **Vol. IV, Annex 15**, Costa Rica, Executive Decree No 24715-MOPT-MEIC-S, 6 October 1995, published in the Official Gazette number 207, 1 November 1995, Article 39.

194 Route 1856 is not included in the list of authorized roads: see **Vol. IV, Annex 70**, Department of Transit Engineering, Ministry of Public Works and Transportation, Costa Rica, Authorization of Routes for the Transport of Hazardous Materials, 1995; **Vol. IV, Annex 76**, Note from the Chief Engineer of the Department of Studies and Designs to the Chief of the Department of Weights and Dimensions of the Consejo Nacional de Vialidad (CONAVI) and to the Director General of the Department of Transit Police, Reference DGIT-ED-4697-2014, 11 June 2014; and **Vol. IV, Annex 77**, Internal Communication of the Costa Rican General Department of Transit Engineering of the Ministry of Public Works and Transportation, regarding the Authorization of Routes for the Transport of Hazardous Materials, June 2014.

195 NR, para 2.94, citing **NR, Annex 6**, Golder Report, Section 7.

196 NR, Annex 6, Golder Report, pp. 42-43.

Route 1856 has no direct impact on tourism in recent years."[197] In its 2014 Report, CCT confirmed this conclusion.[198] Moreover, as explained in subsection (5) below, Costa Rica's extensive remediation works on the Road are restoring the landscape at impacted sites.

2.108. As to the legal basis of this claim, it is not explained. In the absence of any actual evidence of impact, it appears to be based on the proposition that a loss of visual amenity from one State to another can form the basis of significant and compensable harm in international law. This is nonsense. Nicaragua accepts that Costa Rica is able to build a road on its territory.[199] Costa Rica could have built a far larger road. To suggest that Costa Rica has violated its international obligations (and is liable to pay compensation) by building a road which Nicaragua finds visually unappealing is ludicrous.

(5) Remediation of the Road

2.109. As Costa Rica explained in Chapter 2 of its Counter-Memorial, since April 2012, in order to protect the work that has been carried out so far and to mitigate the effects of the Road (primarily in respect of Costa Rican territory), Costa Rica has been carrying out additional maintenance and remedial works on the Road.[200]

2.110. In its Reply, based on Dr Kondolf's visual observations of the Road, Nicaragua asserts that Costa Rica's remediation works are deficient, in that (a) they are confined to the upper 15 km of the Road, ignoring parts of the Road in

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197 **CRCM, Annex 10**, 2013 CCT Report, p. 148 (conclusion 14).

198 **Vol. III, Annex 14,** 2015 CCT Report, para. 7.1.3.

199 See, e.g. NR, para. 4.3.

200 See CRCM, paras. 2.38-2.41.

urgent need of remediation;[201] and (b) they are insufficient to prevent erosion into the River, including on the basis that many of the seedlings planted to provide ground cover have died.[202] Nicaragua claims that Costa Rica's works have not mitigated the alleged risk of significant harm to the River in the future.[203]

2.111. Contrary to Nicaragua's assertions based on observations from a distance, Costa Rica's remediation works have been effective in reducing erosion. These ongoing works are detailed in the reports of the CONAVI Department of Costa Rica's Ministry of Public Works and Transportation,[204] and CODEFORSA, the Commission contracted to plant and maintain more than 50,000 trees at sites along the Road.[205] They include sites beyond the first 15 km and cover many of the sites identified by Nicaragua's experts as the most severely eroding.[206] Explanations of how these works have been effective and photographs demonstrating that fact are provided with the Reports annexed to this Rejoinder. These works include the following:

(a) surfacing the Road with gravel to stabilised and protect it from surface erosion;

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201 See NR, paras. 3.21-3.23.

202 See NR, paras. 3.24-3.28.

203 NR, para. 3.33.

204 **Vol. III, Annex 11**, CONAVI, *Works on National Road N° 856: Before and After - Updated as of December 2014*, December 2014 (the ***2014 CONAVI Report***).

205 **Vol. III, Annex 13**, CODEFORSA, *Consulting Services for the Development and Implementation of an Environmental Plan for the Juan Rafael Mora Porras Border Road*, 2014 (the ***2014 CODEFORSA Report***); and **Vol. III, Annex 12**, CODEFORSA, *Restoration and rehabilitation of ecosystems affected by the construction of the Juan Rafael Mora Porras border road, Ruta 1856,* November 2014 (the ***CODEFORSA Quarterly Report for November 2014***).

206 **Appendix A**, 2015 Thorne Report, paras. 7.20 and 7.26.

(b) compaction and terracing and of loose fill slopes;

(c) protection of cut and fill slopes from surface erosion using coconut fibre and hydroseeding;

(d) clearing and safe disposal of slumped soil accumulated at the base of slopes;

(e) management of concentrated runoff using berms and concrete-lined ditches, with energy dissipaters where necessary;

(f) placement of silt fences and traps to intercept and retain eroded sediment;

(g) installation of culverts with concrete head and tail structures to stabilise small watercourse crossings;

(h) replacement of log bridges with modular bridges at larger watercourse crossings.[207]

2.112. In addition, an extensive programme of reforestation and re-vegetation is in progress. More than 50,000 trees have been planted, covering an area of around 46 hectares. Contrary to Nicaragua's assertions, the vast majority of these trees have survived: they are now aged between 2 and 28 months and range between 50 cm and 7 m in height. Those that did not initially survive were promptly replaced by CODEFORSA, as established in its contract, thus ensuring 100% fulfilment of the established number of trees to be planted. Photographs of each of the relevant sites are included in the CODEFORSA reports submitted with this

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207 See **Appendix A**, 2015 Thorne Report, para. 7.20; **Vol. III, Annex 11**, 2014 CONAVI Report.

Rejoinder.[208] As Professor Thorne explains, the areas selected for reforestation (including gentle but not steep slopes) are locations where trees will be effective in:

(a) reducing the erosivity of rainfall by intercepting precipitation;

(b) reducing the erodibility of the soil by decreasing soil moisture levels through evapotranspiration and by providing root reinforcement;

(c) reducing the generation of overland flow by increasing infiltration;

(d) intercepting surface runoff along concentrated flow paths by increasing surface roughness and ground permeability, to protect the soil and downslope areas from sheet, rill or gully erosion;

(e) intercepting surface runoff that might otherwise reach the Río San Juan; and

(f) creating valuable wildlife habitat.[209]

2.113. As Professor Thorne explains, based on his inspection of the Road:

> "My impression of the Road gained in 2014 is not that erosion has 'visibly worsened' (as Dr Kondolf states on page 11 of his 2014 Report) but, on the contrary, that it has slowed. This is partly due to the natural recovery of stability that follows disturbance of a landscape: the geomorphic 'rate law' which predicts that rates of change decrease exponentially with time since disturbance (Graf, 1977), but is also thanks to the concerted efforts of CONAVI and CODEFORSA in mitigating erosion at multiple sites, including those between the Río Infiernito and Boca San Carlos and

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208 See **Vol. III, Annex 13**, 2014 CODEFORSA Report; and **Vol. III, Annex 12**, CODEFORSA Quarterly Report for 2014.

209 **Appendix A**, 2015 Thorne Report, para. 7.6.

especially those east of the Río Infiernito (which have also been mitigated since Dr Kondolf wrote his 2014 Report).[210]

2.114. In the circumstances, it is apparent that Costa Rica's remediation effects have been and are continuing to be effective, and cannot merely be challenged on the basis of visual observations from a distance or inspection of available satellite imagery. In any event, as explained in paragraph 2.46 above, Costa Rica's estimation of erosion of sediment from the River to the Road has been done on the very conservative basis that its remediation works are having no effect; and even on that basis, there has been no adverse impact on the River.

D. The "Judgment" of the CACJ Should be given No Weight

2.115. In its Memorial, Nicaragua relied heavily on a judgment of the Central American Court of Justice of 21 June 2012 (the ***CACJ "Judgment"***). As Costa Rica explained in its Counter-Memorial, the CACJ "Judgment" should not be taken into account by the Court, because the CACJ did not have any jurisdiction, Costa Rica did not therefore participate in the proceedings, and what is more, the "Judgment" was based on no scientific evidence of harm whatever.

2.116. In its Reply, Nicaragua continues to rely upon the "Judgment", and "fully endorses" it.[211] For the reasons set out in Costa Rica's Counter-Memorial, Costa Rica maintains that CACJ "Judgment" cannot be given any weight by the Court.

E. Conclusion

2.117. Nicaragua's claims of significant harm rest on its assumption that the Road is contributing sediment to the River in quantities which cause or could

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210 **Appendix A**, 2015 Thorne Report, para. 7.26.

211 NR, para. 6.126.

cause harm. Costa Rica's evidence demonstrates that this is not the case, and moreover, *even accepting the estimates of contribution of sediment put forward by Nicaragua's experts, there is no adverse impact on the River, and there is no, and never has been any, risk of significant harm*. In particular:

(a) The sediment load carried by the San Juan in the period since construction of the Road is actually *lower* than it was before the Road was constructed. Hence, there is no evidence that construction of the Road has increased the suspended sediment load carried by the San Juan.

(b) The field monitoring undertaken by Costa Rica's experts on a worst-case scenario (including because the upper bound estimates of all erosion rates are applied at all slopes along the full length of the Road) indicates that the average input of sediment from the Road to the River is approximately 75,000 tonnes per year (a figure that is all the more conservative as it takes no account of the mitigation works). This represents less than 0.6% of the total sediment load of the River, and is obviously too small a proportion to have any significant or adverse impact on the River. If the highest estimate of Road-derived sediment put forward by Nicaragua's experts is accepted, it would represent less than 3% of the total sediment load of the River, which is also obviously too small a proportion to have any significant or adverse effect on the River.

(c) At Delta Colorado, around 10% of the San Juan enters to the Lower San Juan River. It is reasonable to assume that around 10% of the additional sediment would enter the Lower San Juan. Even accepting the figures of Road-derived sediment put forward by Nicaragua's expert (which are significantly overstated), and the proposition that all of it is deposited in the first three kilometres of the Lower San Juan (which is an untenable proposition), this would only cause the bed of the Lower San Juan to rise by 5 to 10 mm per year. This could not have impacted navigation or caused Nicaragua to have to dredge the River.

(d) As the Road is not delivering additional sediment to the River in excessive concentration or any measurable quantity which would cause any harm to the River, there is no evidence to suggest that there has been any adverse impact on the water quality of the San Juan.

(e) There has been no harm to the River in terms of channel morphology.

(f) There is no evidence of any adverse impact neither on the ecosystem, nor on tourism or health of riparians.

(g) Further, as follows from the evidence, there has never been any risk of significant harm from construction of the Road.

Chapter 3
Residual Legal Issues

A. Introduction

3.1. In Chapter 4 of its Reply, Nicaragua insists upon its position that the 1858 Treaty of Limits "puts the River under Nicaragua's sovereignty and, since the construction of the Road causes serious harm to the River, it is, indeed, crucially relevant for the present case".[212] This matter was discussed at length in the Counter-Memorial. The Treaty of Limits is indeed "crucial" for the relations between the two countries. However, it is of no relevance to the present proceedings.[213] Costa Rica rejects the interpretation advanced by Nicaragua in its Reply of the Treaty of Limits, and of the Court's Judgment of 13 July 2009 in the case concerning *Navigational and Related Rights*, for the reasons set out in this chapter.

3.2. Nicaragua's Reply acknowledges that Costa Rica is free to make its own appraisal of its security and communicational needs and of the best means by which to meet those needs within its territory.[214] It also concedes that this case is not about the construction of a road on a State's own territory, but about harm purportedly caused to a neighbouring State as a result of such construction.[215] Insofar as there is no adverse impact on Nicaragua, the effect of these concessions is that all the allegations that Nicaragua has made in its pleadings about the

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212 NR, para. 4.5.

213 See Chapter 4 of CRCM.

214 NR, para. 4.2.

215 NR, para. 4.6.

purported deficiencies in construction work carried out on Costa Rican territory, about the Emergency Decree which authorised the construction work, as well as Nicaragua's extravagant analysis of breaches by Costa Rica of Costa Rican domestic law, must be disregarded.

3.3. Nicaragua has also asserted that an array of other rules are relevant to the present proceedings. Indeed, it appears that the main reason for Nicaragua including in its Memorial allegations premised on its interpretation of the Treaty of Limits and the related arbitral awards, as well as the Court's 2009 Judgment, was to attempt to justify the claim that it is entitled to prevent the exercise of Costa Rica's perpetual right of free navigation on the San Juan River as a counter-measure.[216] Nicaragua has not pursued this claim in its Reply, following Costa Rica's response to it in the Counter-Memorial.[217] Nicaragua also appears to have abandoned other accusations such as the colourful claim that there was an "invasion of Nicaraguan territory".[218]

3.4. However, Nicaragua maintains in its Reply that the (inexistent) harm to the San Juan River that it alleges also constitutes a breach of both its territorial sovereignty, and the 1858 Treaty of Limits, including the judicial and arbitral interpretations thereof. Equally, Nicaragua persists in alleging breaches to its right of navigation (of which no evidence has been presented after two rounds of written pleadings) and the Costa Rican obligation to conduct and to notify an Environment Impact Assessment ("EIA"). This chapter will also discuss these residual legal issues.

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216 NM, para. 4.9 and 6.36.

217 CRCM, paras. 6.24 to 6.25. See also para. 4.4.

218 NM, p. 129, para. 4.13.

B. Nicaragua's insistence that there has been a breach of the 1858 Treaty of Limits and of its territorial sovereignty

3.5. In the Reply, Nicaragua maintains that Costa Rica has breached the Treaty of Limits. It devotes considerable length to the interpretation of this Treaty. Nicaragua acknowledges that Costa Rica's navigational rights on the San Juan River are a limitation on Nicaragua's sovereignty over the waters of the River established by the 1858 Treaty of Limits.[219] However, the Reply wrongly contends that Costa Rica's right to navigate the San Juan is just an exception, and Nicaragua otherwise enjoys unlimited sovereignty over the River. There are two concomitant rights over the San Juan River stemming from the 1858 Treaty: Nicaragua's sovereignty; and Costa Rica's perpetual right of navigation.

3.6. The Reply quotes the following sentence of the Court's judgment of 13 July 2009: "[t]he Treaty of Limits completely defines the rules applicable to the section of the San Juan River that is in dispute in respect of navigation".[220] The Reply then posits as follows: "But this is only an exception, a treaty limitation, to the, for the rest *unlimited*, Nicaraguan sovereignty over the waters of the River".[221] This assertion ignores both the fact that the Treaty of Limits imposes other limitations on Nicaragua,[222] and crucially what the Court also affirmed in the same Judgment, namely:

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219 NR, para.4.3.

220 *Dispute regarding Navigational and Related Rights (Costa Rica v. Nicaragua), Judgment, I.C.J. Reports 2009*, p. 233, para. 36.

221 NR, para. 4.4 (italics in the original).

222 For example Article VIII of the Treaty. Cf. *Dispute regarding Navigational and Related Rights (Costa Rica v. Nicaragua), Judgment, I.C.J. Reports 2009*, p. 234, para. 38.

> "A simple reading of Article VI shows that the Parties did not intend to establish any hierarchy as between Nicaragua's sovereignty over the river and Costa Rica's right of free navigation, characterized as "perpetual", with each of these affirmations counter-balancing the other. Nicaragua's sovereignty is affirmed only to the extent that it does not prejudice the substance of Costa Rica's right of free navigation in its domain, the establishment of which is precisely the point at issue; the right of free navigation, albeit "perpetual", is granted only on condition that it does not prejudice the key prerogatives of territorial sovereignty."[223]

There is no need to further discuss these points here, since they are not relevant for this case.

3.7. Nicaragua does not claim that the 1858 Treaty of Limits imposes specific limitations on works Costa Rica may plan or implement on its territory. The Reply is more indirect than that. Nicaragua asserts that "the Treaty puts the River under Nicaragua's sovereignty and, since the construction of the Road causes serious harm to the River, it is, indeed, crucially relevant for the present case".[224] There has been no serious attempt to rebut what Costa Rica made plain in its Counter-Memorial: that Nicaragua's sovereignty over the waters of the San Juan River and the exercise of this sovereignty are *not put in issue* by any of the Costa Rican conduct complained of, even assuming the existence of the alleged harm to those waters (*quod non*).

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223 *Dispute regarding Navigational and Related Rights (Costa Rica v. Nicaragua), Judgment, I.C.J. Reports 2009*, p. 237, para. 48.

224 NR, para. 4.5.

3.8. This Chapter does not address the lengthy discussion in the Reply concerning a further matter that is not in issue between the parties, namely whether "a State may do anything it wishes within its territory regardless of the transboundary consequences for other States".[225] Nicaragua says this is Costa Rica's position. Manifestly, it is not. Costa Rica also does not address the provocative remark that its position "resonates alarmingly with the Harmon Doctrine of absolute territorial sovereignty".[226] Costa Rica's written pleadings both in this case and the *Certain Activities* case[227] demonstrate that there is no ground on which to make these assertions. That is enough to dispose of Chapter 4 of Nicaragua's Reply.

3.9. Chapter 5 of the Reply sets out Nicaragua's position as follows: "*Any* artificial elements dumped on its territory is a violation of its territorial sovereignty. An unlawful overflight of a State or the pursuit of a criminal in the territory of a neighbouring State would, in most cases, not cause concrete or 'financially assessable damage'; however, when attributable to a State, they indisputably entail State responsibility."[228] Nicaragua has also advanced the unfounded claim that Costa Rica "uses the River as a garbage dump".[229] Again, these allegations are devoid of any supporting evidence. They are simply incorrect. Indeed, even if Costa Rica were as indifferent to environmental harm as Nicaragua contends, as a riparian of the River enjoying navigational rights, it would not be in the interest of Costa Rica to proceed in the way Nicaragua alleges.

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225 NR, para. 4.7.

226 NR, para. 4.14.

227 European Comission, Environmental Impact Assessment (EIA) Directive (85/337/EEC), 1985, available at http://ec.europa.eu/environment/eia/eia-legalcontext.htm.

228 NR, para. 5.10.

229 NR, para 4.4.

3.10. The Reply sets out, again, the same assertions that Nicaragua advanced in the Memorial, without addressing the arguments made by Costa Rica in the Counter-Memorial. After citing once again the celebrated arbitral award of Max Huber in the *Island of Palmas (Miangas)* case, Nicaragua repeats, quoting once again from the well known Judgment of the Permanent Court of International Justice in the *Lotus* case, that "[a]s a consequence, a State 'may not exercise its power in any form in the territory of another State.'"[230] No effort is made to rebut Costa Rica's position, which is in any event obvious on the face of the evidence and pleadings in this case, that there has not been any exercise of Costa Rican power or authority in Nicaraguan territory, whether this be the waters of the San Juan River, Nicaraguan airspace or land.

3.11. All that Nicaragua can summon in support of its contention that there have been "violations to its territorial sovereignty" is the argument that Costa Rica, by constructing the road, is "voluntarily discharging" sediment in the San Juan River and "changing the configuration of the river".[231] In its Counter-Memorial, Costa Rica explained that even if significant harm were caused to the river as a result of the construction of the road (*quod non*), this would not have constituted a breach of the obligation to respect the territorial sovereignty of other States, but rather a breach of the obligation not to cause significant transboundary harm.[232] These are two quite different obligations. Nicaragua has failed to address the significance of this distinction in general, and in relation to this case in particular.

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230 NR, para. 5.12.

231 NR, paras. 5.16-5.17.

232 CRCM, para. 4.9.

3.12. The claim that Costa Rica voluntarily discharges sediment to the San Juan River is repeated in the Reply without any supporting evidence.[233] Nicaragua's argument is that because any sediment would be the product of the construction of the road, such sediment is not "natural",[234] and "*[a]ny* artificial elements dumped on its territory is a violation of its territorial sovereignty".[235] Of course, Costa Rica is not dumping anything. When it comes to explaining this assertion, Nicaragua merely contends that this situation "entails international responsibility",[236] something different from a violation of territorial sovereignty. As a matter of course, international responsibility results from a breach of any international obligation, and not only from a breach of the obligation to respect the territorial sovereignty of other States. In any event, there was no such violation in these proceedings.

3.13. As explained in Chapter 2 above, the amount of sediment coming to the River that can be attributed to the construction of the road is insignificant.[237] Nicaragua seems to consider that the fact that sediment reaches the River *per se* is tantamount to a situation where a State collects sediment or another substance from a source and deliberately discharges it into the territory of another State. The latter situation is obviously not analogous to the facts in the present case. In the present case, it is sediment that is entering the River in inconsequential amounts. There is no deliberate act of transport by Costa Rica, i.e. "dumping". Further, sediment is not an artificial substance; it is soil, which has moved from where it is

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[233] NR, para. 5.15.

[234] NR, para. 5.7.

[235] NR, para. 5.10.

[236] NR, para. 5.10.

[237] See paras. 2.77-2.80 of this Rejoinder.

naturally found by the action of weather or erosion. Causes of erosion are manifold. Some of them are anthropogenic; by walking along the bank of a River erosion can occur. But this does not render the soil any less natural a substance, or the process by which it reached the River deliberate. Further, as appears from Chapter 2 above, the fact that sediment enters the River is not unusual or a cause for concern; fluvial processes are the most common way of transporting sediment, and the San Juan River is a particularly sediment-heavy river. There may be environmental concerns about certain human activities, a point discussed above in this Rejoinder.[238] However, this situation does not in any way amount to a 'breach of the territorial sovereignty and integrity' of States, or a breach of the 1858 Treaty of Limits.

3.14. If Nicaragua's hypothesis was considered correct, then the sediment that was dumped into the San Juan River as a result of the construction by Nicaragua of the Santa Fe bridge would be tantamount to a violation of Costa Rica's sovereignty and integrity, as that sediment entered Costa Rica's Colorado River.

3.15. Shifting its focus regarding its previous general claim about impairment of its right of navigation,[239] Nicaragua further contends "that the formation of numerous 'very visible' and 'massive' deltas, resulting from the construction of the Road changes the very configuration of the River".[240] A number of points are made in response to this ludicrous exaggeration. *First,* there is a dispute between the parties about whether deltas in the San Juan River are the result of the construction of the Road. It is undisputed that deltas are present on both banks of

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238 See para. 2.70.

239 NM, para. 4.15.

240 NR, para. 5.19 (footnote omitted).

the River, and have been so present long before the construction of the Road.[241] *Second*, as explained in the Report by Professor Thorne annexed to this Rejoinder, deltas are natural features that, in the same way they were formed, also disappear.[242] They are ephemeral and unstable adjunctions to the banks. An enormous stretch of imagination is required to consider, as Nicaragua contends, that "[t]hese [indeed, allegedly three] and other Road-derived deltas on the River have a clear negative impact on navigation".[243] Nicaragua explains its claim on the basis that "it is no longer possible to navigate the River in the locations the deltas have come to occupy".[244] Applying this reasoning, Costa Rica could contend that deltas formed on the Nicaraguan side of the River breach its right to navigate the San Juan. That the existence of deltas is a breach of the right of navigation (of any State) simply defies common sense. In its Counter-Memorial, Costa Rica noted that Nicaragua has not submitted any evidence of any impairment of its right to navigation. This remains the position after the filing of Nicaragua's Reply.

C. There is no obligation to notify the construction of the Border Road under the 1858 Treaty of Limits or by reason of the Court's 2009 Judgment

3.16. The Reply insists on a curious reading of the Court's 2009 Judgment in the case concerning *Navigational and Related Rights* to support an alleged obligation by Costa Rica to notify Nicaragua of the construction of the Road in the context of the legal regime of the San Juan River. It extensively quoted paragraphs 94 and 95

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241 See **Appendix A**, Thorne Report, 2015 paras. 5.8 - 5.11.

242 See **Appendix A**, Thorne Report, 2015 para. 5.16.

243 NR, para. 5.24.

244 NR, para. 5.24.

of the 2009 Judgment, omitting once again paragraph 93.[245] Nicaragua's position is that, since the Court acknowledged a right to regulate navigation on the San Juan River and the corresponding obligation of Nicaragua to notify such regulations to Costa Rica, the same obligation of notification would apply to Costa Rica's construction of the Road, even if there is no specific provision of this in the Treaty of Limits.

3.17. The only reasoning supporting this assertion is that the Court's analysis would apply *mutatis mutandis* to the present case, in which there would be not just regulations but concrete acts, which would be detrimental to the navigation and the sovereignty of Nicaragua over the waters of the San Juan, "guaranteed by Article VI of the 1858 Treaty".[246] Costa Rica has already responded to these arguments.[247] In summary, the obligation to notify Costa Rica about regulations concerning navigation on the San Juan River arises by virtue of Costa Rica's right of navigation on the River, as established by Article VI of the Treaty of Limits. There is no Nicaraguan right of any sort pertaining to Costa Rican territory. There is an obligation of consultation in Article VIII of the Treaty of Limits, which is of no relevance to the present case because it applies in the event that Nicaragua envisages canalisation works. None of the factors mentioned by the Court to determine the existence of the Nicaraguan obligation to notify navigational regulations apply to the construction of the Road.

3.18. Nicaragua considers that this alleged Costa Rican obligation to notify

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245 NR, para. 5.28.

246 NR, para. 5.29.

247 CRCM, paras. 4.13-4.17.

extends to the current or planned works on the Road.[248] For the reasons explained above, there is no such obligation under the 1858 Treaty or the 2009 Judgment.

3.19. Whether there exists an obligation to notify works such as the construction of the Road stemming from other international rules applicable to the parties is a matter that is examined below, in the context of the situation of emergency that prompted Costa Rica to construct the Road.[249]

D. EIA in the Context of an Emergency

3.20. The Reply's analysis of the requirement of an EIA in the context of an emergency situation is by and large a repetition of what was stated in the Memorial.[250] Once again, the Reply spent pages addressing the conditions to be met to invoke a state of necessity as a circumstance precluding wrongfulness, even though this is not a claim made by Costa Rica.[251] Costa Rica also does not invoke its domestic law to justify any alleged breach of international law, and thus Nicaragua's submissions on Article 27 of the Vienna Convention on the Law of Treaties are irrelevant.[252] Furthermore, Costa Rica's position cannot be equated to an alleged "unilateral self-help measure"; there is no basis on which to draw an analogy between road works carried out entirely on Costa Rican territory and the situation "which the Court strongly disapproved in *United States Diplomatic and*

248 NR, paras. 5.31-5.32.

249 See below, paras. 3.29 to 3.46.

250 Cf. NM, paras. 2.15-2.23 and NR, paras. 6.6-6.21.

251 Cf. NM, paras. 5.23-5.24, NR, Ch. 6 and CRCM, para. 5.15.

252 NR, para. 6.17.

Consular Staff in Tehran", as evoked by Nicaragua.[253] Leaving these matters to one side, this section will address the following points: a) The threshold required in respect of the obligation to conduct an EIA; b) the emergency exemption under international law; c) the emergency situation in the present case; and d) the existence of an alternative assessment.

(1) The threshold required for an EIA

3.21. The threshold requirement for an EIA is *significant transboundary* harm or impact. The present case concerns the harm that is alleged to have been caused to Nicaraguan territory by reason of the construction of the Road, and nothing else. Any analysis by Nicaragua of harm allegedly caused by Costa Rica to Costa Rican territory is outside the scope of any Nicaraguan claim at the international level and does not fall within the case that is put before the Court in these proceedings. The same applies to the new allegations in the Reply concerning different causes of sedimentation of the San Juan River allegedly originating from Costa Rican territory.

3.22. It is common ground between the parties that the international obligation to conduct an EIA only arises where there is a *risk of significant adverse transboundary impact or harm*. What the parties do not agree on is whether this threshold was met in the present case.

3.23. As Costa Rica has previously stated, the construction of the Road did not and does not lead to the discharge of harmful substances or emissions into the San

[253] NR, para. 6.18.

Juan River, or any other part of Nicaraguan territory.[254] This case is not concerned with an industrial activity, such as a pulp mill. Nicaragua's only response is that Costa Rica has not referred to any "evidence in support of this contention".[255] This position shows a serious misunderstanding of the burden of proof. It is Nicaragua which bears the burden of proving that the construction of the Road threatened or caused significant transboundary harm. Nicaragua appears to require Costa Rica to produce evidence of an abstention: that the Road does not produce discharges of harmful substances or emissions. It is obvious that Nicaragua has not and cannot produce the requisite evidence necessary to prove such alleged discharges or emissions, nonetheless because there are none.

3.24. Another element to be taken into account in order to establish the need for an EIA in the context of the construction of the Road is the risk of significant transboundary harm as a result of erosion or significant quantities of sediment entering into the River. As the evidence has demonstrated, this risk has never existed and significant transboundary harm did not and will not occur.[256]

3.25. In some cases, as evidenced in Professor Craik's report on the requirement to perform a prior environmental impact assessment, to avoid the relative ambiguity of the "significant" threshold, international or regional instruments identify activities that, by virtue of their scale or risk, are automatically subject to an EIA.[257] The Espoo Convention, for example, provides a list of activities that

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254 CRCM, para. 5.12.

255 NR, para. 6.30.

256 See para. 2.117 above.

257 See **Vol. II, Annex 1,** Professor Neil Craik, *The Requirement to Perform a Prior Environmental Impact Assessment*, February 2015, (the ***Craik Report***), para. 4.4.

would require an EIA.[258] A similar approach is used in the European Community EIA Directive,[259] and is acknowledged as an appropriate mechanism in the Guidelines for Biodiversity Inclusive Impact Assessment under the CBD.[260] In relation to the Espoo list (Appendix 1), Nicaragua notes in its Memorial that the list includes, "motorways" and "express roads", as well as "deforestation of large areas".[261] However, to be clear, the definition of the road-related terms in Appendix 1 would exclude a road, such as the one built by Costa Rica.[262] Evidently, this is not a highway or an "express road". The limited clearing activities associated with the Road would not amount to "deforestation of large areas". In other words, were the Espoo Convention to apply – which it does not – Costa Rica would not owe an obligation to conduct an EIA under that treaty.[263]

3.26. As stated above, alleged harm to the ecosystem within Costa Rica is not a matter to be discussed here, since it would not be transboundary, unless there would be an adverse impact on Nicaraguan territory. It is for Nicaragua to demonstrate such impact, or at least its likelihood in order to meet the threshold. But this proof is lacking.

3.27. The only possible environmental consequence of the construction of the Road on the San Juan River is an alleged increase in sediment load. However, the

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258 Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), Finland, 25 February 1991, Article 2(3) and Appendix 1.

259 European Commision, EIA Directive, Article 4.

260 Conference of the Parties to the Convention of Biological Diversity (CBD), Decision VIII/28, "Impact Assessment: Voluntary guidelines on biodiversity-inclusive impact assessment", UN Doc. UNEP/CBD/COP/8/31, (CBD EIA Guidelines) Art. 10.

261 NM, footnote 474.

262 Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), Finland, 25 February 1991, Appendix 1.

263 *Ibid*, Article 2(5).

mere fact that this event may occur is not sufficient to meet the threshold giving rise to an obligation under international law to produce an EIA. As Professor Thorne has demonstrated in his reports, the impact of the Road on the sediment load in the San Juan River is indiscernible,[264] and has never generated any risk of significant harm.[265] This indiscernible amount of sediment falls well short of the threshold of significant harm, which requires – in the words of the International Law Commission – "something more than detectable".[266]

3.28. Nicaragua also referred to "significant adverse effects on biological diversity", the threshold stipulated under Article 14 of the Convention on Biodiversity. More than three years have passed since these proceedings were commenced during which time there has been no manifestation of the "threat" to biodiversity claimed by Nicaragua in December 2011.[267] Nor is there any evidence of a risk of significant adverse effects on biological diversity arising in the future. By reference to the screening criteria identified in the CBD Voluntary Guidelines on Biodiversity-inclusive impact assessment, Nicaragua's Reply does not produce any evidence of (1) biological changes that would increase the "risks of extinction of genotypes, cultivars, varieties, populations of species, or the chance of loss of habitat or ecosystems", (2) activities that would "surpass the maximum sustainable yield, the carrying capacity of a habitat/ecosystem or the maximum allowable disturbance level of a resource, population or ecosystem,

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264 **CRCM, Appendix A**, 2013 Thorne Report, para. 12.2; this Rejoinder, **Appendix A**, 2015 Thorne Report, para. 8.2.

265 **CRCM, Appendix A**, 2013 Thorne Report.

266 International Law Commission, *"Commentaries to the Draft Articles on Prevention of Transboundary Harm from Hazardous Activities"*, in *Report of the International Law Commission.* Fifty-Third Session, UN GAOR, 56th Sess., Supp. No. 10, UN Doc. a/56/10 (2001), Article 2, Commentary 4.

267 Nicaragua's Application instituting proceedings, 21 December 2011, paras. 4 and 10.

and/or (3) activities that would "result in changes to the access to, and/or rights over biological resources".[268] These factors are noted in the Report by Dr W. Sheate annexed to the Reply, which indicates the relevance of a table incorporating these criteria from the CBD Guidelines.[269] But again, the evidence does not directly address these criteria. Nicaragua has not produced any technical comparison showing the conditions of habitats or ecosystems in the San Juan river before and after the construction of the Road, even though Costa Rica requested Nicaragua evidence in this regard when Nicaragua started publicly complaining about road construction.[270]

3.29. Nicaragua has also denied access to Costa Rican technical experts to carry out measurements on the sediment load carried by the River.[271] The Environmental Diagnostic Assessment submitted by Costa Rica in CRCM, as well as the new Follow-up Study, and reports submitted in this Rejoinder have not disclosed any impacts of the nature that would indicate significant transboundary adverse impacts in accordance with the identified factors.[272] Notably, if there would have been serious impacts, they would have taken place in Costa Rican territory, but evidence shows that impacts were small and localized, are being mitigated, and that there is certainly no transboundary effect.[273]

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268 Conference of the Parties to the CBD, Decision VIII/28, UN Doc. UNEP/CBD/COP/8/31, (CBD EIA Guidelines), section 1.2(a) "Screening".

269 **NR, Vol. II, Annex 5**, Sheate Report, p.10.

270 See **CRCM, Vol. III, Annex 39**, Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Ref DM-601-11, 29 November 2011.

271 See paras. 2.28-2.33 above.

272 **CRCM, Vol. III, Annex 10,** 2013 CCT Report; and this Rejoinder, **Vol. III, Annex 14**, 2015 CCT Report.

273 **Vol. III, Annex 14**, 2015 CCT Report, p. 83.

3.30. In summary, the threshold of a risk of significant transboundary harm or impact required for the international obligation to produce an EIA to apply was not met in the present case.

(2) Emergency as an exception to the international obligation to produce an EIA

3.31. Nicaragua does not accept that a situation of emergency may exempt a State from its international obligation to produce an EIA. It considers that this obligation always applies, and only a circumstance precluding wrongfulness would excuse a State not having produced an EIA from committing an international wrongful act. There is no basis for this assertion.

3.32. The only argument advanced by Nicaragua in the Reply is premised on an extrapolation of a statement made by the Court in the *Pulp Mills* case: that as general international law does not specify the scope and content of an EIA, these are two matters left to each State to determine under domestic legislation. *Arguendo a contrario*, Nicaragua contends that *only* these two aspects of an EIA are matters left to domestic law.[274] This is a distortion of the Court's Judgment. The question of an emergency situation was not at issue in the case between Argentina and Uruguay. The Court had no need to refer to it, and the Court quite properly limited its Judgment to only those points it had to address. No inference against the determination of an emergency situation under domestic law as an exception to the obligation to conduct an EIA can be made from paragraph 205 of the Court's Judgment in the *Pulp Mills* case. On the contrary, the Court's

274 NR, paras.6.34-6.35.

methodology that allowed it to make its finding in 2010 is apt to determine the different situation that has to be addressed in the instant case, as Professor Craik's report states.[275]

3.33. It was not until recently, following the clarification by the Court in the *Pulp Mills* case, that the international obligation to produce an EIA in certain circumstances was determined. The Court came to its conclusion with regard to the obligation to conduct an EIA on the basis of a practice that "gained in recent years so much acceptance".[276] Consequently, the question whether international law recognises that it is a matter of domestic law whether an emergency situation is an exception to the obligation to produce an EIA is an issue that must be approached in a similar manner, namely by determining the existence of international practice in support.

3.34. International practice demonstrates that the emergency exception has also "gained … much acceptance", to use the words of the Court. Both international and domestic instruments recognise the ability of States to exempt specific projects under particular circumstances, namely activities undertaken in relation to national security and civil emergencies. In particular:

(1) The Antarctic EIA regime contained in Annex 1 to the Protocol on

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[275] See **Vol. II, Annex 1,** Craik Report, para. 2.11.

[276] "In this sense, the obligation to protect and preserve, under Article 41 (a) of the Statute [of the River Uruguay] has to be interpreted in accordance with a practice, which in recent years has gained so much acceptance that it may now be considered a requirement under general international law to undertake an environmental impact assessment where there is a risk that the proposed industrial activity may have a significant adverse impact in a transboundary context, in particular, on a shared resource." *Pulp Mills on the River Uruguay (Argentina v. Uruguay), Judgment of 20 April 2010, ICJ Reports 2010*, p. 83, para. 204.

Environmental Protection to the Antarctic Treaty includes the following provision, entitled “Cases of Emergency”, which exempts emergencies from the EIA requirements of the treaty:

> “1. This Annex shall not apply in cases of emergency relating to the safety of human life or of ships, aircraft or equipment and facilities of high value, or the protection of the environment, which require an activity to be undertaken without completion of the procedures set out in this Annex.
> 2. Notice of activities undertaken in cases of emergency, which would otherwise have required preparation of a Comprehensive Environmental Evaluation, shall be circulated immediately to all Parties and to the Committee and a full explanation of the activities carried out shall be provided within 90 days of those activities.”[277]

(2) The Espoo Convention contains, in paragraph 2(8), a provision that retains for states the right to implement domestic laws to protect “information the supply of which would be prejudicial to industrial and commercial secrecy or national security”.[278]

(3) The Kyiv Protocol on Strategic Environmental Assessment (to the Espoo Convention on Environmental Impact Assessment in a Transboundary Context) includes a provision, which exempts plans and programmes otherwise subject to assessment in cases of “civil emergencies”.[279]

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277 Protocol on Environmental Protection to the Antarctic Treaty, 4 October 1991, 30 I.L.M. 1455 (1991), Annex 1, Article 7, available at http://www.ats.aq/e/ep.htm.

278 Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), , 25 February 1991.

279 Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context (Kyiv (SEA) Protocol), available at http://www.unece.org/env/eia/sea_protocol.html.

(4) Article 4(6) of the Draft Protocol on Environmental Impact Assessment in a Transboundary Context to the Framework Convention for the Protection of the Marine Environment of the Caspian Sea reserves the rights of the Parties to implement laws in the "interests of national security".[280]

(5) Article 1(3) of the EC EIA Directive provides that states may decide on a case-by-case basis to exempt the Directive from "projects or parts of projects, having defence as their sole purpose, or to projects having the response to civil emergencies as their sole purpose".[281]

(6) The United States federal EIA statute, the National Environmental Policy Act, (the first EIA statute to be enacted globally), contains in its regulations (40 C.F.R. 1506.11), a provision entitled "Emergencies", which states:

> "Where emergency circumstances make it necessary to take an action with significant environmental impact without observing the provisions of these regulations, the Federal agency taking the action should consult with the Council about alternative arrangements. Agencies and the Council will limit such arrangements to actions

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280 Protocol on Environmental Impact Assessment in a Transboundary Context to the Framework Convention for the Protection of the Marine Environment of the Caspian Sea, Draft prepared for Conference of the Parties, Fifth Meeting, 28-30 May 2014, UN Doc. TC/COP5/4 Rev.1, Art. 4(6).

281 European Commission, Environmental Impact Assessment (EIA) Directive (85/337/EEC), 1985, available at http://ec.europa.eu/environment/eia/eia-legalcontext.htm.

necessary to control the immediate impacts of the emergency. Other actions remain subject to NEPA review."[282]

(7) Other national EIA legislation that has an emergency exemption includes Canada[283], Australia,[284] Mexico,[285] Chile,[286] Paraguay,[287] and Peru,[288] as well as Nicaragua's EIA legislation, which contains an emergency exemption in Article 12.[289]

3.35. The Report prepared by Dr W. Sheate for Nicaragua acknowledges that "[a] number of EIA regimes across the world – the European Union, the United States of America, for example – have exemption clauses in relation to civil emergencies or projects associated with national defence, so Costa Rica's exercise of an emergency exemption per se is not particularly unusual". [290] Given the widespread incorporation of emergency exemptions to EIA requirements in

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282 National Environmental Policy Act (NEPA), 42 U.S.C. 4321, et seq, regulations (40 C.F.R. 1506.11), United States of America.

283 Canadian Environmental Assessment Act, 2012, available at http://laws-lois.justice.gc.ca/eng/acts/C-15.21/index.html.

284 Environmental Protection and Biodiversity Conservation Act 1999, (Cth.), s.158(5) available at http://www.comlaw.gov.au/Details/C2012C00248.

285 Reglamento de la Ley General del Equilibrio Ecológico y la Protección al Medio Ambiente en Materia de EIA, (Federal Regulation), Art.7 available at http://www.ibiologia.unam.mx/ reserva/leyes/pdf/4.pdf.

286 Ley General de Bases del Medio Ambiente, Ley 19 300, Art. 15, available at http://www.leychile.cl/Navegar?idNorma=30667.

287 Ley 294 Evaluación de Impacto Ambiental, Art. 9, available at http://www.bacn.gov.py/ampliar-leyes-paraguayas.php?id=2374.

288 Ley del sistema nacional de EIA y su reglamento, Art. 81. available at http://www.minam.gob.pe/wp-content/uploads/2013/10/Ley-y-reglamento-del-SEIA1.pdf.

289 **CRCM, Vol. III, Annex 25**, Nicaragua Decree N°76-2006, Environmental Evaluation System.

290 NR, Annex 5, Sheate Report, p.27 (309 of vol. 2 NR) (references excluded).

international and national instruments, the exemption must be understood as a standard part of the EIA process. The international obligation should, therefore, be interpreted to be subjected to the right of States to incorporate an emergency exemption under domestic law, as Professor Craik equally concludes in his Report.[291]

3.36. While the specific exemption originates in domestic law, in the present case through Costa Rica's Emergency Decree, Nicaragua is incorrect in characterizing the exemption as an internal law used to excuse an international obligation, as it is the international obligation itself that includes the right of States to exempt activities under conditions of civil emergencies and national security concerns.

3.37. The presence of an emergency exemption under international law is consistent with the obligation of States to use due diligence, which was also another element employed by the Court to reach its conclusion of the existence of an obligation to conduct an EIA.[292] In the case of an emergency, it is not "reasonable" nor within the degree of care "expected of a good Government" to require a State to delay urgent activities in order to conduct an EIA. The exemption is also consistent with the deference that international law provides to States to determine the contents of their EIA instruments, as it leaves it up to

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291 **Vol. II, Annex 1,** Craik Report, para. 5.3 pp. 17-18.

292 "In this sense, the obligation to protect and preserve, under Article 41 (a) of the Statute [of the River Uruguay] has to be interpreted in accordance with a practice, which in recent years has gained so much acceptance that it may now be considered a requirement under general international law to undertake an environmental impact assessment where there is a risk that the proposed industrial activity may have a significant adverse impact in a transboundary context, in particular, on a shared resource." *Pulp Mills on the River Uruguay (Argentina v. Uruguay), Judgment of 20 April 2010, ICJ Reports 2010*, p. 83, para. 204.

States to determine whether they implement an emergency exception.

3.38. The extent of the exemption varies from instrument to instrument, but generally allows activities that relate to national security and civil emergencies to be exempted from EIA requirements.[293] The exemption could be implemented either through a provision in the domestic EIA legislation that confers discretion on an administrative decision-maker to exempt an activity meeting the requirements of an emergency, or on a case-by-case basis through an emergency decree, such as the one issued by Costa Rica. This is also a matter that general international law does not specifically regulate.[294]

3.39. To sum up, following the same method employed by the Court in the *Pulp Mills* case, international practice shows that emergency situations are exceptional circumstances exempting the production of a prior EIA. The next section examines the existence of an emergency situation in the present case.

(3) The existence of a situation of emergency in Costa Rica by reason of Nicaragua's actions

3.40. The declaration of a situation of emergency in Costa Rica, which provided the legal framework by which the construction of the Border Road was undertaken, is incorrectly considered by Nicaragua to be beyond the territorial and temporal scope of the particular situation to which Costa Rica was responding. It is not because the military incursion and occupation by Nicaragua of Costa Rican

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293 See, for example, *Winter v. Natural Resources Defense Council Inc.* 129 Supreme Court of the United States of America, 365 (2008).

294 **Vol. II, Annex 1,** Craik Report, para. 5.5 p. 16.

territory occurred in the northern part of Isla Portillos that Costa Rica must confine its reaction to defend itself spatially to that area.[295] Further, whether the project of the Border Road was completed or not in a short period of time is also immaterial to the declaration of a situation of emergency.[296] The Reply also digresses into consideration about whether the measures that Costa Rica took to respond to the emergency were appropriate.[297] The evaluation of the appropriateness of the measures adopted is a purely domestic matter that only concerns Costa Rica. The only valid concern Nicaragua may raise is significant transboundary harm. As seen above, there is no basis for such a claim.

3.41. What is relevant in order to evaluate the construction of the Border Road in a situation of emergency is whether, at the time the decision was taken, an emergency situation was in existence. The Emergency Decree was not issued two months after the construction work on the Border Road commenced, as Nicaragua contends.[298] In December 2010, a matter of weeks after the first Nicaraguan occupation of the northern part of Isla Portillos, the improvement of existing dirt roads began in order to allow access with and between the border posts of Delta Costa Rica and Boca Sarapiquí. It was in that context that the Costa Rican Minister of Public Security considered that, in order to ensure adequate access to the border posts and to facilitate the mobilisation of its citizens in case of the aggravation of the situation, the construction of a road was necessary.[299] Consequently, the Costa Rican Government issued the Emergency Decree on

295 NR, para. 6.14-6.15.

296 NR, para. 6.13.

297 NR, para. 6.16-6.17.

298 NR, para. 6.12.

299 CRCM, paras. 2.25-2.27.

21 February 2011.[300] It was after this Decree was issued that the project of constructing the Border Road started under the responsibility of the Ministry of Public Works and Transportation (CONAVI).[301]

3.42. The Emergency Decree was adopted in accordance with Costa Rican law, as confirmed by the Costa Rican Constitutional Court.[302] This is not challenged by Nicaragua.

3.43. The Nicaraguan action that prompted the emergency reached its first peak with the occupation of the northern part of Isla Portillos, and the construction of an artificial *caño* thereon, and the second peak with its subsequent claim of sovereignty over this area. This constituted an express rejection of the territorial boundary between the two countries established by the 1858 Treaty and demarcated by the Alexander Awards. It was both preceded and followed by a concentration of Nicaraguan troops in the border area, and with further rejections by Nicaragua of the 1858 Treaty, such as claims of sovereignty over the Costa Rican province of Guanacaste and a claim of an inexistent right to navigate the Colorado River (an entirely Costa Rican river). These matters were explained in the Counter-Memorial,[303] and Nicaragua's current position is in clear contrast not only with elementary rules of international law but also with joint statements made at the highest level and by Nicaragua's conduct at the Bilateral Sub-Commission dealing with border and maritime issues, in which it has never raised

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300 See **CRCM**, **Vol. III Annex 28**, Executive Decree 36440-MP of 21 February 2011, published in the Official Gazette N°47 of 7 March 2011.

301 CRCM, paras. 2.29-2.30.

302 CRCM, para. 2.33.

303 CRCM, paras. -2.3, 2.10-2.19 and 2.24.

these issues.[304]

3.44. These threats and rejections of the 1858 Treaty occurred at a time in which Nicaragua also persistently prevented or otherwise impeded the exercise of Costa Rican rights of navigation on the San Juan River, including the enactment of a discriminatory decree in contravention of the Court's Judgment in the *Navigational and Related Rights* case.[305] Nicaragua's numerous violations of Costa Rica's right to navigate the San Juan River are well documented in correspondence between the parties, [306] affidavits,[307] and press reports.[308] These

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304 See **Vol. IV Annex 59**, Press Release of 26 October 1976 and Minutes of Liberia meeting, 25 January 1977, in: Ministry of Foreign Affairs and Worship of Costa Rica referring to the initiation of discussions of a maritime boundary in the Pacific Ocean, Annual Report 1976-1977, Vol. I, pp. 156-160 see also **Vol. IV, Annex 60**, Minutes of the First Meeting of the Sub-Commission on Limits and Cartography, 7 November 2002.

305 See **CRCM, Vol III, Annex 26**, Nicaraguan Decree N° 79-2009 is titled "*Creation of the Inter-Institutional Commission to Develop and Implement the Regulations regarding Navigation on the San Juan River, specifically where the International Court of Justice Grants Limited Navigation Rights to the Republic of Costa Rica*".

306 **See Vol. IV, Annex 16,** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-543-09, 27 July 2009; **Vol. IV, Annex 17,** Note from the Acting Minister of Foreign Affairs and Worship of Costa Rica, to the Acting Minister of Minister of Foreign Affairs of Nicaragua, Reference DVM-176-09, 21 August 2009; **Vol. IV, Annex 18,** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-674-09, 7 September 2009; **CRCM Vol. III, Annex 34**, Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-816-09, including annex entitled *Annex to Note DM-AM-816-09. Decree N° 79-2009 of the President of the Republic of Nicaragua contravenes the judgment of the International Court of Justice of 13 July 2009,* 20 November 2009; **CRCM Vol. III Annex 35**, Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference MRE/DM-AJST/297/3/2010, 25 March 2010,; **See Vol. IV, Annex 71,** Note from the Chief of Post, Police Delegation of Sarapiquí, Costa Rica, to the Regional Director of the Fourth Region-Heredia, Ref. 1571-2010-DPS 27 September 2010; **CRM *Certain Activities Case,* Vol. III, Annex 62**, Note from the Ministry of Foreign Affairs and Worship to the Ministry of Foreign Affairs of Nicaragua, 24 November 2010, Reference DM-478-10; **CRM *Certain Activities Case,* Vol. III, Annex 84**, Note from the acting Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica , Reference MRE/DVM/AJST/121/04/11, 8 April 2011; **CRM**

matters, individually and collectively established the existence of an emergency.

3.45. Following the Court's Order of 22 November 2013, it is now known that Nicaragua even failed to comply with the Court's Order of 8 March 2011, *inter alia* by entering the northern part of Islas Portillos with its personnel, and maintaining thereon its armed forces. Nicaragua also carried out works aimed at transforming the territory through the construction of new *caños*. Nicaragua's conduct in disregarding obligations imposed by the Court in a case *sub judice*

Certain Activities Case, **Vol. III, Annex 87** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Ref. DM-255-11, 15 April 2011; **CRCM Vol. III, Annex 36**, Note from the Minister of Foreign Affairs and Worship of Costa Rica, to Minister of Foreign Affairs of Nicaragua, Reference DM-AM-327-10, 22 April 2010; **Vol. IV, Annex 19,** Note from the Acting Minister for Foreign Affairs and Worship of Costa Rica to the Acting Minister of Foreign Affairs of Nicaragua, Reference DM-264-11, 27 April 2011; **CRCM Vol. III, Annex 48** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference MRE/DM-AJ/129/03/13, 5 March 2013; **Vol. IV, Annex 23,** Note from the Acting Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-DVM-550-2013, 24 September 2013; **Vol. XX, Annex 27,** Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference DM-AM-685-13, 10 December 2013; **Vol. IV, Annex 33,** Note from the Minister of Foreign and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-0373-14, 24 July 2014.

307 See **Vol. IV, Annex 62** Affidavit of Mr. Victor Julio Vargas Hernandez, recorded by Notary Public, Mr. Gustavo Arguello Hidalgo, Deed no. 177-9; also **Vol. IV, Annex 63,** Affidavit of Mr. William Vargas Jimenez, recorded by Notary Public, Mr. Gustavo Arguello Hidalgo, Deed no. 178-9; **Vol. IV, Annex 64,** Affidavit of Ms. Mayela Vargas Arce, recorded by Notary Public, Mr. Gustavo Arguello Hidalgo, Deed no. 179-9; **Vol. IV, Annex 65,** Affidavit of Ms. Gabriela Vanessa Lopez Gomez, recorded by Notary Public, Mr Gustavo Arguello Hidalgo, Deed no. 189; **Vol. IV, Annex 66,** Affidavit of Mr. Claudio Arce Rojas, recorded by Notary Public, Mr. Gustavo Arguello Hidalgo, Deed no. 181-9; **Vol. IV, Annex 67,** Affidavit of Mr. Ruben Francisco Valerio Arroyo, recorded by Notary Public, Mr. Gustavo Arguello Hidalgo, Deed no. 194-9.

308 See for example **Vol. IV, Annex 68**, La Nación, 'Costa Ricans denounce mistreatment and detentions in the northern border', 3 August 2014, http://www.nacion.com/nacional/gobierno/Caos-frontera-provoca-detenciones-costarricenses_0_1430656995.html; and also **Vol. IV, Annex 69,** La Nación, 'He demanded that I pull down my pants', 3 August 2014, http://www.nacion.com/nacional/gobierno/exigio-bajara-pantalones_0_1430657010.html.

demonstrates the seriousness of Costa Rica's concerns regarding Nicaraguan conduct in the border area.

3.46. Furthermore, Costa Rica's well rooted concerns have again been confirmed by the recent Nicaraguan rejection not only of Costa Rican navigational rights, but also of a practical arrangement informed by both parties to the Court in *Certain Activities* case, that would have allowed Costa Rica to fill the last *caños* constructed by Nicaragua in violation of the Court's Order of 8 March 2011.[309]

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[309] See **Vol. IV, Annex 32,** Note from the Acting Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, reference DM-AM-348-14, 17 July 2014; **Vol. IV**, **Annex 34**, Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference MRE/DM/336/8/14, 4 August 2014; **Vol. IV, Annex 36,** Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference MRE/DM-AJ/414/09/19, 19 September 2014; **Vol. IV, Annex 37,** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-574-14, 22 September 2014; **Vol. IV, Annex 38,** Note from the Agent of Nicaragua to the Registrar of the International Court of Justice, reference HOL-EMB-124, 23 September 2014; **Vol. IV, Annex 39,** Note from the Co-Agent of Costa Rica to the Registrar of the International Court of Justice, reference ECRPB-103-14, 25 September 2014; **Vol. IV, Annex 47,** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-707-14, 7 November 2014; **Vol. IV, Annex 49,** Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference MRE/DM/DGAJST/456/11/14, 11 November 2014; **Vol. IV, Annex 50,** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-718-14, 14 November 2014; **Vol. IV, Annex 51,** Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference MRE/DM/677/12/14, 2 December 2014; **Vol. IV, Annex 52,** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-774-14 2 December 2014; **Vol. IV, Annex 53,** Note from the Acting Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-789, 4 December 2014; **Vol. IV, Annex 54,** Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference MRE/DM-AJ/478/12/14, 5 December 2014; **Vol. IV, Annex 55,** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-0818-14, 12 December 2014; **Vol. IV, Annex 56,** Note from the Minister of Foreign Affairs of Nicaragua to the Minister of Foreign Affairs and Worship of Costa Rica, Reference MRE/DM-AJ/482/12/14, 15 December 2014; **Vol. IV, Annex 57,** Note from

3.47. In sum, it is the Nicaraguan escalation of its rejection of the 1858 Treaty that prompted Costa Rica to declare the emergency that allowed the beginning of the construction of a road in the border area in the shortest time.

4) The existence of an alternative assessment

3.48. Nicaragua challenges the position that Costa Rica has satisfied its international obligations by conducting an Environmental Diagnostic Assessment ("EDA").[310] Nicaragua does not however challenge the position under Costa Rican regulations that an activity carried out without an EIA may be later assessed by undertaking a study similar to an EIA, namely an EDA.[311] The Reply confines itself to drawing a distinction between a prior EIA and a "post hoc" assessment, and to distorting the content of the EDA as limited to monitoring and mitigation issues.[312] This is an oversimplification that does not take into account the purpose of the EDA, as summarised in the Counter-Memorial:

> "This type of study has two main objectives: first, to identify any negative impacts and risks of the activity on the environment; and second, to recommend environmental control measures necessary to prevent or to mitigate those negative impacts and risks. In relation to the 1856 Road, the

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the Acting Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-0826-14, 16 December 2014; **Vol. IV, Annex 58,** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-AM-0832-14, 18 December 2014; **Vol. IV, Annex 61,** National System of Conservation Areas, Tortuguero Conservation Area, Log of the meeting held on the premises of the Nicaraguan Army Post, on 17 December 2014.

310 NR, para. 6.36.

311 CRCM, para. 2.35.

312 NR, paras. 6.36-6.38.

Costa Rican Government commissioned an Environmental Diagnostic, which was carried out by a team of experts from the Tropical Science Center, a well-respected Costa Rican organization established in 1962. The Center has extensive experience in scientific environmental research in areas subject to tropical conditions, including environmental impact assessments. The Environmental Diagnostic covers the entire 108 km of the Road in the vicinity of the San Juan River, from Boundary Marker 2 to Delta Colorado. It considers the existing physical environment where the Road is constructed, including the climate, hydrology, terrestrial and aquatic flora and fauna, and ecology. It incorporates recommendations for the work to complete the Road, taking account of any potential risk of environmental impact. The Environmental Diagnostic fully complies with the guidelines established by Costa Rican administrative regulations for a project of this type."[313]

3.49. Contrary to what Nicaragua contends,[314] the EDA fulfils the functions of an EIA with regard to works that have not yet been implemented. To insist upon a "fresh EIA" that Costa Rica should carry out is not only legally wrong, it is a formalistic approach without any concrete practical distinction and fundamentally it is materially impossible to carry out, given the "ex ante" character of an EIA.

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3.50. In summary, this section has shown that the threshold for an EIA with regard to the type of road constructed in Costa Rica along the border has not been met, and that in any event, in accordance with the emergency situation declared by the Costa Rican Government, it was not possible to conduct an EIA. Once the works commenced an EDA was conducted, and the continuing planning and monitoring of the work on the Road takes into account the environmental concerns raised by Nicaragua in this case in order to avoid any harm being caused to Nicaragua.

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313 CRCM, para. 2.35.

314 NR, para. 6.38 and 6.55.

3.51. Furthermore, two final points must be mentioned in this regard. *First*, it is striking, and somewhat ironic, that the same State that now blames its neighbour for not having carried out an EIA is the same State that created the very emergency situation that prompted the construction of the Border Road in the first place. This was made clear by Costa Rica in a note from its Foreign Minister to his Nicaraguan counterpart dated 29 November 2011: "the Government of Nicaragua is fully aware that the reasons which have forced Costa Rica to undertake this infrastructure work are related to Nicaragua's activities in the border area".[315] *Second*, it is all the more striking that the same State that now makes claims against Costa Rica in this case did not include any analysis of potential transboundary environmental harm to Costa Rica in an EIA it purported to carry out with regard to dredging and other works in the San Juan River, which was produced for the first time at a hearing before the Court in the context of a request for the indication of provisional measures in January 2011.[316]

3.52. After having prevented Costa Rica from exercising its navigational rights on the San Juan River, occupying Costa Rican territory, challenged the long-established territorial boundary between the two countries by claiming new territorial rights, and even conducting activities in the border area that may cause significant harm to Costa Rica without first conducting an EIA, Nicaragua is precluded from alleging any breach of an obligation to conduct an EIA by Costa Rica.

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315 **CRCM, Vol. III, Annex 39**, Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Ref. DM-601-11.

316 Documents Submitted by Nicaragua to the Court during the Hearings on Provisional Measures, REF: *Certain Activities* case, **CRM, Vol. IV Annexes 158 to 165 and NCM, Vol. II, Annexes 12 and 13**.

E. Notification

3.53. In the Reply, Nicaragua maintains that Costa Rica breached its obligation to notify Nicaragua about the construction of the Road on the basis of general international law or conventional instruments. This allegation ignores the fact that the threshold for the application of this obligation of notification was not met, as well as the fact of the emergency situation under which the Road was constructed, as stated above.[317] Nicaragua further contends that Costa Rica's declaration of emergency was not communicated to Nicaragua, and that there were no consultations and negotiations with Nicaragua.[318] These assertions give rise to two comments:

(1) *First*, it is unprecedented for State A to request State B to communicate to State A not only its declaration of an emergency, but also the measures it plans to take in response, in circumstances where the emergency has arisen by reason of State A's actions, and the measures State B plans to take are for the purpose of defending itself against State A.

(2) *Second*, Nicaragua has inaccurately presented the relevant correspondence between the two countries in its Reply.

3.54. It is not correct that Costa Rica refused to consult with Nicaragua. By note dated 29 November 2011 from the Minister of Foreign Affairs of Costa Rica to his Nicaraguan counterpart, which is reproduced in Nicaragua's Application as

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[317] See above paras. 3.21 to 3.27 and paras. 3.40 to 3.47.

[318] NR, para. 6.63.

Annex 18, Costa Rica invited Nicaragua to engage seriously in a cooperative dialogue in order to address the issue. The note provides in relevant part as follows:

> "In turn, Costa Rica considers that these works are not affecting Nicaraguan territory. Nonetheless, in the interests of maintaining a policy of good neighbourliness, as well as of protecting the environment, and in compliance with agreements regarding this matter, the Government of Costa Rica is willing to hear Nicaragua's concerns in relation to this Road.
>
> In this respect, my Government invites Nicaragua to formally state the reasons why it considers environmental damage could be caused as a result or how it could affect Nicaraguan interests, and Costa Rica requests that it be sent objective and serious scientific information confirming Nicaragua's claims. Along these same lines, my country expects the same attitude from the Government of Nicaragua in relation to works that could affect Costa Rican territory.
>
> Finally, and also within the framework of Facilitation provided by the Governments of Guatemala and Mexico, Costa Rica is more than willing to accept the participation of both nations in the discussion and analysis of common environmental issues."[319]

3.55. By note dated the same day, Nicaragua merely stated that the construction of the Road was contrary to international law, and requested the suspension of the works until the production of an EIA.[320] Clearly, if Nicaragua were seriously concerned about protecting the environment, it would have responded positively to this invitation made by Costa Rica. Unfortunately, that was not the case. Instead, it instituted these proceedings less than one month later.

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319 **CRCM, Vol. III, Annex 39**, Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Ref. DM-601-11.

320 **Nicaragua's Application, Annex 17**, **NM, Vol. II, Annex 14**, Diplomatic note from the Minister of Foreign Affairs of Nicaragua, to the Minister of Foreign Affairs of Costa Rica, Ref: MRE/DVM/AJST/500/11/11.

3.56. All attempts made by Costa Rica, from the beginning of the dispute until recently, in order to undertake a joint monitoring of the waters of the San Juan River, have failed.[321] This is a further confirmation that the environmental concerns raised by Nicaragua are not the real reason for instituting these proceedings. On the other hand, it shows Costa Rica's willingness to address the issue in a scientific and constructive manner.

3.57. Furthermore, although Nicaragua did not communicate any EIA to Costa Rica with regard to the dredging and other works on the San Juan River, it now claims a breach by Costa Rica of the same obligation to produce an EIA for the construction of a two-car carriageway on Costa Rican territory. Nicaragua's dredging work, and its attempts to modify the course of the River (not to mention the construction of artificial *caños* on Costa Rican territory and the planned construction of an Interoceanic Canal) are able to affect Costa Rican navigational rights and produce significant environmental harm within Costa Rica, particularly with regard to the water flow from the San Juan to the Colorado River, the latter being an entirely Costa Rican river. Failure to comply with its own prior obligation to notify Costa Rica in these circumstances also prevents Nicaragua from invoking any alleged lack of notification by Costa Rica.

F. Alleged Breaches of other Treaties

3.58. In its Reply, Nicaragua insists that the construction of the Road entails violations of the Convention on Biological Diversity ("CBD"), the Ramsar Convention, the Central American Convention for the Protection of the Environment and other regional instruments, as well as the bilateral "SI-A-PAZ"

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[321] See paras. 2.28-2.33.

agreement.[322] These allegations have already been addressed and rejected in the Counter-Memorial.[323]

3.59. At the outset, it must be said that, since Nicaragua has not demonstrated the existence of any significant transboundary harm, most of these allegations fall away without any need for detailed analysis. This is the case for Article 3 of the CBD and the 1992 Convention for the Conservation of Biodiversity and the Protection of Wilderness Areas in Central America, the Regional Agreement on the Transboundary Movement of Hazardous Wastes and the "SI-A-PAZ" agreement.

3.60. The Reply does not make attempt to rebut the analysis set out in the Counter-Memorial concerning the lack of relevance of Article 8 of the CBD.[324] As to Article 14 of the same Convention, for the reasons explained above,[325] it is not correct that Costa Rica did not deny that it had failed to comply with its obligation of planning, notification, exchange of information and consultation.[326] Leaving aside the fact that nothing in the present case concerns the CBD, it was Costa Rica that proposed to Nicaragua that the two countries consult one another in order to address any environmental issue that could emerge from the construction of the Road.[327]

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322 NR, Chapter 6, Section F.

323 CRCM, Chapter 5, Section E.

324 Cf CRCM, para. 5.28 and NR, para. 6.107.

325 See paras. 3.53 to 3.56.

326 NR, paras. 6.110-6.111.

327 Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Minister of Foreign Affairs of Nicaragua, Reference DM-601-11, 29 November 2011, **CRCM, Vol. III, Annex 39**.

3.61. Nicaragua does not deny that the condition of reciprocity applies for the obligation of notification, exchange of information and consultation set out in Article 14 (1) of the CBD.[328] This condition of reciprocity is not exclusive to the CBD; it also applies at the general level. In this case, and as early as 29 November 2011, Costa Rica invited Nicaragua to present objective evidence, and to engage in bilateral dialogue, to review its concerns about the construction of the Road. As explained above, Nicaragua failed to comply vis-à-vis Costa Rica with its obligations of notification, exchange of information and consultation with regard to the dredging, deviation of waters and other major works in the San Juan River.[329] Consequently, the condition of reciprocity is absent.

3.62. In its attempt at justifying the lack of reciprocity, Nicaragua provides an explanation, set out in full as follows:

> "Nicaragua's dredging was undisputedly conducted within its sovereign territory, the San Juan de Nicaragua River, and could not possibly have any appreciable effect, on biological diversity or otherwise, in Costa Rica; and Nicaragua's cleaning of the *caño* was conducted in what Nicaragua believed, and continues to believe, is also part of its sovereign territory and would thus not affect Costa Rica; Nicaragua has shown that in any event these activities did not, in fact, cause harm to Costa Rica. Therefore, reciprocity cannot possibly be found to be lacking."

3.63. Nicaragua thus employs the same arguments that it strongly criticises when used by Costa Rica. In both cases (putting aside for the purpose of this analysis the most important issue of the *Certain Activities* case: the occupation by Nicaragua of the Costa Rican territory), it is a matter of proof whether the activities carried out in the respective territories may cause significant

328 NR, para. 6.111.

329 See para. 3.57 above.

transboundary harm or affect biological diversity. What is clear is that Nicaragua's activities that preceded the construction of the Border Road were not subject to any notification, consultation or exchange of information with Costa Rica. As there is no reciprocity, Nicaragua is precluded from invoking such obligations in the context of the present case.

3.64. With regard to the Ramsar Convention, Nicaragua advances the novel idea that it can raise before the Court any alleged violation by Costa Rica in relation to its internal wetlands, even if this does not affect Nicaragua.[330] There is no need to address this issue here. Costa Rica has proceeded to notify the Ramsar Secretariat about the 22 km of the section of the Road that is constructed on a site declared by Costa Rica as protected wetland, and it continues to discuss with the Ramsar Secretariat all measures that have to be taken to ensure compliance with the Ramsar Convention.[331] Contrary to what the Reply asserts without explanation,

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[330] NR, para. 6.113.

[331] CRCM, Vol I, par. 5.33 and **Vol. III, annexes 43** and **44.** See also **Vol. IV, Annex 73,** Ministry of Foreign Affairs and Worship of Costa Rica, *New works in the Northeastern Caribbean Wetland. Report to the Executive Secretariat of the Ramsar Convention on Wetlands*, July 2013; **Vol. IV, Annex 22**, Note from Permanent Representative of Costa Rica to the United Nations-Geneva to the Secretary General of the Ramsar Convention Reference MPCR-ONUG/2014-324, 17 July 2013; **Vol. IV, Annex 25,** Note from the Permanent Representative of Costa Rica to the United Nations-Geneva to the Secretary General of the Ramsar Convention, Reference MPCR-ONUG/2013/534, 25 November 2013; **Vol. IV, Annex 26,** Note from the Secretary General of the Ramsar Convention to the Permanent Representative of Costa Rica to the United Nations-Geneva, 29 November 2013; **Vol. IV, Annex 28,** Note from the Permanent Representative of Costa Rica to the United Nations-Geneva to the Secretary General of the Ramsar Convention, Reference MPCR-ONUG-2014-190, 26 March 2014; **Vol. IV, Annex 29,** Note from the Secretary General of the Ramsar Convention to the Permanent Representative of Costa Rica to the United Nations-Geneva, Reference SG2014-103/CHB/MAR, 7 May 2014; **Vol. IV, Annex 30,** Note from the Permanent Representative of Costa Rica to the United Nations-Geneva to the Secretary General of the Ramsar Convention, Reference MPCR-ONUG/2014/407, 18 June 2014; **Vol. IV, Annex 46,** Note from the Minister of Foreign Affairs and Worship of Costa Rica to the Secretary General of the Ramsar Convention Secretariat, Reference DM-AM-0706-14, 6 November 2014.

the construction of the Road does not concern wetlands extending over the territories of both countries. Also, what is at issue in this case is not works related to a water system shared by two States. Indeed, this case is not related to any hydraulic endeavour that could affect any water system, but to a road constructed entirely on Costa Rican territory. The mere fact of proximity to a river does not render Article 5 of the Ramsar Convention applicable.

3.65. In its analysis of regional treaties, the Reply relies upon the so-called "judgment" of the Central American Court of Justice of 21 June 2012.[332] As explained in the Counter-Memorial and also in Chapter 2 above, Costa Rica is not a party to the Statute of that Court, hence, its alleged "judgment" has no validity at all.[333]

3.66. With regard to the regional agreements themselves, the Reply adopts the same approach as the Memorial of advancing general considerations about the supposedly "grave doubts" Nicaragua has about "Costa Rica's commitment to the objectives of these agreements", and suggesting that the construction of the Border Road would be contrary to the object and purpose of them.[334] Costa Rica has already set out its position on these issues in the Counter-Memorial.[335]

3.67. The only new elements included in the Reply with regard to regional agreements are the references to "anthropogenic sediment" as "pollution" and the fact that rains "have brought insufficiently moored culverts into the river". Both

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332 NR, paras. 6.117.

333 CRCM, para. 3.70, this Rejoinder, paras. 2.115-2.116.

334 NR, para. 6.127.

335 CRCM, paras. 5.34-5.39.

are considered by Nicaragua as breaches of the Regional Agreement on the Transboundary Movement of Hazardous Wastes.[336] The only evidence to support this is a photograph and a general reference to the 2014 Kondolf Report, which in turn reproduces the same photograph.[337] As explained above, this is another unsubstantiated claim.[338] The Reply also speculates that trucks that may potentially carry hazardous materials could provoke a major spill into the River.[339] As demonstrated in Chapter 2 above, there is no basis for such a speculation.[340]

3.68. Finally, with regard to the SI-A-PAZ Agreement, the Reply continues to fail to indicate which provisions of this bilateral agreement Nicaragua claims are breached by construction of the Road.

G. Conclusions

3.69. The present chapter has demonstrated that the Reply has failed to rebut the following conclusions:

(a) Costa Rica has not violated the sovereignty and territorial integrity of Nicaragua, or the 1858 Treaty of Limits;

(b) Neither the 1858 Treaty of Limits nor the 2009 Court's Judgment in the *Navigational and Related Rights* case impose on Costa Rica an obligation

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336 NR, para. 6.133.

337 NR, para. 6.133, footnote 741, 2014 Kondolf Report, **NR, Vol. II, Annex 1**, p. 17 (19).

338 This Rejoinder, para. 2.104.

339 NR, paras. 3.34-3.42.

340 This Rejoinder, para. 2.105.

to notify Nicaragua about the construction of a Border Road on Costa Rican territory;

(c) The threshold for the international requirement of an EIA has not been met in the present case;

(d) General international law acknowledges the exemption from an EIA in situations of emergency;

(e) The emergency declared by Costa Rica as a consequence of the continued rejection by Nicaragua of the 1858 Treaty of Limits, including the military occupation of part of its territory by Nicaragua, falls within such exemption;

(f) It was Nicaragua itself that created that emergency situation;

(g) The EDA in any event addresses the environmental transboundary concerns for works already completed, the monitoring of these works, as well as future infrastructure work, and thereby fulfils any applicable international obligations;

(h) Costa Rica has not breached any obligation of notification, exchange of information and consultation. On the contrary, it invited Nicaragua to engage in such a procedure, with no concrete results;

(i) In any event, Nicaragua failed to fulfil the condition of reciprocity with regard to the production of an EIA, notification, exchange of information and consultation while dredging the San Juan River, deviating its waters, constructing *caños* on Costa Rican territory, amongst other works, which are activities that occurred before or at the time of the situation of emergency leading to the construction of the Road.

(j) None of the alleged violations of international obligations stemming from any of the treaties referred to by Nicaragua are grounded in fact or in law.

Chapter 4

Remedies

A. Introduction

4.1. In its Application, Nicaragua requested a shopping list of different forms of reparation, namely:

(a) declarations of unlawful conduct and responsibility,[341] requiring Costa Rica to cease all the constructions underway,[342] and requiring Costa Rica to produce and present to Nicaragua an adequate environmental impact assessment ('EIA');[343]

(b) orders requiring Costa Rica to restore the situation to the *status quo ante*,[344] to pay for all alleged damages caused including the costs added to the dredging of the San Juan River,[345] and prohibiting Costa Rica from undertaking any further development in the area without an appropriate transboundary EIA.[346]

4.2. In its Memorial, Nicaragua repeated its claims for:

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341 Application instituting proceedings, 22 December 2011, para. 49.

342 *Ibid*, para. 51*(a)*.

343 *Ibid*, para. 51*(b)*.

344 *Ibid*, para. 50*(a)*.

345 *Ibid*, para. 50*(b)*.

346 *Ibid*, para. 50*(c)*. Nicaragua further requested the Court to order Costa Rica to produce an EIA, without formerly requesting provisional measures.

(a) a declaration of unlawful conduct and responsibility;[347]

(b) an order requiring Costa Rica to cease its unlawful conduct, and prohibiting Costa Rica from undertaking any further development in the area without an appropriate transboundary EIA;[348] and

(c) an order requiring Costa Rica to restore the *status quo ante*, which it presented together with a claim for compensation.[349]

4.3. It also included new claims for reparation in its Memorial, namely:

(a) an order requiring Costa Rica to provide assurances and guarantees of non-repetition;[350]

(b) a declaration that Nicaragua is entitled to suspend Costa Rica's right of free navigation on the San Juan;[351]

(c) a declaration that Nicaragua is entitled to execute works to improve navigation on the San Juan River "as it deems suitable",[352] and to re-

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347 NM, paras. 6.10 to 6.12.

348 *Ibid*, paras. 6.13 to 6.17.

349 *Ibid*, paras. 6.26 to 6.34.

350 *Ibid*, paras. 6.18 to 6.25.

351 *Ibid*, paras. 6.35 to 6.44.

352 *Ibid*, Submission 3(i).

establish the conditions of navigation that existed at the time the 1858 Treaty of Limits was concluded;[353] and

(d) a request for the Court to order provisional measures *proprio motu*.[354]

4.4. In its Reply, Nicaragua appears no longer to pursue its request that the Court suspend Costa Rica's right of free navigation, following Costa Rica's robust response to this extravagant claim.[355] However, it contends that Costa Rica is "strangely mute" in response to what Nicaragua terms, for the first time in its Reply, its "primary request" for the re-establishment of the *status quo ante*.[356] This request was presented by Nicaragua together with a claim for compensation,[357] which Costa Rica addressed at length in its Counter-Memorial.[358] Insofar as remains necessary, it is addressed below. Further, Nicaragua contends that Costa Rica has overlooked Nicaragua's requests for cessation and for guarantees and assurances of non-repetition.[359] These requests were expressly addressed by Costa Rica in its Counter-Memorial,[360] and are addressed again below.

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353 *Ibid*, Submission 3(ii).

354 *Ibid*, Submission 4.

355 CRCM, paras. 6.15 to 6.26.

356 NR, para. 7.7.

357 NM, paras. 6.26 to 6.34.

358 CRCM, paras. 6.12 to 6.14.

359 NR, para. 7.2.

360 CRCM, paras. 6.7 and 6.8.

B. Nicaragua's claim for re-establishment of the *status quo ante*

4.5. Nicaragua's claim for re-establishment of the *status quo ante*[361] is very confused. It is also groundless, it requires the Court to make an order of no utility, and is internally inconsistent with its claim for compensation.

4.6. As to the confused nature of the claim, this has evolved from a request for an order requiring Costa Rica to "restore the *status quo ante*",[362] to a claim for the re-establishment of the *status quo ante* "as far as possible"[363] or "as proximate as possible".[364] At the same time, Nicaragua now says that it "does not claim a complete re-establishment of the *status quo ante*, which would lead to a complete destruction of the road",[365] and that it "does not challenge the right of Costa Rica to build whatever road it deems useful on its territory."[366]

4.7. It follows that the true position is that Nicaragua does not claim, and recognises that it is not entitled to claim, re-establishment of the *status quo ante*, and that even the qualifiers such as "as far as possible" are inapposite to the relief really sought under this head, which is ultimately that Costa Rica carry out the mitigation works according to recommendations made by experts appointed by Nicaragua, including as to re-routing of sections of the Road.[367]

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361 NR, paras. 7.7 to, 7.10 and Submissions, para. 2(ii).

362 NM, para. 6.31.

363 NR, para. 7.7.

364 NR, para. 7.8.

365 NR, para. 7.8.

366 NR, para. 7.19.

367 NR, para. 7.10.

4.8. However, there is no basis for granting even this reformulated relief. *Restitutio in integrum* in the present situation would go no further than the mitigation works already being implemented by Costa Rica (not as a result of any breach of international law, but as a sovereign decision of Costa Rica). It is for Costa Rica to carry out, by means of its own choosing, appropriate mitigation measures to improve the road infrastructure on its sovereign territory. Those works are under way, and are being monitored by Costa Rica's experts. It would be "an administration of the law altogether out of touch with reality"[368] to make any order in respect of such works, and likewise to impose the demands and supervision of Nicaragua's experts. There is no precedent for such an intrusive, unworkable and unnecessary request; and even if there were, as the Court will have observed from the reports submitted, Costa Rica's own experts are fully capable of analysing and supervising any remedial work that Costa Rica may deem necessary in its territory.

4.9. The different forms of reparation that Nicaragua claims are internally inconsistent. In its Reply, Nicaragua appears to claim compensation not alternatively, but simultaneously with its claim for *restitutio in integrum*.[369] Compensation is an alternative to restitution, where restitution is either not possible or appropriate, and Nicaragua cannot of course claim both, and at any rate, it is not entitled to either.

4.10. Even assuming the claim for compensation is a true alternative,[370] the simple point is that Nicaragua's claim for compensation is not based on any

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368 *Gabčíkovo-Nagymaros Project (Hungary/Slovakia)*, *Judgment*, *I.C.J. Reports 1997*, para. 136.

369 NR, para. 7.9; cf. NM, para. 6.31.

370 NR, para. 7.19.

showing of actionable damage. The water continues to flow from the south basin on Costa Rican territory to the San Juan River, as it has always done. There is no evidence whatsoever that there has been any change in this pattern resulting from construction of the Road, and no evidence of any form of compensable loss or damage as a result of such construction. Nicaragua cannot avoid this point by seeking to delay assessment of damages to a further phase. Even at the current phase, it must make a colourable showing of loss and damage. It is wholly unable to do so.

C. Nicaragua's claims for cessation / guarantees and assurances of non-repetition

4.11. As Costa Rica has already explained,[371] an order requiring a State to cease its wrongful conduct, and/or requiring guarantees and assurances of non-repetition – like a claim for compensation – must necessarily be premised on an internationally wrongful act. As Nicaragua has failed to demonstrate that any such internationally wrongful acts have been committed by Costa Rica, there is no basis on which to ground its requests for cessation and for assurances and guarantees of non-repetition. Without prejudice to the foregoing, Costa Rica sets out below why, in any event, Nicaragua has failed to meet the additional requirements of these forms of reparation.

4.12. As to Nicaragua's claim for cessation, even if Costa Rica's conduct were declared unlawful (*quod non*), Nicaragua has not demonstrated why the Court

[371] CRCM, para. 6.8.

should depart from the general rule that an order for a State to cease its wrongful conduct is:

> "… not necessary, and it serves no useful purpose … for the Court to recall the existence of this obligation in the operative paragraphs of the judgment it renders: the obligation incumbent on the State concerned to cease such conduct derives by operation of law from the very fact that the Court establishes the existence of a violation of a continuing character."[372]

4.13. Nicaragua has failed to advance a "particular reason"[373] to ground its claim for an order requiring Costa Rica to cease its alleged wrongful conduct. Nicaragua merely argues that the road works are causing ongoing erosion to the bank of the San Juan River entirely on Costa Rican sovereign territory.[374] It is not the case (contrary to what Nicaragua asserts) that "Costa Rica itself accepts that the effects on the River are continuing".[375] It is for Nicaragua to establish, not only that the road works are having a substantial harmful effect on the San Juan River, but that any such effect constitutes a continuing breach by Costa Rica of an applicable obligation under international law. Nicaragua has failed to establish any such breach. There is not, and there will not be any relevant damage to Nicaragua by Costa Rica's road construction. That is a fact.

4.14. As to Nicaragua's claim for guarantees and assurances of non-repetition, Nicaragua has failed to demonstrate the "special circumstances" necessitating the

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372 *Dispute Regarding Navigational and Related Rights (Costa Rica v. Nicaragua), Judgment, I.C.J. Reports 2009*, para. 148.

373 *Ibid*.

374 NR, para. 7.5.

375 *Ibid*.

order of such a measure by the Court.[376] Nicaragua's claim for guarantees and assurances of non-repetition is grounded on the same facts as its claim for cessation, namely the ongoing erosion Nicaragua alleges the road works are causing. Ongoing erosion – even if established – does not constitute actionable damage when it is on the scale alleged by Nicaragua, still less that disclosed by the evidence; in the present case there is no showing of actual transboundary harm and no risk of such harm. Without prejudice to its position in the present proceedings, the fact is that Costa Rica has undertaken extensive mitigation works on the Road, and continues to undertake such works, in a manner which it has fully documented. This conduct further demonstrates that Costa Rica has always acted, and continues to act, in good faith. Even if its conduct were declared unlawful in some respect (*quod non*), the Court must presume that Costa Rica will continue to act in good faith in the future, including with respect to mitigation works and completion of the Road.[377] Consequently, there are no "special circumstances" warranting an order requiring Costa Rica to provide guarantees and assurances of non-repetition.

D. Late Nicaraguan request for the appointment of an expert by the Court

4.15. The present proceedings were initiated by Nicaragua in December 2011. In accordance with the timetable agreed by the Court, Nicaragua presented its Memorial on 19 December 2012, and Costa Rica its Counter-Memorial on

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376 *Dispute Regarding Navigational and Related Rights (Costa Rica v. Nicaragua), Judgment, I.C.J. Reports 2009*, p. 267, para. 150.

377 *Factory at Chorzów*, Merits, P.C.I.J. Judgment N° 13, 1927, Series A, No. 17, p. 63; *Nuclear Tests (Australia v. France), Judgment, I.C.J Reports 1974*, p. 272, para. 60; *Nuclear Tests (New Zealand v. France), Judgment, I.C.J. Reports 1974*, p. 477, para. 63; *Military and Paramilitary Activities in and against Nicaragua (Nicaragua v. United States of America)*, *Jurisdiction and Admissibility*, *Judgment, I.C.J. Reports 1984,* p. 437, para. 101.

19 December 2013. When Nicaragua presented its Reply on 4 August 2014, the covering letter proposed that the Court

> "…could deem it useful to appoint a neutral expert on the basis of Articles 66 and 67 of the Rules in order to assist the Court in evaluating the scientific evidence submitted by the Parties and, after the Judgment, to assist the Parties in its implementation. In Nicaragua's view, such an expert should be a geomorphologist or geotechnical engineer with expertise on road construction and road impacts." [378]

4.16. This proposal was repeated in Nicaragua's Reply.[379] Costa Rica rejected this proposal in its Note ECRPB-085 dated 14 August 2014,[380] as follows:

> "The Court is well-equipped to assess the evidence submitted and to be submitted by the Parties and to draw conclusions from it as appropriate. This has been the approach taken in recent cases, notably Pulp Mills on the River Uruguay (Argentina v. Uruguay), Judgment, I.C.J. Reports 2010 (see p. 62, para. 168).
>
> Moreover, the Court has already set a schedule for the oral hearings on the merits. In the circumstances, Nicaragua's suggestion for the appointment of an expert is merely dilatory. Nicaragua's proposal would extend the length of the hearing, and result in a delay in the prompt delivery of its Judgment on the merits in this case (and also in the prior case, now joined, concerning Certain Activities carried out by Nicaragua in the Border Area (Costa Rica v. Nicaragua)". [381]

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378 Note from the Agent of Nicaragua to the Registrar of the ICJ, Reference HOL-EMB-095, 4 August 2014.

379 NR, para. 7.14.

380 Note from the Co-Agent of Costa Rica to the Registrar of the ICJ, Reference ECRPB-085, 14 August 2014.

381 *Ibid*.

4.17. There is no good basis for Nicaragua waiting until the close of the written proceedings before making a request for the appointment of an independent expert. The fact that Nicaragua proposes a road engineer, rather than a river expert, shows that it has no case, other than to claim that it does not like the road. The obvious explanations for this late request are that either it is a dilatory tactic or it constitutes a belated recognition that it has been unable to make out its case by reference to its own evidence. Either way, the proposal should be rejected.

E. Costa Rican position with regard to the order by the Court rejecting the provisional measures requested by Nicaragua

4.18. In its Reply, Nicaragua contends that Costa Rica has not complied with commitments as to mitigation made in the course of the 2013 provisional measures hearing,[382] and also that it was primed to restart construction works[383] on or around 4 August 2014 (the date Nicaragua filed its Reply with the Court), contrary to representations made during the oral hearings on provisional measures in 2013.

4.19. In its order of 13 December 2013, rejecting Nicaragua's request for provisional measures, the Court stated:

> "It [Costa Rica] explained that, under the updated version of the schedule, the resumption of construction works on the section of the road along the south bank of the San Juan River would not begin "before late 2014 or

382 NR, para. 7.18.

383 NR, para. 5.31.

> early 2015", thereby further underscoring, in its view, the lack of any basis to Nicaragua's arguments concerning urgency."[384]

4.20. As stated during the oral hearings and Costa Rica's Counter Memorial, the public contracting procedures in Costa Rica are lengthy and can be slowed down by a diversity of factors, which are not in control of the Government. As Costa Rica explained in the 2013 oral hearings:

> "This schedule indicates that the tendering process for designs will re-open in December this year, with different deadlines for the different sections. Only the designs for Section 5, which runs from Delta Costa Rica to the mouth of the Sarapiquí, may be finalized in the next six months. Section 5 is that area of the road downstream from Delta Costa Rica, which is of course the long stretch of road which traverses over flatter terrain, and follows pre-existing roads. Nicaragua has no criticism of this part of the road… Construction in the other four sections, which cover the only part of the road that Dr. Kondolf finds troubling, will not be before late 2014 or early 2015. These works will not begin in days or weeks, or even months."[385]

4.21. As of the date of this Rejoinder (early 2015), the public tendering for the final designs of the Road has closed, and the development of those designs for the five segments of the Road, has been assigned to two companies, which are now working on the corresponding technical studies necessary to design a road of this kind, including environmental considerations.

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[384] *Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica); Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua), Provisional Measures, Order of 13 December 2013, I.C.J. Reports 2013*, para. 33.

[385] *Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica),* Oral Hearing, 8 November 2013, CR 2013/31, p. 14, para. 21. (Parlett).

4.22. Once the designs are ready, another public tendering process will begin and one or several companies will be selected to resume the construction process. As at the date of this Rejoinder, construction works have not resumed, although mitigation work has continued to be implemented. The situation on the ground accurately reflects what Costa Rica said during the oral hearings on provisional measures in 2013, and there is no basis for Nicaragua's contention that Costa Rica has failed to act in accordance with the statements it made on carrying out remedial works.[386]

4.23. As Costa Rica stated during the oral hearings in 2013, it has no intention to suspend the construction works. As a matter of courtesy, it informed the Court that the construction process was delayed, and that construction works would not recommence until late 2014 at the earliest. It also made it clear that the design process would continue and that installation of bridges[387] and other remedial works would continue,[388] as indeed has happened.

4.24. The aim of the works being carried out on the Road, and of the final designs for the segments of the Road, is to improve the quality of the Road, including through preventing environmental harm taking place in the territory of Costa Rica. A natural consequence of carrying out these works is that, in addition to preventing environmental harm occurring in Costa Rica, the works would also prevent any possible harm being potentially caused in the surrounding area, including to Nicaragua. As stated in Chapter 2 above, Nicaragua had not

386 Cf. NR, para. 7.18.

387 *Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica),* Oral Hearing, 6 November 2013, CR 2013/29, p. 18, para. 18. (Parlett).

388 *Ibid*, p. 20, para. 24. (Parlett).

established that any such harm has been or risks being caused to its territory, and further, has failed to establish that any such harm is or would be caused by Costa Rica in breach of any applicable international obligation.

F. Groundless requests for declaratory relief

4.25. For similar reasons, Nicaragua's request for declaratory relief has no legal or factual basis. As a matter of law, Nicaragua is requesting the Court to make declarations about matters that are either outside the scope of the present case, or are in any event without legal foundation. As a matter of fact, Nicaragua seeks to ground its request on speculations about risks of potential harm that are unsubstantiated by any evidence, expert or otherwise.

4.26. In particular, Nicaragua requests declaratory relief as regards the following matters,[389] each of which is addressed in turn below:

(a) by its conduct, Costa Rica has breached a number of its obligations *vis-à-vis* Nicaragua (section 1 below);

(b) Costa Rica is bound to prepare an appropriate transboundary EIA (section 2 below);

(c) Costa Rica must refrain from using the Border Road to transport hazardous material until the Border Road meets the conditions required for such use (section 3 below); and

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[389] NR, para. 7.22.

(d) Nicaragua is entitled to dredge the San Juan de Nicaragua River as deemed necessary (section 4 below).

(1) Alleged breaches by Costa Rica

4.27. For the reasons set out in Costa Rica's Counter-Memorial, and this Rejoinder, Nicaragua has not established any of the breaches of international law alleged to have been committed by Costa Rica. For its part, Nicaragua does not recognise that it is bound by these same obligations in relation to Costa Rica, for its deeply alarming conduct addressed in the *Certain Activities* case.[390]

4.28. Nicaragua invokes the allegation that Costa Rica has denied any wrongdoing as a basis for declaratory relief. Nicaragua interprets the mere fact that a country robustly defends baseless claims made against it in the context of an artificially conceived case as grounds for declaratory relief. This is untenable.

(2) Production of a transboundary EIA

4.29. Costa Rica has presented comprehensive evidence in support of its case that no significant transboundary damage has been caused to Nicaragua and/or that there was any significant risk of the same. Further, under the circumstances of the declared emergency, there was no obligation to prepare a transboundary EIA, particularly when the emergency was caused by the very State that now demands

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390 *Dispute Concerning Certain Activities carried out by Nicaragua in the Border Area (Costa Rica v. Nicaragua)*, NCM, Vol. I, paras 3.21-3.52.

an EIA. It is submitted that the Court must reject Nicaragua's request for declaratory relief on these bases.[391]

4.30. Such relief would not be warranted in any case, given that Costa Rica has produced an extensive Environmental Diagnostic Assessment,[392] a follow up Assessment,[393] various expert reports,[394] and a number of actions to mitigate environmental impacts.[395] Nicaragua has even complained of the volume of scientific evidence presented by Costa Rica, to the point of requesting a second round of written pleadings.

4.31. It may also be added that it would have been materially impossible for Costa Rica to conduct a transboundary EIA since Nicaragua has systematically denied Costa Rica access to the San Juan River. Chapter 2 describes the attempts made by Costa Rica in 2013 and 2014 to carry out joint measurements of the San Juan and Colorado Rivers.[396] Nicaragua, by erecting a series of obstacles, making repeated excuses and by engaging in generally disruptive behaviour, made it impossible to carry out these measurements.[397]

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391 See paras. 3.31 - 3.47 above.

392 **CRCM, Vol. II, Annex 10**.

393 **Vol. III, Annex 14,** 2015 CCT Report.

394 See **CRCM, Vol. I, Appendix A and Vol. II, Annexes 3, 4, 5, 6 and 9**. See also **Appendix A** in this Volume, **Annex 2 in Vol. II**, and **Annexes 4, 5, 6, 7 and 9, in Vol. III**.

395 See **CRCM, Vol. I, Appendix A** and **Vol. II, Annexes 2, 7 and 8**. See also **Appendix A in this Volume**, **Annex 2 in Volume II**, and **Annexes 11, 12 and 13 in Volume III**.

396 See paras. 2.28 - 2.33 above.

397 *Ibid*.

(3) Transport of hazardous material

4.32. The belated case put forward in respect of transport of hazardous materials has been considered in Chapter 2 above.[398] As Costa Rica has shown, the transport of fuels and any hazardous material is rigorously regulated by Costa Rican regulations.[399] In circumstances where Nicaragua has put forward no evidence (or even argument) to suggest that these would not be applied so far as concerns the Road, and that there is some significant risk of harm to Nicaragua arising out of non-application, there is no conceivable basis for the relief sought.

4.33. Costa Rica does emphasise here that, although the issue of the transport of hazardous material does not arise in relation to the Road, Nicaragua's announcement that it intends to build an inter-oceanic canal raises very considerable (extra) concern because it intends to use the canal for the transportation of hazardous materials, such as oil and liquefied gas. The transport of hazardous materials in this context, does pose a real danger of true significant transboundary damage to Costa Rica and to Nicaragua, unlike allegations of humble farmers carrying out a couple of gallons of fuel.

(4) Dredging of the San Juan River

4.34. Nicaragua's request that "it is entitled … to execute works to improve navigation on the San Juan River as it deems suitable", is duplicative of submissions made in the *Certain Activities* case. Indeed, this is the third time that Nicaragua makes the same request before the Court. The first time was in the

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398 See paras. 2.104 and 2.105 above.

399 See para. 2.105 above.

Navigational and Related Rights case, and the Court dismissed this request in its Judgment of 13 July 2009.[400] Nicaragua has not offered any factual basis for this request in the instant case; it merely states that there is "nothing abnormal about making the same submission in both cases".[401] Costa Rica submits that in the context of the present case, the Court must reject this submission again.[402] Indeed, it is all the more untenable to claim an entitlement in this case that is in no way related back to alleged harm caused by the Road, but is merely an alleged entitlement to execute works as Nicaragua "deems suitable".

4.35. It is also noted that, all the more extraordinary, Nicaragua requests not simply the right to dredge the San Juan River "as it deems suitable", but also an entitlement to re-establish the conditions of navigation that existed at the time the 1858 Treaty was concluded. Two short points must be made: first, the relief sought has no reference back to the allegations made by Nicaragua in this case. In the context of the current case, it is at best misconceived. Secondly, the 1858 Treaty gave no rights to a freezing of navigational conditions and, even if it had somehow purported to do so (regardless of geographical reality), shortly after conclusion of the Treaty the navigational conditions were materially impacted by changes in the geography of the region, which *inter alia* changed the ratio of flow as between the San Juan and Colorado Rivers at least since 1860, something which Nicaragua itself has acknowledged.[403]

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400 *Dispute Regarding Navigational and Related Rights (Costa Rica v. Nicaragua), Judgment, I.C.J. Reports 2009*, para. 155.

401 NR, para. 7.46.

402 Costa Rica's position regarding Nicaragua's dredging program is as set out and documented in the *Certain Activities* case.

403 Certain Activities Case, NCM Vol I, p. 79, para. 4.10.

4.36. For the reasons explained above, all of Nicaragua's remedies must be rejected.

(5) Conclusion

4.37. Nicaragua's constant changes in its request for remedies in the written phase of these proceedings underscores the fact that it has not built a credible case. The continuous adding up to the litany of reparations it demands only reinforces Costa Rica's position as to the artificial nature of the present case. A general declaration of unlawful conduct warranting remedies requires that the applicant state formulate a credible case grounded on verified facts. Nicaragua's case has revolved around criticisms of Costa Rica's evidence, yet, it has not built a case of its own. The lack of verifiable evidence in two rounds of written and oral pleadings, even after Costa Rica proposed joint efforts to that end, raises concerns as to the chimerical character of Nicaragua's legal strategy. It is Costa Rica's view not only that the Court must reject wholly the remedies thus requested, but that it should seriously consider the bringing up of such gratuitous and wasteful proceedings as un acceptable show of poor judgment by a country that is constantly complaining about the expense of treasure and time that these cases demand.

Summary

1. Article 49, paragraph 3, of the Rules of the Court states that "[T]he Reply and Rejoinder, whenever authorized by the Court, shall not merely repeat the parties' contentions, but shall be directed to bringing out the issues that still divide them."

2. Nicaragua's Reply was used as an opportunity to expand its claims into an environmental case that seeks to bring into play, for the first time, Costa Rican development and agricultural activities in vast tracts of its territory and spanning many decades. For the reasons noted in this Rejoinder, Costa Rica considers this claim to be beyond the scope of the dispute submitted to the Court. But in any event, changes in land use have not been the principal cause of the high sediment load in San Juan River, which is in fact a constant across many millennia, and is attributable to geological and natural phenomena which control the functioning and the fate of both the San Juan and Colorado Rivers.

3. In its Application and Memorial, Nicaragua sought to have the Court, in effect, stop the Road. It claimed that the lack of an EIA would produce an environmental disaster. Not merely has no trace of a disaster supervened, but Nicaragua has produced no credible evidence that the road was *capable* of causing such a disaster.

4. While making new, unsupportable and inadmissible claims in its Reply, Nicaragua appears to have jettisoned a number of claims earlier made. For example, it finally appears to have accepted that it cannot legally exclude the navigational rights of Costa Rica in the San Juan River (although it has done

everything possible to render those rights empty of content by other means). It also appears to have abandoned the idea of having the Road stopped altogether.

5. Nicaragua has nonetheless sought to portray the Road in the worst possible light, by reference to a very few limited stretches, which appear repeatedly in the photographs submitted with Nicaragua's Reply and in its technical reports. But even in the part of the Road which Nicaragua considers to be problematic, remediation works are either now complete or underway. Further, when Nicaragua's claims are considered in their correct context, even on their inflated figures of sediment eroded from the Road to the River, it becomes clear that what is in dispute is no more than a very small – even imperceptible – increase in the sediment load of a River which is naturally adapted to a sediment load that is "very heavy". Indeed, Nicaragua implicitly accepts that the impact of the Road is very small, as is demonstrated by its belated attempt to depict the existing sediment load as "excessive" and unnatural, alongside its new claims that the existing sediment load is the responsibility of Costa Rica. Ultimately, the issue for the Court to decide is whether the Road – which in large part is a track built on existing paths – is having a significant impact on the San Juan River.

6. Costa Rica submits that the answer to that question is no. Indeed, even accepting the estimates of sediment eroding from the Road to the River put forward by Nicaragua's experts in its Reply (which Costa Rica most certainly does not accept), this sediment would represent an addition of less than 3% to the total annual sediment load of the River. On this basis, while there remain a number of issues in dispute between the Parties' experts in terms of the extent of the alleged impacts of the Road, including if any impacts have actually occurred, ultimately these issues are immaterial, because *even on Nicaragua's own estimates, the Road is having no adverse impact on the River*. These matters are

explained in the expert report of Professor Colin Thorne submitted as Appendix A to this Rejoinder.

7. In addition to having no significant impact on the San Juan River, as Costa Rica has demonstrated, there was never a risk of significant transboundary harm. It follows that the threshold requirement for conducting a transboundary EIA was never met. In these circumstances, Costa Rica was not obliged to conduct an EIA. Moreover, general international law acknowledges an exemption from an EIA in situations of emergency, as is explained in this Rejoinder by reference to the expert report of Professor Neil Craik submitted as Annex 1. The emergency declared by Costa Rica, which was created by Nicaragua, and which precipitated the construction of the Road falls within that exemption. It follows that Costa Rica has not breached any requirement to conduct an EIA, and nor has it breached any obligation of notification, exchange of information, or consultation. For these reasons, all the alleged breaches of a considerable number of multilateral and bilateral agreements invoked by Nicaragua have no ground.

8. At the close of the written phase of these proceedings, it is clear that the case boils down to the following three points:

(a) Nicaragua's case is based on no facts and little law. It alleges serious environmental damage to the San Juan River, yet it has not even measured sediment and water flows on the River, something entirely within its capacity to do. (Or if it has measured them, it has not disclosed the measurements to the Court). It has dedicated all its efforts to criticizing Costa Rica's building of the Road, as well as the scientific and technical evidence it has submitted, but it has made no showing of any adverse impacts on the San Juan.

(b) For its part, Costa Rica has shown that the San Juan River has not been significantly damaged; indeed, taking Nicaragua's own technical case at its highest, the Road hypothetically contributes an insignificant quantity of sediment to the River, less than the annual variability of the sediment load in what is, and always has been, a highly sediment laden and variable river. In short, the impact on the San Juan River as a result of the construction of the Road is imperceptible. In these circumstances, it is apparent that the Road is not causing harm to the San Juan River, let alone significant harm.

(c) In these circumstances, Costa Rica's sovereign right to develop its own territory and to construct roads anywhere in its territory must be fully respected.

9. Costa Rica is confident that the Court is now able to appreciate the artificiality of the present case. All Nicaraguan claims and submissions must consequently be rejected.

Submissions

For these reasons, and reserving the right to supplement, amplify or amend the present submissions, Costa Rica requests the Court to dismiss all of Nicaragua's claims in this proceeding.

Ambassador Sergio Ugalde
Co-Agent of Costa Rica
2 February 2015

APPENDIX A

Professor Colin Thorne

Assessment of the Impact of the Construction of the Border Road in Costa Rica on the San Juan River: Reply Report

February 2015

Appendix A

DISPUTE CONCERNING

CONSTRUCTION OF A ROAD IN COSTA RICA ALONG THE SAN JUAN RIVER

(NICARAGUA V COSTA RICA)

Assessment of the Impact of the Construction of the Border Road in Costa Rica on the San Juan River: Reply Report

Prepared by

Colin Thorne
Nottingham, UK

Professor and Chair of Physical Geography
University of Nottingham

February 2015

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1. Introduction

1.1. I am Colin Thorne, Professor of Physical Geography at the University of Nottingham. I have been requested by Costa Rica to prepare an independent expert report for the International Court of Justice (the ***Court***) in connection with the claim brought against Costa Rica by Nicaragua concerning the construction of a road in Costa Rica near the San Juan River (the ***Road***). I provided an independent expert report entitled "Assessment of the Impact of the Construction of the Border Road in Costa Rica on the San Juan River" in December 2013, which was submitted to the Court as Appendix A to Costa Rica's Counter-Memorial in the *Road* case. This Report responds to Nicaragua's Reply in the *Road* Case, and evidence annexed thereto, dated 4 August 2014.

1.2. I am instructed to form an independent expert opinion on the matters set out in the Terms of Reference below. In that regard I understand that I have an obligation to the Court to express my honest opinion.

1.3. Pursuant to those instructions, I have reviewed Nicaragua's Reply of 4 August 2014 in the *Road* Case, and in particular have focused on the following documents:

(a) Report prepared by Dr G. Mathias Kondolf entitled "Erosion and Sediment Delivery to the Río San Juan from Route 1856", July 2014 (the ***2014 Kondolf Report***), which is Annex 1 to Nicaragua's Reply;

(b) Mr Danny Hagans and Dr Bill Weaver, "Evaluation of Erosion, Environmental Impacts and Road Repair Efforts at Selected Sites along Juan Rafael Mora Route 1856 in Costa Rica, Adjacent the Río San Juan, Nicaragua", July 2014 (the ***Hagans and Weaver Report***), which is Annex 2 to Nicaragua's Reply;

(c) Dr Edmund D. Andrews, "An Evaluation of the Methods, Calculations, and Conclusions Provided by Costa Rica Regarding the Yield and Transport of Sediment in the Río San Juan Basin", July 2014 (the ***Andrews Report***) which is Annex 3 to Nicaragua's Reply;

(d) Dr Blanca Rios Touma, "Ecological Impacts of the Route 1856 on the San Juan River, Nicaragua", July 2014 (the ***Rios Report***), which is Annex 4 to Nicaragua's Reply; and

(e) Golder Associates Inc., "The Requirements of Impact Assessment for Large-Scale Road Construction Project in Costa Rica Along the San Juan River, Nicaragua", July 2014 (the ***Golder Report***), which is Annex 6 to Nicaragua's Reply.

2. My Qualifications

2.1. My relevant qualifications are set out in Section 2 of my report of December 2013 (Appendix A to Costa Rica's Counter-Memorial). My curriculum vitae is included as **Attachment 1** to that Report.

3. Terms of Reference and Methodology

A. Terms of Reference

3.1. I have been asked to provide an independent expert opinion on the environmental impacts of the Road on the Río San Juan in Nicaragua. In this context, I have been asked to review and assess the information and opinions given in the reports listed in paragraph 1.3 above and the claims made by Nicaragua in its Reply in the *Construction of a Road* case relating to harm or potential harm to Nicaraguan territory.

3.2. As in my report annexed to Costa Rica's Counter-Memorial I have been instructed to consider the potential environmental impacts of the Road on Nicaragua. Therefore, I have not addressed any impacts of the Road within Costa Rican territory. Nor do I express any opinion on any question of law.

B. Methodology

3.3. In preparing this Report, my approach has been as follows:

(a) I have reviewed the reports listed in paragraph 1.3 above and I have reviewed Nicaragua's Reply insofar as it deals with harm or potential harm to the San Juan River and makes statements that rely on the Reports listed above. I have also reviewed the letter from Dr Andrews dated 12 December 2014 and attached Letter from the Court to Costa Rica, 16 December 2014, Reference 144543.

(b) I have conducted a review of the published academic literature on the sediment and environmental impacts of sediment on rivers, focusing on sources mentioned in the 2014 Kondolf and Andrews Reports.

(c) I have participated in three further site visits to the Road, on 23 April, 29 August and 17 November 2014. On each occasion I drove along stretches of the Road and made detailed observations at sites I selected as well as viewing those sites and longer stretches of the Road from the air. I also spoke first hand to engineers and scientists engaged in works along the Road and took photographs from the ground and the air;

(d) I have requested, formulated and supervised continuing scientific and technical studies performed by qualified Costa Rican scientists and engineers, to elicit the data and information needed to evaluate the potential for construction of the Road to impact the Río San Juan;

(e) I have participated in meetings with the technical team of scientists and engineers in San Jose in April, August and November 2014, during which we discussed approaches and methodologies to be employed in performing the work, reviewed progress and discussed the results of investigations employing archive-based, field, remote-sensing and GIS-based research, and computer modelling; and

(f) I have reviewed the preliminary findings of the team, requesting additional clarification where appropriate.

(g) The technical reports have been produced and provided to me as the outcomes of this supervised research process are:

Eng. Rafael Oreamuno Vega, M. Eng. and Eng. Roberto Villalobos Herrera 2014. Second Report on Systematic Field monitoring of Erosion and Sediment Yield along Route 1856, University of Costa Rica, CIEDES, San José, Costa Rica, November, 2014, 37 pages [the ***2014 UCR Report***]

Mende, A. 2014. Inventory of Slopes and Watercourses related to the Border Road Nº 1856 between Mojón II and Delta Costa Rica: Second

Report, presented to the Ministry of Foreign Affairs - Costa Rica, San José, Costa Rica, December 2014, 42 pages, plus Appendix B: Inventory of Slopes (402p) and Appendix C: Inventory of Watercourses (142p) [the ***Mende Report***]

Institute of Electricity (ICE) 2014. Second Report on Hydrology and Sediments for the Costa Rican River Basins Draining to the San Juan River, Center for Basic Engineering Studies, Department of Hydrology, San José, Costa Rica, December 2014, 34 pages [the ***2014 ICE Report***]

Fallas, J. C. 2014. Comments on the Report By Dr Kondolf (as it pertains to Hurricanes And Tropical Storms) In: Section 1.2 - Risks Of Large Contributions From Rte. 1856 [Annex I, pages 71-74], Costa Rican National Meteorological Institute, San José, Costa Rica, 4 pages [the ***Fallas Report***].

Astorga, A. 2014. Extraordinary sediment inputs due to exceptional events on the San Juan River, Central American School of Geology at the University of Costa Rica, San José, Costa Rica, 21 pages [the ***Astorga Report***].

Angulo, A. 2014. Fish Fauna in the San Juan River, Tropical Science Center, 7 pages (the ***Angulo Report***).

Pacheco, B. 2014. Answers and Study Analysis, "Ecological Impacts of the Route 1856 on the San Juan River, Nicaragua", by Dr Rios Touma 2014), Tropical Science Center, 7 pages (the ***Pacheco Report***).

Gutierrez, P.E. 2014. Critical statistical analysis of the report "Ecological Impacts of the Route 1856 on the San Juan River, Nicaragua" by Blanca Ríos Touma, Licenciado in Water Resources, University of Costa Rica, San José, Costa Rica, 5 pages (the ***Gutierrez Report***).

CODEFORSA 2014a. Consulting Services for the Development and Implementation of an Environmental Plan for the Juan Rafael Mora Porras Border Road, Comisión de Desarrollo Forestal De San Carlos, Ciudad Quesada, San Carlos, Costa Rica (the ***2014 CODEFORSA Report***)

CODEFORSA 2014b. Restoration and rehabilitation of ecosystems affected by the construction of the Juan Rafael Mora Porras border

road, Ruta 1856, Comisión de Desarrollo Forestal De San Carlos, Ciudad Quesada, San Carlos, Costa Rica (the ***CODEFORSA Quarterly Report for November 2014***).

CONAVI 2014. Works on National Road N° 856: Before and After - Updated as of December 2014 (the ***2014 CONAVI Report***).

(h) I have also reviewed an independent expert opinion by Professor Ian Cowx on the impacts of the Road on fish and macroinvertebrates in the San Juan River, Nicaragua (the ***Cowx Report***).

3.4. Where I rely on information and data contained in these reports and studies, or any other reports prepared in the course of the investigations and activities referred to in the sub-sections of paragraph 3.3 above, I indicate that I am doing so.

4. Has Sediment from Route 1856 had any significant impact on Sediment loads in the Río San Juan?

A. *Field monitoring of erosion by landslides, gullies, rills, and sheet erosion*

4.1. In September 2013 the Centre for Research in Sustainable Development (CIEDES) at the University of Costa Rica submitted to the Ministry of Foreign Affairs of Costa Rica a document titled 'Report on Systematic Field monitoring of Erosion and Sediment Yield along Route 1856' (Annex 1 to Costa Rica's Counter-Memorial). This report detailed their programme of field monitoring of erosion of the Road, Cut and Fill slopes, and listed their results to date.

4.2. The same team continued monitoring in 2014, but gained access to better instrumentation and introduced additional sites to improve data accuracy. They also used the new measurements to check the reliability of data reported in the 2013 Report. The combined data were then used to make upper bound estimates of average erosion rates occurring along Route 1856.

4.3. Two technical changes were made. First, terrestrial LiDAR (**Li**ght **D**istance **A**nd **R**angefinding) replaced manual measurements of slope topography at the long-term slope erosion monitoring sites (Figure 4.1). Second, new measurement sites were added, with aerial, photogrammetric surveys performed for three additional sites, which are very difficult to access and which were therefore surveyed from the air (Figure 4.2). These Sites (numbered 11, 12 and 13 in the UCR Report) correspond to SES Sites 8.1, 9.4 and 9.5 in the 2014 Kondolf Report.

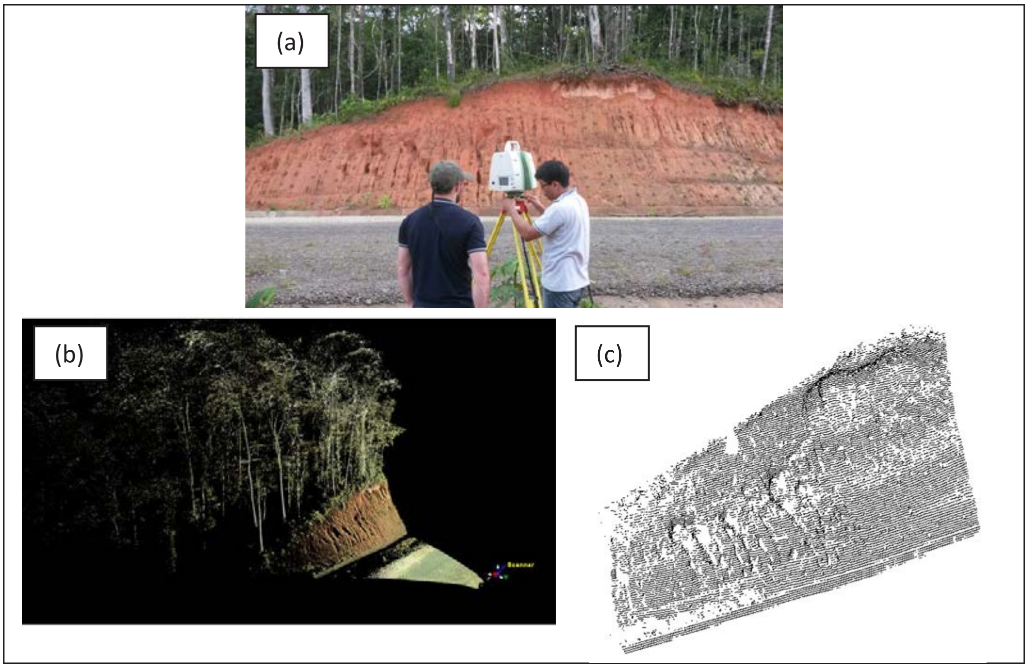

Figure 4.1 (a) Terrestrial LiDAR at monitoring Site 4 on May 27, 2014 (b) LiDAR point cloud (c) contour data for use in erosion measurements (from the 2014 UCR Report).

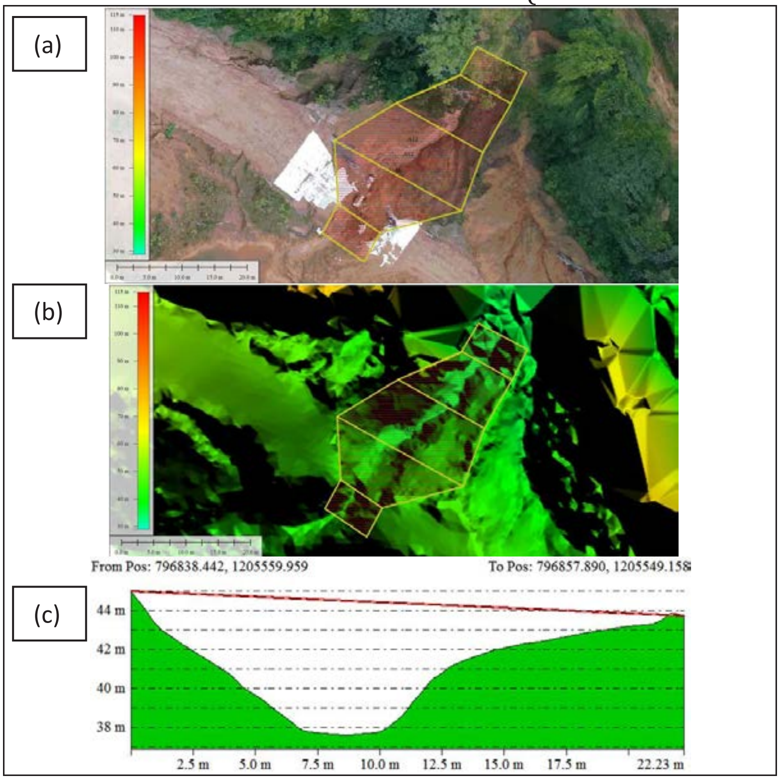

Figure 4.2 (a) Orthophoto, (b) Digital Elevation Model and (c) cross-section through gully at Site 12 (Dr Kondolf's SE Site 9.4) derived from photogrammetric survey on October 28, 2014 and used to estimate gully planform area and eroded volume (from the 2014 UCR Report).

4.4. These technical changes directly address and deal with Dr Kondolf's most serious criticisms of the 2013 UCR Report. On page 48 of his 2014 Report, Dr Kondolf states that, "*The most fundamental weakness of the UCR study is its failure to measure erosion downstream in the more severely eroding sites.*" As explained in the 2014 UCR Report, the problem of lack of ground access to the Road east of the Río Infiernito was resolved in 2014, allowing addition of erosion measurements at sites 11, 12 and 13, which correspond to SES sites 8.1, 9.4 and 9.5 in the 2014 Kondolf Report.

4.5. On page 51 of his 2014 Report, Dr Kondolf presents his second fundamental criticism, stating that, *"The authors of the UCR Report also applied a flawed methodology. Rather than directly measuring all significant erosion features within the areas experiencing significant erosion and mapping the occurrence of smaller features such as areas of rilling (thereby collecting real data for the sites of significant erosion), they used a complicated system to take their measured erosion rate for a feature such as a gully, and then reduced the rate by dividing it over the area of the entire exposed "slope" in which it occurred. This was effectively an arbitrary reduction to the rate because the size of the exposed area in which the eroding feature occurred was unrelated to the eroding feature itself. The authors of the UCR Report also did not account for other erosional processes occurring over the rest of the slope, which artificially reduced the resulting erosion rate. This is a principal reason that the erosion rates reported in Table 6 of Annex 1 are unreasonably low."*

4.6. Application of terrestrial LiDAR at UCR's long-term monitoring sites has made it possible to estimate the rate of erosion for the area of each erosion feature individually, instead of averaging it over the entire area of monitored slope. Hence, erosion rates now represent the areas actually affected by each type of erosion, rather than being averages for the monitored slope. The 2013 field measurements remain unaffected, only the area over which the erosion rates are averaged has changed. The LiDAR scans have allowed UCR to reprocess their 2013 data and the results largely validate the simpler methods used in 2013. They also indicate that erosion rates measured in 2014 are comparable to but generally lower than those monitored in 2013.

4.7. UCR have established characteristic erosion rates for each type of erosion rather than for each monitored slope so that these rates can be applied specifically to the types of erosion and areas affected identified in the Inventory of Slopes prepared by Dr Mende. This allows accurate estimation of an upper bound annual erosion rate applicable not just to the monitored slopes, but to every slope along the entire length of the Road.

4.8. The 2014 UCR Report includes erosion measurement and monitoring results for a total of 11 sites (sites 6 and 7 were not used for technical reasons explained in the 2014 UCR Report) over a two year period (Table 4.1 and Figure 4.3, overleaf).

Table 4.1 UCR erosion monitoring and measurement sites (from the 2014 UCR Report).

Site number		Description	Coordinates
UCR (Dr Kondolf)	Mende		
1	N/A	Large rotational landslide on cut slope. Un-mitigated.	84°21'43.571" W 10°59'30.461" N
2	T-33	Large rotational landslide on cut slope. Un-mitigated.	84°20'45.712" W 10°56'55.931" N
3	T-37	Gully on cut slope. Un-mitigated.	84°20'27.579" W 10°56'50.991" N
4	T-42	Rills on cut slope. Un-mitigated.	84°19'33.653" W 10°55'15.459" N
5	T-39	Sediment trap.	84°20'07.509" W 10°56'27.451" N
6	C-29	Sediment trap (not used). Refer to 2013 report for details.	84°19'26.847" W 10°55'07.199" N
7	T-58a	Sediment trap (not used). Refer to 2013 report for details.	84°18'18.025" W 10°54'50.528" N
8	T-8b	Gully on fill slope. Partially mitigated.	84°21'19.775" W 10°59'26.769" N
9	T-57a	Gully on fill slope. Un-mitigated.	84°18'21.896" W 10°54'52.695" N
10	T-45b	Rills on fill slope. Un-mitigated.	84°19'31.562" W 10°55'09.799" N
11 (8.1)	T-65	Large gully on fill slope. Un-mitigated.	84°17'22.664" W 10°54'24.191" N
12 (9.4)	T-68	Large gully on fill prism. Mitigation imminent.	84°17'02.137" W 10°53'39.912" N
13 (9.5)	T-70	Large gully on fill prism. Mitigation imminent.	84°16'54.725" W 10°53'35.477" N

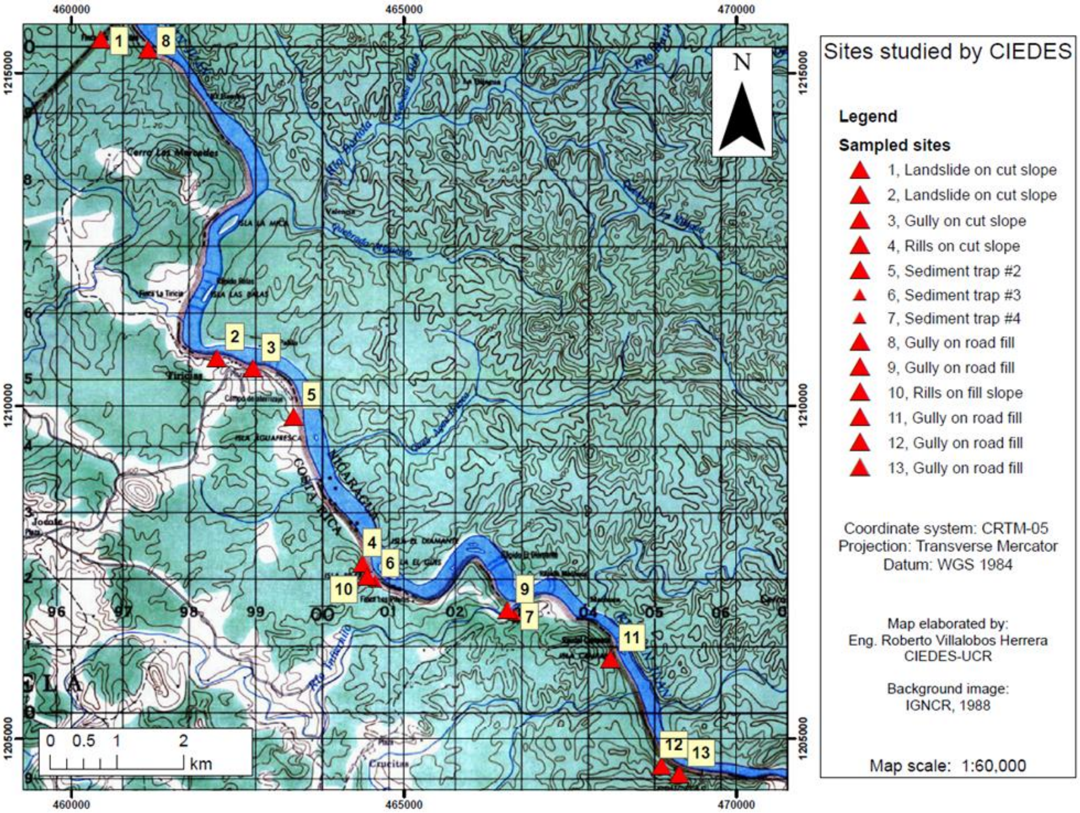

Figure 4.3 Location map showing UCR erosion monitoring and measurement sites (from the 2014 UCR Report).

4.9. Data analysis techniques applied to derive slope erosion data and details of how the outputs from terrestrial LiDAR scanning and stereo photogrammetry were processed are described in the 2014 UCR Report.

4.10. The method used to estimate sheet erosion was refined from that used in 2013. The underlying principle remains using the sediment trap at site 5 to capture sediment eroded from a typical cut slope that was subject only to sheet erosion, but the method used to measure the depth of accumulated sediment was enhanced. In August 2014 an excavator was used to empty the sediment trap and a Total Station was used to establish its dimensions and topography. Stakes with which to record the depth of sediment throughout the trap and around its edges were installed and surveyed-in (Figure 4.4). Sediment surface elevations relative to the stakes were measured on two subsequent dates in October 2014. Digital elevation models of the sediment surface were then differenced to calculate the volume of sediment that had accumulated in the trap between visits.

Figure 4.4 (a) Sediment trap at Site 5 on October 1, 2014. (b) Survey points and contour map of sediment surface elevations on October 22, 2014 (from the 2014 UCR Report).

4.11. Erosion measurements and rates recorded for each of the monitoring sites are listed and fully described in the 2014 UCR Report together with site-specific details and observations of the erosion features monitored. UCR summarize the outcomes of their comprehensive, multi-year, multi-site field campaign in Table 7 of their 2014 Report, which is reproduced here as Table 4.2.

Table 4.2 Maximum annual erosion rates (from the 2014 UCR Report).

Erosion type	Fill slope erosion rate (m/yr)	Cut slope erosion rate (m/yr)
Rotational landslide	0.40[a]	0.40
Gully	0.76	0.27
Rill	0.16[b]	0.16
Sheet	0.14[c]	0.07

a. As no deep-seated, rotational landslides were measured in fill slopes, the cut slope landslide erosion rate is recommended.
b. The 2013 report conservatively used the same erosion rate for rills in cut slopes and fill slopes and this has been repeated in this report. The estimated erosion rate for rills in fill slopes is lower (0.07 m/yr.) therefore the higher erosion rate recorded in cut slopes (0.16 m/yr.) has been conservatively recommended for both sites.
c. Recommended sheet erosion rate is estimated by doubling rate measured for a cut slope to account for uncompacted condition of soil in fill prisms.

The equivalent Table from the 2013 UCR Report (Table 4.3) is also shown for comparison.

Table 4.3 Summary erosion monitoring results in the 2013 UCR Report.

Type of feature	Erosion type	Eroded Area/Area of Feature (%)	Average erosion depth (m)	Average rate of land surface lowering (m y^{-1})
Cut Slope	Landslide	13	0.38	0.19
Cut Slope	Gully	2	0.01	0.005
Cut Slope*	Rill	50	0.12	0.06
Road bed and Cut Slope	Sheet	100	0.02	0.095
Fill Slope	Gully	9	0.10	0.20

4.12. It should be noted that, as in the 2013 Report, UCR recommend using the highest erosion rate measured for each type of erosion and slope, so the rates listed for each type of erosion represent upper bound mean annual rates of erosion measured at the monitoring sites over the monitoring period and, hence, the results obtained are conservative.

4.13. In comparing the data in Tables 4.2 and 4.3, it is important to note that the way in which average annual rates of erosion are expressed differs between them, for the reasons set out in paragraphs 4.6 and 4.7 above. The erosion rates in Table 4.2 are higher than those in Table 4.3 only because the volume of sediment eroded is divided by the area of the erosion feature, rather than the entire area of the slope affected. In fact, UCR report that, in 2014, erosion has slowed at most monitoring sites compared to that measured in 2013.

4.14. Dr Kondolf critiques site selection in the 2013 UCR field campaign, and opines on page 52 that, *"there is no scientific justification for applying the depths measured in small gullies to large gullies".* In the 2014 UCR Report, Costa Rica's expert engineers explain the basis upon which their long-term monitoring sites were selected. Selection was based on pragmatic and practical decisions that are sensible and justified. Dr Kondolf's criticism of the sites selected for monitoring, underpinned by his assumption on page 48 that the large size of gullies observed at his SES sites 8 and 9 necessarily makes them "*more severely eroding*" than those monitored by UCR, is used to support his assertion that UCR's measured data under-represent erosion rates for slopes located along the full length of the Road.

4.15. Application of stereo photogrammetry to survey and estimate rates of erosion in large gullies at Dr Kondolf's sites 8.1, 9.4 and 9.5 (in the least accessible stretch of Route 1856, between the Río Infiernito and Boca San Carlos) now allows testing of Dr Kondolf's assumption that these large gullies have higher average erosion rates and, hence, his assertion that UCR rates are unrepresentatively low. The results obtained using stereo photogrammetry and terrain analysis are listed in Table 4.4.

Table 4.4 Measured data for fill slope gullies at UCR Sites 8, and 11-13 (from the 2014 UCR Report).

Site	Gully area (m^2)	Volume eroded (m^3)	Annual Erosion rate (m/y)*
8	86	101.4	0.76
9	18.4	8.7	0.30
11 (8.1)	174	134.5	0.22
12 (9.4)	500	659.9	0.38
13 (9.5)	720	303.1	0.12

*note: that the annual erosion rate at Site 8 is double that at the most rapidly eroding of the Sites mentioned in the 2014 Kondolf Report.

4.16. These measurements reveal that while the gullies at Dr Kondolf's sites 8.1, 9.4 and 9.5 are indeed larger and have eroded greater *volumes* of sediment than gullies formed in fill slopes monitored at UCR Sites 8 and 9, the mean annual *erosion rates* (that is their volumes eroded divided by their planform areas, divided by their age, i.e. how much they have lowered the ground surface in a year) at Dr Kondolf's sites 8.1, 9.4 and 9.5 are actually much *lower* than that measured at Site 8, and are comparable to those measured at Site 9.

4.17. The rates of erosion measured at Dr Kondolf's sites 8.1, 9.4 and 9.5 are also comparable to the erosion rate recommended in the 2013 UCR Report, which was 0.2 m/y (as listed in Table 4.2). Hence, Dr Kondolf's conclusion that the rates UCR reported in 2013 were unrepresentatively low is not supported by the measurements made at his sites 8.1, 9.4 and 9.5 in 2014.

4.18. In Figure 21 of the 2014 Kondolf Report, Dr Kondolf identifies several locations he classifies as 'severely eroding sites' (SES) that were not included in UCR's programme of long-term monitoring and measurement. These include his SES sites 10 to 17. The key point is that UCR selected their long-term monitoring sites specifically to be representative of erosion by sheet flow, rills, gullies and landslides that were accessible during all seasons. As UCR's measurements at Dr Kondolf's SES sites 8 and 9 now demonstrate, the largest features do not lower the land surface the fastest. In fact, the most rapid land surface lowering is driven by mid-sized erosion features, where the forces driving a particular erosion process are concentrated in relatively small area. As the area of a feature increases, the average rate at which it lowers the land surface within that area tends to decrease, because forces driving the erosion process become diffused and the shear stress responsible for sediment entrainment (that is the tangential force per unit area) decreases. The results of precise measurements made using photogrammetric analysis of stereo pairs of high definition, orthogonal aerial photographs of Dr Kondolf's sites 8.1, 9.4 and 9.5 prove that long-term average rates of land surface lowering by the large gullies that existed at those site prior to mitigation by CONAVI in late-2014 were lower than the that measured by UCR using terrestrial LiDAR at UCR's Site 9. The rates of land surface lowering measured at Dr Kondolf's sites 8.1, 9.4 and 9.5 are comparable to the rate recommended in the 2013 UCR Report and lower than that recommended in the 2014 UCR Report (Table 4.4).

4.19. UCR considered making measurements at the rest of Dr Kondolf's SES but did not do so for reasons explained in detail in the 2014 UCR Report. In summary: Dr Kondolf's Site 8.2 was excluded because it was not possible to isolate different types of erosion; Dr Kondolf's Site 9.6 was not measured as erosion was already being mitigated at the time of the photogrammetric survey; no rates of erosion were provided in either the Kondolf or Hagans and Weaver Reports for Sites 10-17 (estimates were provided only for Sites 8.1, 8.2, 9.4, 9.5, and 9.6), and these sites were also out of range of the UAV. UCR report that, based on their observations of sites 10-17, it appears unlikely that rates of erosion at these sites would be any higher than those recommended in their 2014 Report. I concur and conclude that erosion rates measured at the sites monitored by UCR reasonably represent those at all 201 slopes along the Road.

4.20. Some confusion is apparent in the Kondolf Report concerning the existence of landslides on fill slopes (see page 45 of the Kondolf report). In his commentaries Dr Kondolf interprets erosion on fill slopes as being driven by the juxtaposition of gullies and landslides. If Dr Kondolf is referring to deep-seated, rotational landslides resulting from gravitational slope instability, this is a misinterpretation. As Dr Kondolf correctly notes, the sediment in fill slopes is unconsolidated. The cohesive strength of the fill material is consequently low. As a result, fill slopes are at or less than the angle of repose. Deep seated, rotational landslides do no occur on slopes with these geotechnical and geometric properties. What actually happens is that fill prisms along the Road are eroded by gullies that incise deeply into the fill, creating steep scarps and side slopes that slough into the gully by toppling and/or shallow sliding. These gully head and bank failures are driven by fluvial scouring at the base of the head and sides of the gully. As such, they are part of the gully erosion process and are not conventional landslides. This is why what Dr Kondolf identifies as 'fill slope landslides' are located at the heads or margins of fill slope gullies. Dr Kondolf's misidentification of the occurrence of deep-seated, rotational landslides on fill slopes undermines the credibility of the Kondolf Report as a treatise on slope mechanics compared to the Reports produced by UCR's geotechnical engineers.

B. Estimated annual erosion of sediment from cut and fill slopes under a 'worst case' rainfall scenario

4.21. Inventorying cut and fill slopes in 2013 posed significant challenges to Dr Mende in his attempt to survey about 200 slopes and inspect well over a hundred watercourse crossings along the 108 km between Marker II and Delta Costa Rica. These challenges were compounded by the fact that the work had to be performed at a time of year characterized by inclement weather that made making measurements in the field difficult, rendered some stretches of the Road impassable by vehicle and made others inaccessible even on foot.

4.22. In 2014 a new field campaign was therefore planned with the aim of upgrading the inventories of slopes and watercourse crossings that were presented in the 2013 Mende and Astorga Report.

4.23. The 2014 field campaign was undertaken during the dry season, additional resources were allocated to support Dr Mende in the field, and accurate measurements of slope geometry (width, height, length, angle) were made possible through the use of a Laser Hypsometer Nikon Forestry Pro, which is a hand-held, electronic rangefinder. This device may be used to measure distances between 10 and 100 metres with an accuracy of +/-0.5 m, and to measure elevation differences to and accuracy of +/- 0.2 m. Full details of its mode of operation may be found at http://www.forestry-suppliers.com/product_pages/Products.asp?mi=7852&title=Nikon%C2+Forestry+PRO+Laser+Rangefinder%2FHypsometer.

4.24. The Mende Report uses the updated upper bound mean annual erosion rates recommended in the 2014 UCR Report, together with new field measurements of slope heights and areas, to derive accurate upper bound estimates of the volumes of sediment eroded from cut and fill slopes along the entire length of the Road between Marker II and Delta Costa Rica. Given that the erosion rates presented in the 2014 UCR Report are conservative for the reasons explained above, the results obtained for each slope in the Mende Report are also conservative.

4.25. On pages 52 to 56 of his 2014 Report, Dr Kondolf criticizes the way that slope heights were estimated in the field in 2013 and how eroded areas were subsequently calculated and volumes of erosion estimated by Mende and Astorga in their 2013 report. Having taken account of these comments, the 2014 Mende Report incorporates accurate measurements of slope height and hence its results are more robust.

4.26. The 2014 Inventories also identify the mitigation status of each slope and crossing, categorizing these features on the basis of whether mitigation to prevent erosion and/or eroded sediment from reaching the River is complete, in progress, scheduled, or unnecessary. The category of 'other' has been added to cover minor crossings in stretches where the Road exists only as a trail accessible on foot or horseback. The outcomes of this assessment of the mitigation status of slopes and watercourse crossings are considered further in Section 7, below.

4.27. Dr Mende took advantage of the additional time and resources made available in 2014 by inspecting every slope and watercourse crossing in person, effectively walking the entire trace of the Road (including those stretches where it is no more than a trail) between Marker II and Delta Costa Rica in the process – a distance of around 108 km. Close scrutiny possible only through this on-the-ground survey resulted in him adding eight small watercourse crossings and five more slopes to the 2013 Inventories. Based on his closer inspection in 2014, Dr Mende also chose to sub-divide some complex slopes to improve the way they are presented in the Inventory. Consequently, slope T-83 has been subdivided into six segments (T-83a to T-83f); T-114 into three segments (T-114a to T-114c); and T-161 into two segments (T-161a, T-161b).

4.28. The first outcome of the 2014 field campaign led by Dr Mende was, then, to increase the number of entries in the inventory of slopes from 188 to 201, and the number of entries in the inventory of watercourse crossings from 121 to 129. These slopes and crossings are not distributed evenly between Marker II and Delta Costa Rica. Over 60% of slopes and crossings are located in the 41.6 km stretch between Marker II and Boca San Carlos, while a third are located in the 43.6 km stretch between Boca San Carlos and Boca Sarapiquí. There are only ten crossings and four slopes in the 22.6 km stretch between Boca Sarapiquí and Delta Costa Rica (see Table 7.2, below).

4.29. Walking from Marker II to Delta Costa Rica provided the opportunity for Dr Mende to observe and map the condition of the road surface, classifying this as being a 'gravel road', a 'dirt road' or a 'trail' (Figure 4.5). Along stretches categorized as a 'gravel road', the surface of the Road is protected from erosion because it is covered by gravel-sized rocks. Along stretches categorized as a 'dirt road' its surface is unprotected. Along stretches categorized as a 'trail' the Road does not exist except as a narrow track passable on foot or horseback. In Section 6 (page 39) of the 2014 Kondolf Report, Dr Kondolf made it clear that he did not believe that the surface of most of the road is covered in gravel. Dr Mende's observations and map show that it is (Figure 4.5).

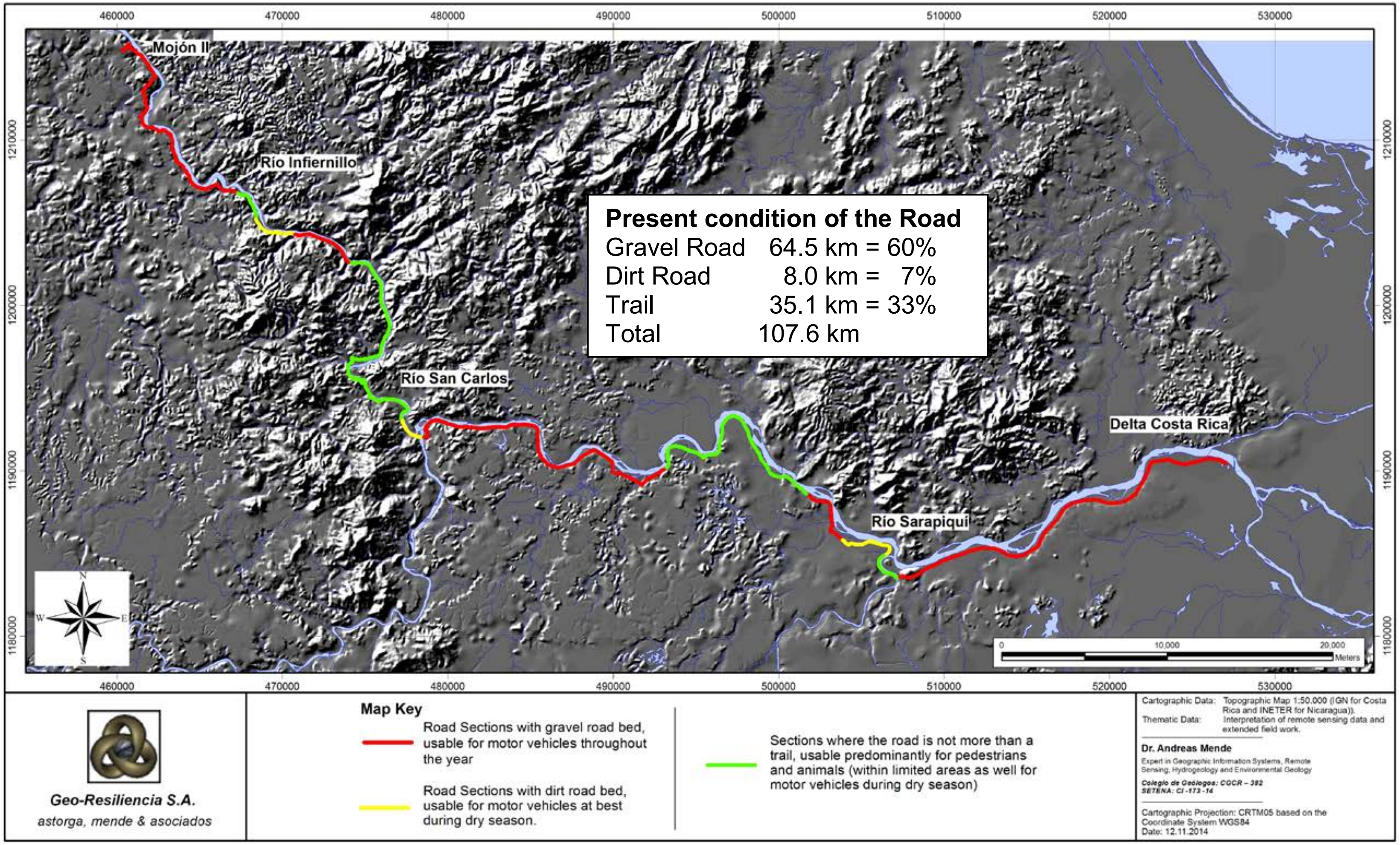

Figure 4.5 Current condition of the Road between Marker II and Delta Costa Rica derived from on the ground inspection by Dr Mende (from the Mende Report).

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4.30. The Mende Report presents accurately measured, detailed information on the relative frequencies of the different types of erosion acting on slopes along the Road (Table 4.6).

Table 4.5 Types of slope erosion observed along the entire length of the Road between Marker II and Delta Costa Rica (from the Mende report).

Erosion type	Slope area (ha)	Slope area (%)
Sheet erosion	16.5	53
Rill	6.4	21
Gully	5.9	19
Landslide	1.9	6
None	0.2	1
Totals	30.9	100

4.31. These observations demonstrate that the prevalent erosion process on the slopes along the Road is sheet erosion. Rills and gullies each occupy about a fifth of the overall area of the slopes. While landslides feature in most of the slopes photographed in Dr Kondolf's 2014 Report, they occupy only 6% of the overall area of slopes. Hence, any impression that landslides are prevalent along the entire length of the Road is inaccurate.

4.32. The annual erosion rates recommended by UCR (listed in Table 4.2 above) were accepted and applied without modification, as demonstrated in Table 9 on page 32 of the Mende Report and Table 4.7, below. As noted in paragraph 4.12 above, in their 2014 Report, UCR again recommend using the highest mean annual erosion rate for each type of erosion and slope, so the rates listed for each type of erosion represent the highest mean annual rate of erosion measured at the monitoring sites over the monitoring period. In this sense they are, therefore, conservative.

4.33. In the Mende Report, the updated rates of erosion supplied in the 2014 UCR Report are combined with the new field measurements of slope geometry made using more accurate techniques and instruments to estimate the annual volume of sediment eroded from each of the 201 slopes in the inventory. In these calculations, at each slope, the upper bound erosion rate recommended by UCR for each erosion process (landslides, gullies, rills and sheet erosion) is multiplied by the area recorded in the Inventory of Slopes as exhibiting that erosion process, and the volumes eroded by each process are summed to estimate the total for the slope as a whole. The annual volume of erosion calculated at each slope is, therefore, also an upper bound, conservative value.

4.34. An example of the calculation procedure for Slope T-8a, which exhibits all four erosion processes, is presented in Table 4.7.

Table 4.6 Example calculation of annual erosion volume for Cut Slope T-8a.

Erosion type	Cut slope erosion rate (m/y)	Slope area affected (m^2)	Estimated annual volume of erosion (m^3/y)
Sheet erosion	0.07	185	13
Rills	0.16	554	89
Gullies	0.27	369	100
Land Slides	0.40	739	296
Totals	--	1,847	497

4.35. Applying this approach to all 201 slopes along the Road between Marker II and Delta Costa Rica, Dr Mende estimated the total volume of slope erosion to be just under 72,000 m^3/y.

4.36. This volume is based on a scenario in which all four erosion processes operate at their upper bound rates, simultaneously at every slope along the entire length of the Road. For erosion of 72,000 m^3 actually to occur in one year, it would require rainfall sufficiently heavy, frequent and widespread to maximize annual erosion rates along the entire length of the Road, which is improbable for the meteorological reasons explained in Section 4*D*, below. Hence, I believe this to be a 'worst case' rainfall scenario for slope erosion along the Road and one that is actually very unlikely to occur, making it a highly conservative estimate. Also, no account is taken of reductions in slope erosion resulting from the programme of erosion mitigation performed by CONAVI and CODEFORSA, which has progressed significantly since 2013 (see Section 7, below). It follows that the annual slope erosion volume of 72,000 m^3/y produced by Dr Mende is very much a 'worst case' value, not a mean annual average value.

4.37. The slope erosion volume estimated in 2014 is nearly double that estimated in 2013, which was 36,590 m^3/y (or 61,100 t/y). The increase results from Dr Mende's underestimation of slope surface areas in 2013. Use of improved instrumentation in the 2014 field campaign allowed him to measure slope dimensions precisely instead of estimating them, to produce more accurate results, especially for those fill slopes where the road is situated at the top of the slope. Applying the same conversion rate for cubic metres of sediment to metric tonnes of 1.67 t/m^3 used in 2013, 72,000 m^3/y converts to almost exactly 120,000 t/y.

4.38. I note that the estimates of slope erosion by landslides, gullies and surface erosion in the 2014 Kondolf Report (147,515 – 158,515 m^3/y, reported on page 61) have also changed compared to those in the 2012 Kondolf Report (218,400 – 273,000 m^3/y, reported on page 46 of that Report), with the 2013 estimates being 1.5 to 1.7 times greater than those suggested in the 2014 Kondolf Report. Dr Kondolf's 2014 estimates are based on applying the average erosion rate for rills, gullies and landslides reported in the 2013 UCR Report (0.558 m/y) to all sites identified by Dr Kondolf as 'severely eroding'. This erosion rate replaces that assumed in the 2012 Kondolf Report (1 m/y), which was much too high.

4.39. In In his Table A (on page 53 of the 2014 Kondolf Report), Dr Kondolf notes a discrepancy between the erosion rates recommended in the 2013

UCR Report and those applied in the 2013 Mende and Astorga Report. As explained by Dr Mende, this discrepancy has now been corrected and the updated 2014 UCR erosion rates are applied in the 2014 Mende Report. In any event, I note that in 2013 more conservative, i.e. higher, estimates of erosion rates were applied by Mende and Astorga, resulting in a higher estimate of erosion from the Road to the River. Furthermore, this discrepancy had no impact on my overall conclusions in the 2013 Thorne Report because, in establishing the relative contribution of Road-derived sediment to the River and whether this was sufficient to cause harm to its water quality, morphology, environment or ecosystems, I applied Dr Kondolf's 2013 estimate of erosion from the Road to the River, which was substantially higher.

4.40. I am confident that the revised estimate of 72,000 m^3/y (equivalent to 120,000 t/y) proposed in the 2014 Mende Report represents a reliable, 'worst case' estimate of the annual erosion rate for slopes along the Road between Marker II and Delta Costa Rica, because:

(a) it is based on two years of field monitoring and measurements using accurate technologies;

(b) upper bound, measured erosion rates are applied to all the slopes along the Road simultaneously; and

(c) no reduction is made for the mitigating effects of CONAVI and CODEFORSA's slope stabilizing work (which now reduces erosion at over half of the slopes requiring mitigation).

In summary, I believe this figure to be a highly conservative estimate, representative of erosion under an unlikely, 'worst case' rainfall scenario.

C. The contribution of the sediment eroded from the Road to the sediment load and average annual sediment budget of the River

4.41. In 2013, hydrologists and hydraulic engineers with the Costa Rican Institute of Electricity (ICE) prepared a report that investigated whether the Road has, or could have, significant impacts on the hydrology or sedimentology of the Río San Juan, drawing on the best information available at that time. In 2014, the work presented in the 2013 Report was re-visited, taking advantage of new and better information gathered in the interim, and applying more advanced analyses to refine the outcomes and increase confidence in their accuracy.

4.42. Based on the outcomes of hydrological analyses presented in the 2013 ICE Report, it was concluded in the 2013 Thorne Report (page 65, paragraph 7.17) that, *"there is no possibility that the Road has had, will have, or indeed could ever have any measurable impact on the hydrology of the Río San Juan"*. This conclusion was not challenged in the 2014 Kondolf Report and is restated here as confirmation that it remains my belief.

4.43. In light of this, the 2014 ICE report focuses on sediments, using advanced techniques in the hydrological, river and engineering sciences to better model catchment sediment erosion and yields, and to reevaluate measured and calculated sediment transport in the Río San Juan, with a special emphasis on establishing the best possible sediment budget. The 2014 ICE Report also pays particular attention to identifying and quantifying natural variability and uncertainty which are unavoidable and characteristically high in sediment measurement, estimation and modelling.

4.44. ICE's work in 2014 addresses the view that, "*When Professor Thorne says that the contribution of sediment from the Road is insignificant, he is not comparing that contribution to a figure that accurately represents the* *sediment load of the Río San Juan."*, which is made on page 66 of the 2014 Kondolf Report in a subsection titled, "*Costa Rica's Experts Compare the Road's Contributions to Unreliable Total Load Figures".* Dr Kondolf does not support this statement with technical criticisms of the way that ICE in their 2013 Report estimated the annual average suspended load of the Río San Juan, which makes up much the greater part of the total load.

4.45. However, Dr Kondolf does criticise the way that ICE estimated the bedload, relying on views advanced in the Andrews Report, that ICE used an exaggerated value for the slope of the river in calculating the bedload using the Einstein bedload function. This criticism is conflated with a further criticism (on page 67 of the 2014 Kondolf Report) that values of slopes for sub-reaches of the river listed in Table 1 of the 2013 Thorne Report are, "*overstated by factors of about 55 to 58"*. On the same page, Dr Kondolf then concludes that, *"The implications of this error are significant, in that channel slope is a fundamental variable of rivers, which affects many river process, including bedload transport, whose calculation can be distorted by use of erroneously large slope values."*

4.46. The slopes listed in Table 1 of the 2013 Thorne Report are correct, but they are expressed in degrees rather than being dimensionless - as incorrectly indicated in the column heading in Table 1. Any confusion the error in the heading may have caused is regrettable. This was purely a labelling error and it had no bearing on calculations performed by ICE in estimating the bedload component of the total load of the Río San Juan.

4.47. Having clarified this, the remainder of this sub-section reports significant advances in the analyses presented in the 2014 ICE Report (compared to the 2013 ICE Report) that improve the accuracy of the suspended, bed and total sediment loads estimated for the Río San Juan and, hence, the reliability of the sediment budget. The 2014 ICE Report and my comments in this sub-section also address Dr Andrews' over-arching criticism (on page 13 of the Andrews Report) that the 2013 Thorne and ICE Reports include, *"numerous examples of insufficient and poor quality hydrologic information, incorrect and improper analysis, and unsupported or wrong conclusions".* This criticism is inconsistent with the facts that the Andrews Report; (1) itself relies heavily on the hydrologic information provided by the 2013 ICE Report, (2) misconstrues data extracted from the literature on sediment yields from tropical basins, (3) constructs an implausible 'natural' sediment load for the Río San Juan, and (4) demonstrates a lack of knowledge concerning sediment processes in the San Juan Basin, including especially those in its mountainous, headwater basins and its coastal delta.

4.48. Before presenting the enhanced analyses performed by ICE in 2014, it is necessary to note that it was necessary for ICE to use data from hydrometric stations on tributaries to the Río San Juan draining from Costa Rica, rather than using data from the Río San Juan itself. This is the case because Costa Rica is unable unilaterally to measure discharges and sediment loads in the Río San Juan and, notably, Nicaragua's experts choose not to do so, or indeed to supply any measured discharges or sediment loads to support any of their statements regarding the significance of Road-derived sediment in the context of the sediment load currently carried by the Río San Juan.

4.49. With respect to estimation and budgeting of the mean annual suspended load, advances in 2014 include:

(a) greater spatial density and congruence in the meteorological and hydrological information used as inputs to the 2014 analyses;

(b) longer records from discharge and sediment measurement stations and adoption of power functions to generate sediment rating curves (as recommended by Dr Andrews);

(c) enhanced uncertainty analysis throughout, including in the calibration processes;

(d) better assessment of suspended sediment inputs to the Río San Juan at Boca San Carlos and Boca Sarapiquí made using the probabilistic flow duration curve method of Krasovskaia and Gottschalk (2014) and the sediment duration curve approach proposed by Garcia (2014);

(e) development of a spatially-distributed model of erosion in the San Juan Basin downstream of Lake Nicaragua that improves on the 2013 CALCITE model by taking advantage of improvements in spatial resolution, hydrological congruence, calibration (which is now uncertainty weighted) and sensitivity to the use of alternative functions for the delivery index; and

(f) enhanced consideration of uncertainty in the USLE model so that it can better be accounted for in calculating the annual sediment budget and variability therein.

4.50. With regard to estimation of the bedload, advances in 2014 include:

(a) improved bedload calculations using the Engelund-Hansen approach (as recommended by Dr Andrews); and

(b) enhanced consideration of uncertainty in the estimated bedload.

4.51. The distributed sediment model was used to generate an upgraded sediment budget for the Río San Juan and its main tributaries in a manner similar to 2013. The outputs of the 2014 UCR and Mende Reports were then applied to determine the contribution of sediment eroded from Route 1856 to annual average sediment loads in the Río San Juan, lower Río San Juan and Río Colorado.

4.52. Perhaps the most striking finding of the 2014 ICE study and Report is the very high level of inter-annual variability identified in the annual average suspended sediment loads, which can be traced back to natural variability in the hydrological and sediment records used to construct the sediment budget for the Río San Juan and uncertainties in the spatial and regression models. This is significant because it demonstrates that spatial and inter-annual variability in the sediment load of the Río San Juan is so large that the sediment input from the Road, even at its potential highest, is inconsequential in comparison.

4.53. In constructing the 2014 sediment budget for the Río San Juan, the first step was to assemble the base physiographic data needed to build a distributed model of soil erosion in the study area, which is the basin between Lake Nicaragua and Delta Costa Rica (Figure 4.6(a)). The study area comprises 13 tributary basins (Figure 4.6(b)), six in Nicaragua and seven in Costa Rica.

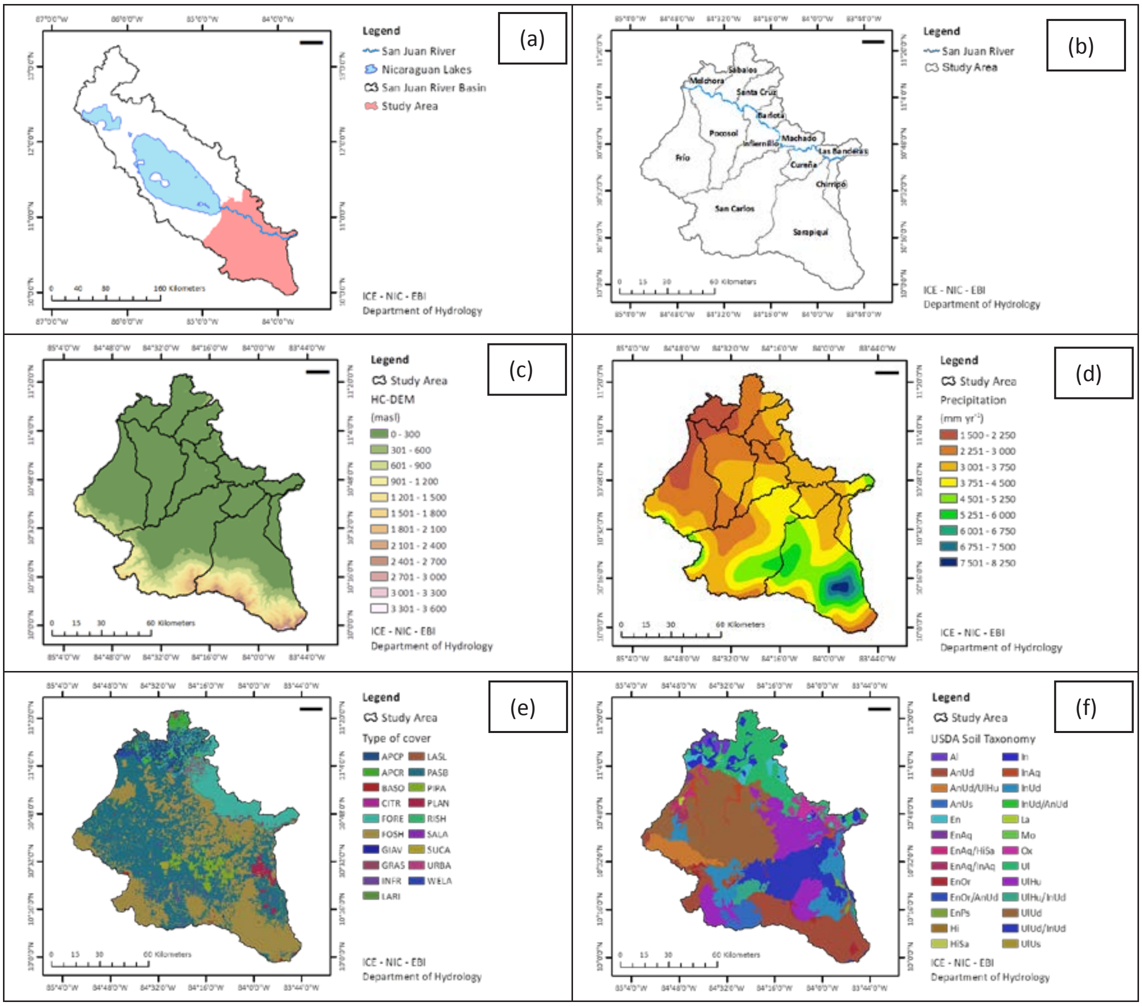


Figure 4.6 (a) Study area of the Río San Juan Basin (b) tributary basins (c) digital elevation model (d) mean annual precipitation (e) land cover map (f) soil classification map (based on maps presented in the 2014 ICE Report).

4.54. Topography was mapped using a Digital Elevation Model (DEM) with a 30 m grid size, derived from official 1:50,000 maps of Costa Rica and point data extracted from the ASTER GDEM for Nicaragua (Figure 4.6(c).

4.55. Mean annual precipitation was mapped by the National Institute of Meteorology using rainfall data for Costa Rica and published INETER data for Nicaragua, all collected between 1971 and 2000 (Figure 4.6(d)).

4.56. Soils were mapped using the USDA soil taxonomy classification (Figure 4.6(e)), based on the soil map published by the Costa Rican

Association of Soil Science (2013) and digitalized information from INETER (2008, p. 58).

4.57. Land cover was mapped using RapidEye satellite imagery for Costa Rica 2009-10 and visual interpretation of available thematic land-cover imagery for the Nicaraguan part of the study area (Figure 4.6(f)).

4.58. As in 2013, the Universal Soil Loss Equation (USLE) was used to estimate potential soil erosion (E) throughout the study area, based on factors representing: crop and cover management (C), soil erodibility (K), slope length and steepness (LS), rainfall erosivity (R) and conservation practice (P), which was taken to be unity (meaning that no allowance is made for reductions in potential erosion due to soil conservation practices). USLE does not account for catchment erosion by gullies and landslides, and so it is expected to under-estimate actual erosion in the San Juan Basin where these processes are widely observed. The contributions of sediment from gullies and landslides are accounted for when the sediment budget is balanced using measured loads in the Río Colorado and at the mouths of the Río San Carlos and Río Sarapiquí (as explained in paragraph 4.75 and shown in Table 4.18, below).

4.59. The other four factors were calculated using the information mapped in Figure 4.6 and then mapped in a GIS.

(a) The land cover factor, C, accounts for differences in potential soil erosion depending on vegetation and land use. There is no unique C value for a given land cover and, in their report, ICE recount in detail how they investigated alternatives for representing this variability before selecting an asymmetrical probability density distribution to account for uncertainty in the C factor. Mean values of 'C' are mapped in Figure 4.7(a). The probability distribution selected has the form of a bell-curve (similar to that for a normal distribution) centered on the most likely (modal) value, but which differs in that the range of possible values is spread asymmetrically around the mode. Accordingly, the bell curve is skewed rather than being symmetrical, as would be the case for a normal distribution.

(b) Information on soil categories was used to derive maximum, minimum and mean values of the soil erodibility factor, 'K' together with coefficients of variation estimated using an asymmetrical probability density distribution to account for uncertainty. Mean K-factor values are mapped in Figure 4.7(b).

(c) The rainfall erosivity factor, 'R' was calculated using over sixty thousand rainfall events recorded at 52 ICE meteorological stations between 1995 and 2014, by linking the results to mean annual precipitation using an empirical power function specific to the study area, with the 95% confidence and prediction intervals used to represent uncertainty in this relationship. Predicted R-factors are mapped in Figure 4.7(c).

4.60. The slope length parameter, 'LS' in the USLE was estimated and mapped using the Digital Elevation Model (Figure 4.7(d)). ICE could not obtain the information necessary to characterise uncertainty in this factor and so it is not accounted for in the uncertainty analysis. Consequently, uncertainties in values of potential soil erosion estimated by ICE are more likely to be under rather than over-estimated.

4.61. Values of potential soil erosion (E) in the study area of the Río San Juan basin calculated using the USLE are mapped in Figure 4.8.

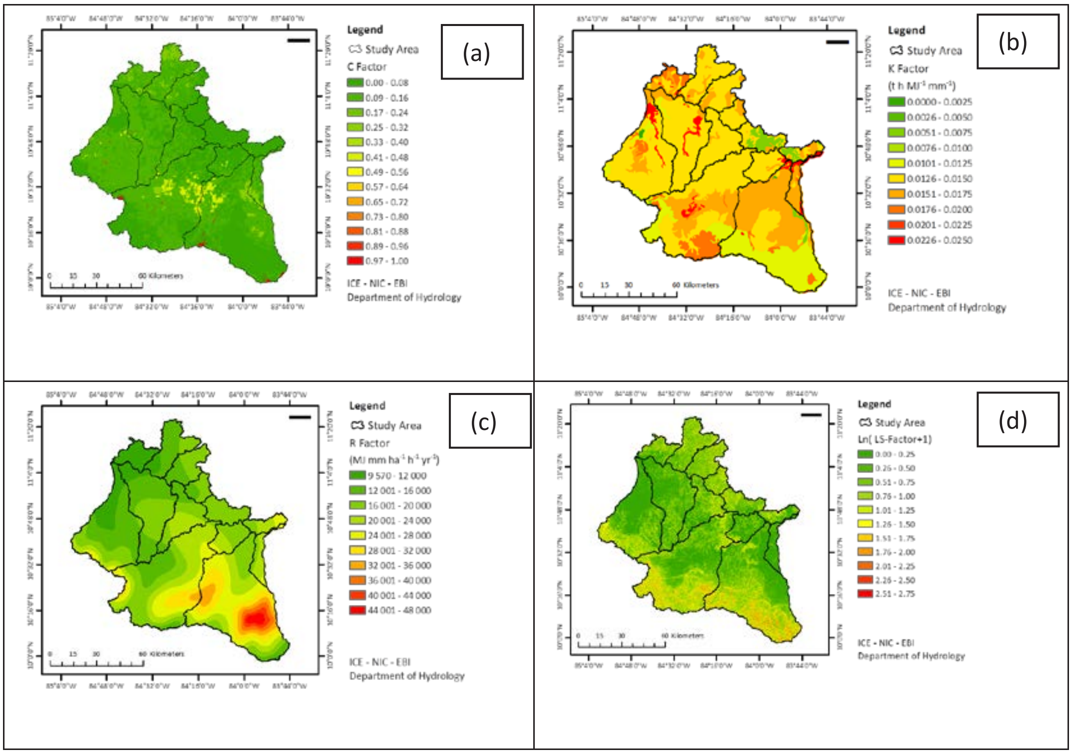


Figure 4.7 (a) land cover factor, C (b) soil erodibility factor, K (c) rainfall erosivity, R and (d) slope length factor LS.

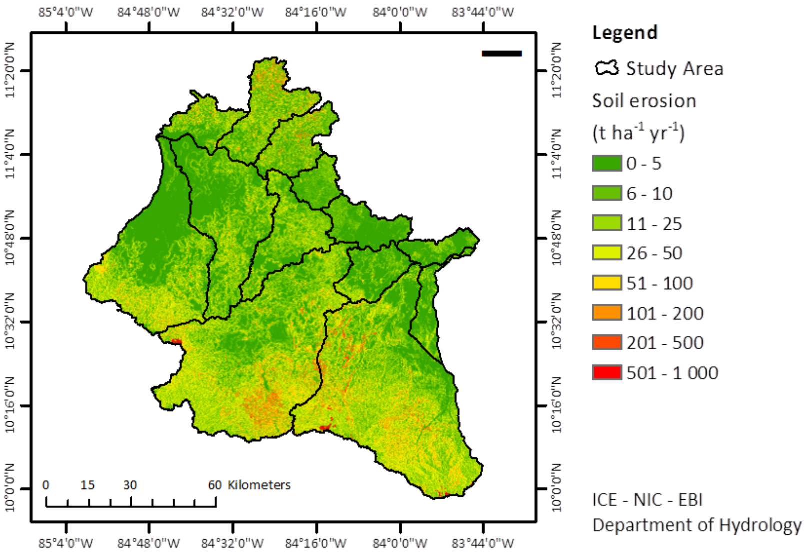


Figure 4.8 Distribution of potential soil erosion in the Río San Juan basin between Lake Nicaragua and Delta Costa Rica (based on maps presented in the 2014 ICE Report).

4.62. Uncertainty in potential soil erosion was quantified using a partial derivatives approach suggested by Singh et al. (2007) and the probability density distributions derived for C, K and R. The impacts of uncertainty on potential erosion were explored using a catchment-aggregated approach (in the manner of the CALCITE model used in 2013) compared to a fully-distributed application of the USLE. The results (Table 4.8) reveal that while uncertainty is reduced using the spatially distributed approach adopted in 2014, it cannot be eliminated entirely.

4.63. Not all of the soil eroded according to the USLE will be transported out of the catchment. Values of the delivery index estimated using the delivery index developed by Bradbury (1995) are mapped in Figure 4.9.

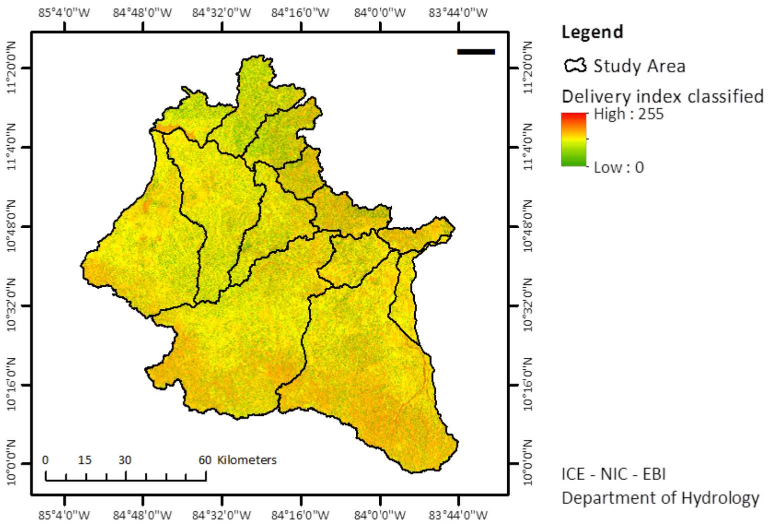


Figure 4.9 Spatial distribution of the delivery index in the study area (from the 2014 ICE Report).

4.64. Records of observed catchment sediment yield available from the 14 hydrologic and sediment gauging stations in the Costa Rican part of the study area were used to calibrate the soil erosion and delivery model and the results are mapped in Figure 4.10 and listed in Table 4.9.

Table 4.7 Potential erosion based on catchment-aggregated and fully-distributed applications of the USLE (from the 2014 ICE Report).

Basin	Mean USLE factors				Aggregated Model (e.g. CALCITE)		Fully Distributed Model	
	C	K	LS	R	Erosion	CV	Erosion	CV
Las Banderas	0.022	0.013	0.91	22300	5.67	3.43	4.73	1.07
Machado	0.020	0.010	1.05	18500	3.97	3.29	3.86	0.90
Barlota	0.020	0.015	1.35	16700	6.49	3.52	6.73	0.59
Santa Cruz	0.065	0.015	1.25	16500	19.92	1.40	19.73	0.16
Sábalos	0.109	0.015	1.14	14100	25.39	1.13	26.02	0.09
Melchora	0.091	0.018	0.91	10100	14.80	0.91	16.19	0.15
San Carlos	0.095	0.015	1.31	21200	40.20	0.69	30.20	0.04
Cureña	0.055	0.014	0.51	20300	7.72	1.16	7.21	0.44
Sarapiquí	0.084	0.014	1.45	26800	47.00	0.76	32.80	0.04
Chirripó	0.105	0.018	0.20	21500	8.11	1.06	6.86	0.48
Frío	0.089	0.015	0.72	15000	14.51	0.83	13.74	0.08
Pocosol	0.086	0.016	0.46	15100	9.19	0.90	9.38	0.14
Infiernito	0.070	0.014	0.80	18600	14.93	1.17	12.79	0.19
Study Area	0.083	0.015	1.06	19900	25.92	0.52	21.58	0.03

Note: Erosion = best estimate (t ha^{-1} yr^{-1}), CV = coefficient of variation

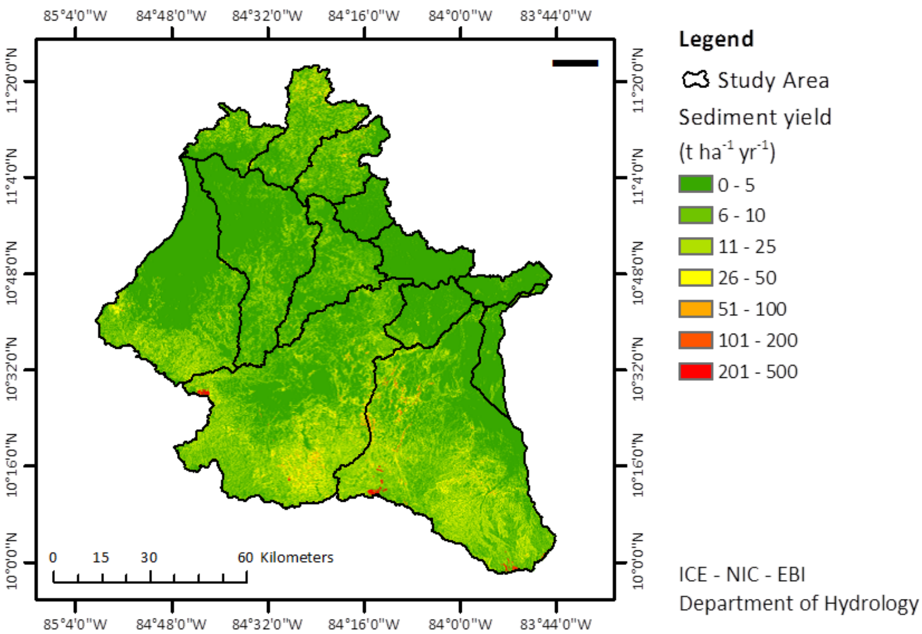


Figure 4.10 Calibrated specific sediment yields in the study area (from the 2014 ICE Report).

Table 4.8 Soil erosion and sediment yields in the Study Area of the San Juan Basin (from the 2014 ICE Report).

Basin	DA (km^2)	SSE ($t\ ha^{-1}\ yr^{-1}$)	SE ($t\ yr^{-1}$)	SSY ($t\ ha^{-1}\ yr^{-1}$)	SY ($t\ yr^{-1}$)
Melchora	305	16.19	494 000	4.97	152 000
Sábalos	571	26.02	1 486 000	7.99	456 000
Santa Cruz	418	19.73	825 000	6.06	253 000
Barlota	219	6.73	147 000	2.07	45 000
Machado	352	3.86	136 000	1.19	42 000
Las Banderas	198	4.73	94 000	1.45	29 000
Frío	1577	13.74	2 167 000	4.22	666 000
Pocosol	1224	9.38	1 148 000	2.88	353 000
Infiernillo	609	12.79	779 000	3.93	239 000
San Carlos	2642	30.20	7 979 000	9.28	2 451 000
Cureña	353	7.21	254 000	2.21	78 000
Sarapiquí	2770	32.80	9 087 000	10.07	2 791 000
Chirripó	236	6.86	162 000	2.11	50 000
Study area	11474	21.58	24 758 000	21.58	7 605 000

Note: DA = drainage area; SSE = specific soil erosion; SE = soil erosion; SSY = specific sediment yield; SY = sediment yield.

4.65. In the 2014 Report, ICE re-examined the measured suspended loads carried annually by rivers in the San Juan basin, based on measurements made at 14 hydrometric stations in the study area (Figure 4.11) plus additional sites at the mouths of the Ríos San Carlos and Sarapiquí.

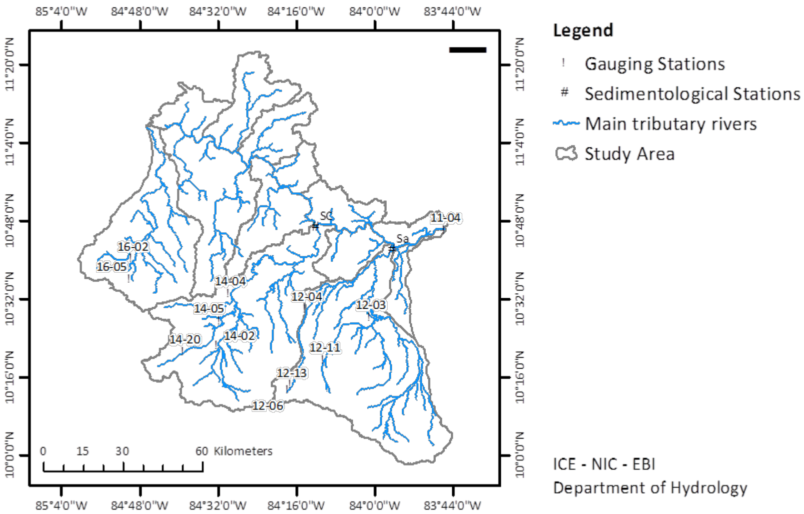


Figure 4.11 Hydrometric stations with sediment records in the Río San Juan basin (from the 2014 ICE Report).

4.66. Suspended sediment rating curves (SSRCs) were generated using measured discharges and measured suspended sediment concentrations for each of the fourteen stations. These measurements are made routinely, using internationally recognized equipment and techniques. The relation between discharge and suspended sediment load is customarily represented as a power function (and this is also recommended by Dr Andrews in his 2014 Report) and this approach was adopted in 2014 (see Figure 4.12 for an example).

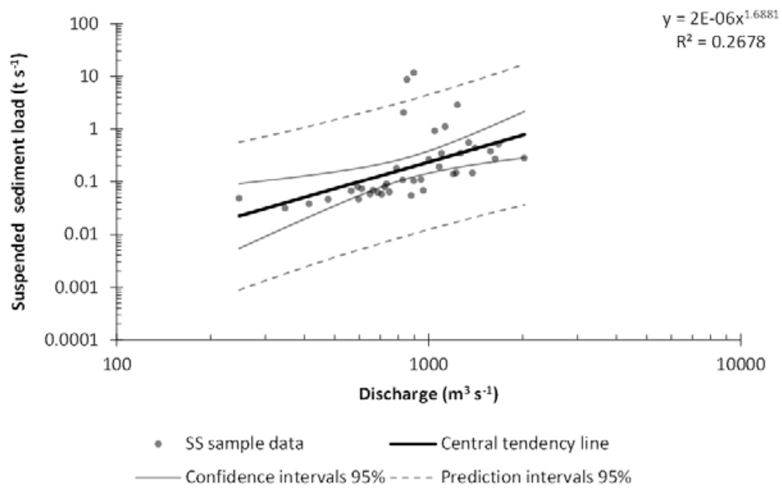


Figure 4.12 Suspended sediment rating curve for the Río Colorado at Delta Costa Rica (Station 11-04) between 2010 and 2014 (from the 2014 ICE Report).

4.67. The SSRCs were combined with discharge records to generate daily and hourly SSL time series at each station. The average annual suspended sediment load was then calculated as the integral of the SSL time series divided by the length of record. This approach is not straightforward and, appropriately, the stringent steps necessary to avoid bias in the resulting mean annual suspended sediment loads were taken. The results are listed in Table 4.10 and described in detail in the 2014 ICE Report.

Table 4.9 Mean annual suspended sediment loads for the 14 hydrometric stations (from the 2014 ICE Report)

CODE	Station	Annual suspended sediment load (t yr^{-1})				
		Mean	TLCI	TUCI	SSRC LCI	SSRC UCI
11-04	Delta Colorado	**7 599 000**	2 611 000	12 586 000	4 023 000	15 148 000
12-03	Puerto Viejo	161 000	141 000	182 000	140 000	186 000
12-04	Veracruz	86 000	37 000	135 000	62 000	123 000
12-06	Toro	12 000	7 000	17 000	8 000	18 000
12-11	San Miguel	22 000	12 000	33 000	13 000	40 000
12-13	Río Segundo	2 000	1 000	3 000	1 000	6 000
14-02	Jabillos	215 000	155 000	274 000	170 000	274 000
14-04	Terrón Colorado	1 175 000	988 000	1 362 000	783 000	1 806 000
14-05	Peñas Blancas	141 000	115 000	167 000	116 000	172 000
14-20	Pocosol	130 000	85 000	175 000	98 000	174 000
16-02	Guatuso	55 000	49 000	61 000	48 000	62 000
16-05	Santa Lucía	3 000	3 000	4 000	3 000	4 000

Note:
TLCI = lower 95% confidence interval due to time series variability;
TUCI = upper 95% confidence interval due to time series variability;
SSRC LCI = lower 95% confidence interval due to uncertainty in SSRC;
SSRC UCI = upper 95% confidence interval due to uncertainty in SSRC.

Table 4.10 Confidence intervals as normalized anomalies for the mean annual suspended sediment loads at the hydrometric stations (from the 2014 ICE Report)

CODE	Station	UTSV (normalized anomalies)		USSV (normalized anomalies)	
		LCII	UCI	LCII	UCI
11-04	Delta Colorado	-66%	+66%	-47%	+99%
12-03	Puerto Viejo	-13%	+13%	-13%	+15%
12-04	Veracruz	-58%	+58%	-28%	+43%
12-06	Toro	-40%	+40%	-32%	+47%
12-11	San Miguel	-48%	+48%	-43%	+79%
12-13	Río Segundo	-28%	+28%	-61%	+192%
14-02	Jabillos	-28%	+28%	-21%	+28%
14-04	Terrón Colorado	-16%	+16%	-33%	+54%
14-05	Peñas Blancas	-18%	+18%	-18%	+22%
14-20	Pocosol	-34%	+34%	-25%	+34%
16-02	Guatuso	-11%	+11%	-12%	+14%
16-05	Santa Lucía	-12%	+12%	-21%	+27%

Note:
UTSV = uncertainty due to time series variability;
USSV = uncertainty due to sample variability in the suspended sediment rating curve;
LCI = lower 95% confidence interval;
UCI = upper 95% confidence interval.

4.68. High uncertainty is evident in the wide 95% confidence intervals in Figure 5.12. This arises both from variability in the SSL time series and uncertainty in the SSRCs. The high degree of uncertainty generated in the resulting mean annual suspended sediment loads is obvious from the lower and upper 95% confidence intervals listed in Table 4.10, above and expressed as percentages of the mean in Table 4.11.

4.69. It is not possible to construct empirical bedload sediment rating curves (like those described above for suspended sediment loads), because bedload transport measurements are unavailable. Consequently, measured discharges and sampled bed sediment sizes available for the Río Colorado at the Delta were used to generate a theoretical sediment rating curve (Figure 4.13). In producing this rating curve, the channel slope was estimated from the Engelund-Hansen hydraulic resistance relation (García 2007, p. 125). The resulting slope of 1.79×10^{-4} m/m for the Río Colorado immediately downstream of the Delta is very close to that recommended by Dr Andrews in his 2014 Report for the Río San Juan immediately upstream of the Delta (which is 1.7×10^{-4} to 1.5×10^{-4} m/m).

4.70. This sediment rating curve was then combined with the discharge time series for Station 11-04 to generate a bedload time series, and uncertainty parameters for this time series were estimated based on sample and time variability. The resulting estimates for the mean annual bedload transported by the Río Colorado are listed in Table 4.12. Confidence and prediction intervals are included to illustrate that uncertainty in these estimates is high.

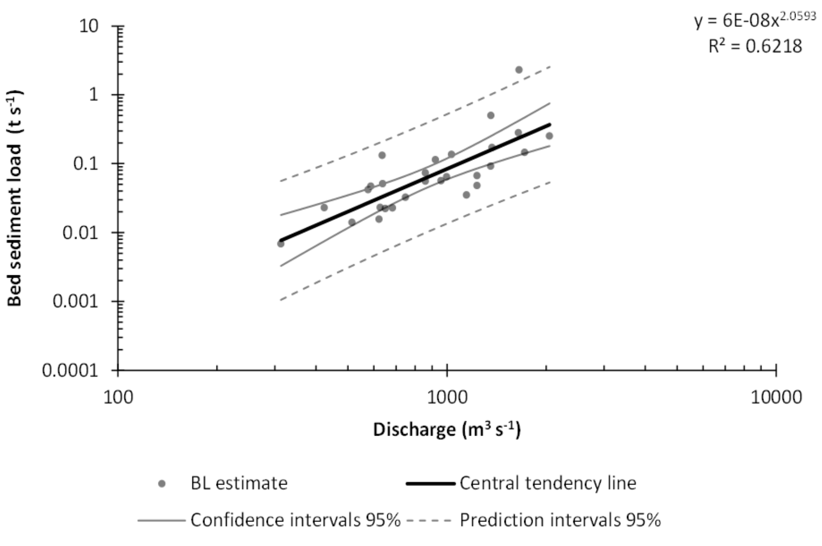


Figure 4.13 Bed load rating curve for the Delta Colorado (11-04) station (from the 2014 ICE Report).

Table 4.11 Mean annual bedload transport in the Río Colorado at Station 11-04 (from the 2014 ICE Report).

CODE	River	Annual Bedload (t yr^{-1})				
		Mean	TLCI	TUCI	BLRC LCI	BLRC UCI
11-04	Colorado	**2 898 000**	719 000	5 077 000	1 798 000	4 809 000

Note:
TLCI = lower confidence interval due to time series variability;
TUCI = upper confidence interval due to time series variability;
BLRC LCI= lower confidence interval due to uncertainty in the bedload rating curve;
BLRC UCI= upper confidence interval due to uncertainty in the bedload rating curve.

4.71. The estimate of bedload transported by the Río Colorado in 2011-12 by Dr Andrews (on page 25 Andrews Report) is 330,000 t/y. This is much less than the mean annual bedload estimated by ICE (2,898,000 t/y). It would be expected that bedload in that particular water year would be lower than average as runoff was lower than usual. Dr Andrews estimated that bedload in that period should be 2.2 times lower than average for this reason, leading him to propose that the mean annual bedload carried by the Río Colorado is 730,000 t/y. This figure falls within the confidence band for ICE's estimate, being close to but a little larger than the lower confidence interval of 719,000 t/y. The fact that Dr Andrews' estimate is near the lower edge of the confidence band probably results from application of a different bedload function by Dr Andrews, who selected the Fernandez-Luque and van Beek equation, while ICE based their calculations on the Engelund-Hansen approach.

4.72. However, there is reason to suspect that the basis upon which Dr Andrews estimates inter-annual variability of the sediment load is flawed. The sediment load in a river draining a tectonically active basin with live volcanoes does indeed vary widely from year to year. However, this is not only due to varying rainfall and runoff; it is also dependent on the quantities of sediment supplied by major sources such as landslides triggered by earthquakes. For example, in 2009, the Cinchona Earthquake generated 349 landslides that disturbed 21.7 km^2 of formerly vegetated land around the epicentre, releasing 4 to 6 million tonnes of sediment, 95% of which entered streams draining to the Río San Juan (Alvarado 2010). Consequently, Dr Andrews is mistaken to estimate inter-annual variability in sediment loads solely as a function of the inter-annual variability recorded in rainfall and runoff. In my opinion, the analyses performed by Costa Rica's experts at ICE, which are based on sediment records from long-term measurement stations, more reliably establish variability and uncertainty in estimates of the annual load of the Río San Juan.

4.73. Annual bedloads at the mouths of the Río Sarapiquí and Río San Carlos had to be estimated using a different approach as no hydrological records are available for those specific locations. To overcome this lack of flow data, ICE selected, tested and calibrated a probabilistic method using flow and sediment records from the twelve hydrometric stations located in other parts of the drainage systems of Río Sarapiquí and Río San Carlos and then applied this to the mouths of the rivers. Full details are presented in the

2014 ICE Report and, having reviewed these, in my opinion the approach applied is viable. The results are listed in Table 4.13.

Table 4.12 Hydrological data, hourly and daily coefficients of variation and mean annual suspended sediment loads at the mouths of the Río Sarapiquí and Río San Carlos (from the 2014 ICE Report).

CODE	Station	DA (km^2)	Qa[a] (m^3s^{-1})	CVD[b]	CVH[b]	SSL[c] (t yr^{-1})
BSa	Boca Sarapiquí	2 643	377	0.647	0.683	2 342 000
BSC	Boca San Carlos	2 771	266	0.644	0.678	2 928 000

Note: DA = drainage area; Qa = mean annual discharge; CVD = daily coefficient of variation; CVH = hourly coefficient of variation; SSL = annual suspended sediment load.
[a]Based on rainfall-area methodology. [b]Based on coefficient of variation-area functions. [c]Based on modeled sediment duration curves.

4.74. As no data are available for current mean annual sediment loads in the Río San Juan immediately upstream of the Delta or the lower Río San Juan immediately downstream of the Delta, these were estimated based on measurements made in the Río Colorado at gauging station 11-04 immediately downstream of the Delta. It is believed that about 90% of the discharge of the Río San Juan passes to the Río Colorado and so the suspended and bedload rating curves constructed for station 11-04, which is in the Río Colorado immediately downstream of the Delta, are reasonable approximations of those for the Río San Juan. As no bedload data are available for the Río San Juan, and given the high variability and uncertainty associated with sediment loads in these rivers anyway, using the bedload rating curve developed for the Río Colorado to estimate bedload in the Río San Juan is a tenable approximation and so estimating the sediment load this way is reasonable.

4.75. On page 22 of the Andrews Report, Dr Andrews points out that, given the data currently available, the division of discharges at the Delta, "*cannot be determined with any confidence*". The division of flows at the Delta *could* be determined with confidence if Nicaragua or its experts measured and made known the discharge of the lower Río San Juan.

4.76. As Nicaragua has chosen not to measure discharge in the lower Río San Juan it was necessary for ICE to account for uncertainty in the division of flow at the Delta when calculating the mean annual sediment loads in the Río San Juan and lower Río San Juan. To do so, these calculations were performed not only for the scenario that 90% of the flow passes to the Río Colorado, but also for scenarios of 85% and 95%. The discharge time series for the Río Colorado was modified to reflect these three possible divisions of the flow and then transformed into suspended and bedload time series using the relevant rating curves. Results for the Río San Juan and lower Río San Juan are listed in Tables 4.14 and 4.15, respectively.

Table 4.13 Mean Annual suspended and bedloads in the Río San Juan for a range of percentage discharges flowing to the Río Colorado (from the 2014 ICE Report).

PRSJ	Qa ($m^3 s^{-1}$)	Annual sediment load ($t\ yr^{-1}$)				
		Mean	**TLCI**	**TUCI**	**SSRC LCI**	**SSRC UCI**
				Suspended load		
95	1055	8 286 000	2 847 000	13 725 000	4 300 000	16 951 000
90	1114	**9 078 000**	3 119 000	15 036 000	4 598 000	19 153 000
85	1180	9 997 000	3 435 000	16 559 000	4 919 000	21 873 000
				Bedload		
95	1055	3 221 000	799 000	5 643 000	1 967 000	5 447 000
90	1114	**3 600 000**	893 000	6 307 000	2 157 000	6 227 000
85	1180	4 050 000	1 005 000	7 095 000	2 373 000	7 191 000

Table 4.14 Mean Annual suspended and bedloads in the lower Río San Juan for a range of percentage discharges flowing from the Río San Juan to the Río Colorado (from the 2014 ICE Report)

PRSJ	Qa ($m^3 s^{-1}$)	Annual sediment load ($t\ yr^{-1}$)				
		Mean	**TLCI**	**TUCI**	**SSRC LCI**	**SSRC UCI**
				Suspended load		
95	1055	687 000	236 000	1 139 000	277 000	1 803 000
90	1114	**1 479 000**	508 000	2 450 000	575 000	4 005 000
85	1180	2 398 000	824 000	3 973 000	896 000	6 725 000
				Bedload		
95	1055	323 000	80 000	566 000	169 000	638 000
90	1114	**702 000**	174 000	1 230 000	359 000	1 418 000
85	1180	1 152 000	286 000	2 018 000	575 000	2 382 000

Note:
PSJR = Percentage of Río San Juan discharge flowing to the Río Colorado;
Qa = Mean annual discharge;

TLCI = lower 95% confidence interval due to time series variability;
TUCI = upper 95% confidence interval due to time series variability;
SSRC LCI= lower 95% confidence interval due to uncertainty in SSRC;
SSRC UCI= upper 95% confidence interval due to uncertainty in SSRC.

4.77. Best estimates of mean annual loads in the Río San Juan are: suspended load = 9,078,000, bedload = 3,600,000, total load = 12,678,000 t/y. For comparison, on page 27 of his report, Dr Andrews suggests a *"mean annual supply of sediment to the head of the delta of about 13.7 million tons of suspended and bedload sediment."*, which is similar to but somewhat greater than that estimated by ICE. In the lower Río San Juan the best estimates of mean annual loads are: suspended load = 1,479,000, bedload = 702,000 and total load = 2,181,000 t/y. For comparison, Dr Andrews estimates that 1,370,000 t/y would pass to the lower Río San Juan (that being 10% of the total load of the Río San Juan just upstream of the Delta).

4.78. However, the proportions of the suspended load and bedload in the Río San Juan approaching the delta that pass to the lower Río San Juan and Río Colorado are not identical to those of the river water, due to non-linearity in the suspended and bedload rating curves. The percentages of the suspended and bedloads in the Río San Juan that pass to the lower Río San Juan and Colorado are illustrated in Figures 4.14 and 4.15, respectively.

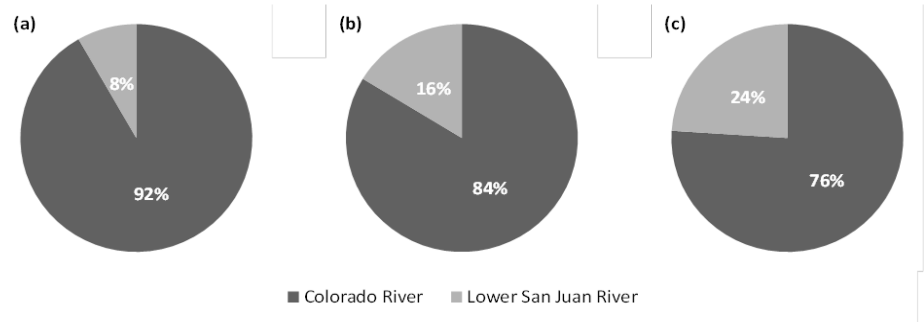


Figure 4.14 Mean annual suspended loads in the Río Colorado and lower San Juan as percentages of suspended load in the Río San Juan assuming that (a) 95%, (b) 90% and (c) 85% of the discharge flows to the Río Colorado (from the 2014 ICE Report).

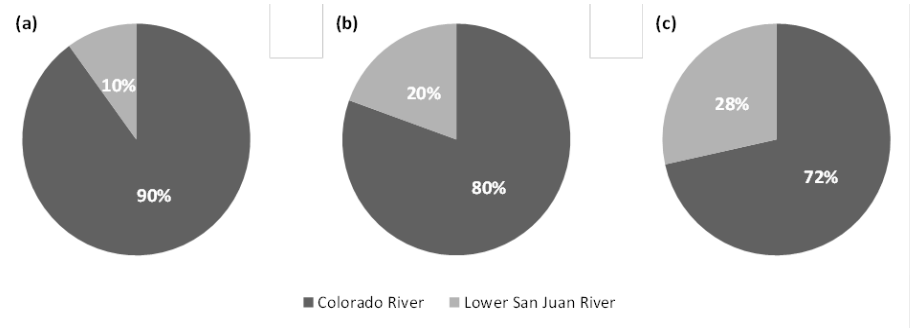


Figure 4.15 Mean annual bedloads in the Río Colorado and lower Río San Juan as percentages of bedload in the Río San Juan assuming that (a) 95%, (b) 90% and (c) 85% of the discharge flows to the Río Colorado (from the 2014 ICE Report).

4.79. Road-bed erosion rates recommended in the 2014 UCR Report for stretches of dirt road with gentle or steep slopes were modified as appropriate to apply to stretches where the surface of the Road is gravel and stretches where it exists only as a trail (Table 4.15).

Table 4.15 Erosion rates for the Road surface (from the 2014 ICE Report).

Road Character	Erosion rates for gentle slopes (m yr^{-1})	Erosion rates for steep slopes (m yr^{-1})
Gravel	0.0014[b]	0.0044[b]
Dirt	0.0140[a]	0.0440[a]
Trail	0.0028[c]	0.0088[c]

[a]Based on ICE (2013).
[b]Approximated as 10% of dirt road erosion rate.
[c]Approximated as 20% of dirt road erosion rate.

4.80. These rates were applied to estimate the volume of sediment eroded from the surface of the Road annually in each of the major Costa Rican tributary basins between Marker II and Delta Costa Rica, under the 'worst case' rainfall scenario. The width of the Road was taken to be 10 m in stretches where it actually exists and 5 m where it is no more than a trail, based on observations in the field by Dr Mende. A sediment delivery ratio of 0.6 was used, based on Gómez et al. (2013) – a figure accepted and adopted in the 2014 Kondolf Report. Yields of sediment from erosion of cut and fill slopes in each tributary basin were derived by multiplying the annual erosion volumes for cut and slopes listed as being in that tributary basin in the Inventory of Slopes in the Mende Report by the delivery ratio (again taken as being 0.6). The results are listed in Table 4.17and graphed in Figure 4.16. As these yields were estimated using upper bound erosion rates, under a ‘worst case’ rainfall scenario, the figures listed and illustrated are highly conservative.

Table 4.16 Annual yields of Road-derived sediment from the basins of major Costa Rican tributaries between Marker II and Delta Costa Rica under a ‘worst case’ rainfall scenario (from the 2014 ICE Report).

Tributary Basin	Road length (km)	‘Worst case’ sediment yields ($m^3\ yr^{-1}$)				‘Worst case’ sediment yields ($t\ yr^{-1}$)
		Road bed	Cut slopes	Fill slopes	Total	
Major Costa Rican tributary basins draining directly to the Río San Juan						
Infiernito	41.0	855	12,348	19,051	32,253	53,863
San Carlos	11.1	173	253	399	825	1,378
Cureña	29.5	387	1,738	8,966	11,091	18,521
Sarapiquí	4.5	172	49	---------	221	369
Chirripó	22.8	192	190	107	489	817
Costa Rican area draining directly to the Río San Juan						
Total	108.8	1,778	14,578	28,523	**44,880**	**74,949**

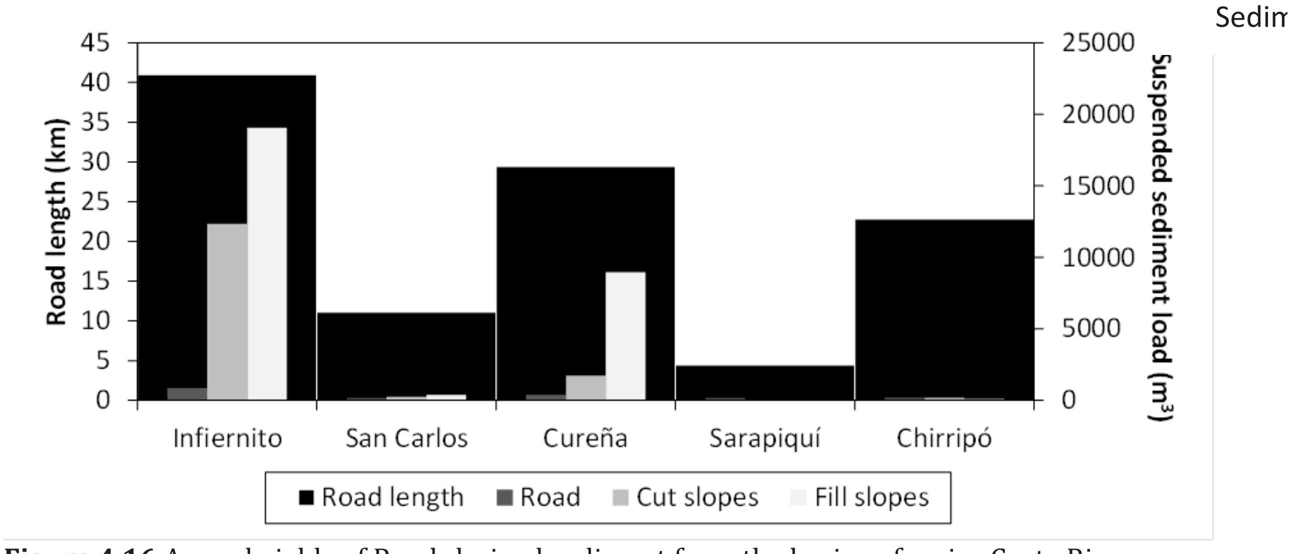


Figure 4.16 Annual yields of Road-derived sediment from the basins of major Costa Rican tributaries between Marker II and Delta Costa Rica under a ‘worst case’ rainfall scenario (from the 2014 ICE Report).

4.81. These yields of Road-derived sediment do not consider erosion from areas disturbed during construction in 2011. This is because those areas have subsequently revegetated, either naturally or due to vegetation planting by

CODEFORSA and CONAVI. Neither do the estimates consider erosion at failed watercourses. This was criticised in relation to the 2013 estimates in paragraph 2.119 of Nicaragua's Reply. To explain why it was decided not to attempt to estimate erosion at failed crossings in 2014, it is only necessary to examine a typical example, as illustrated by Dr Kondolf in Figure 24, on page 36 of his 2014 Report, which shows the point where the Road intersects a small ditch draining an area of pasture. The width of the ditch is not specified, but as the Road has an average width of 10 m and the ditch is clearly much narrower than this, it is perhaps 2 m wide. In the vicinity of the ditch, the channel of the Río San Juan is about 200 m wide. The River in this reach conveys an average annual discharge of the order of 500 m^3/s and an annual sediment load of several millions of tonnes. It follows that volume of sediment that a ditch that is only 2 m wide could erode from a failed crossing that extends along that ditch for about 10 m is insufficient to have any impact on the Río San Juan or the lower Río San Juan that could be either significant or long-lasting. In any case, of 127 watercourse crossings surveyed in the updated inventory of crossings in the 2014 Mende Report, erosion has already been mitigated or is in progress at 40% and is unnecessary at 36% because these crossings are either stable (19%) or the Road is just a trail (17%). Mitigation is scheduled at the remaining 24% of crossings where it is needed.

4.82. As in the 2013 ICE Report, the input of suspended sediment from Lake Nicaragua is taken to be 588,000 t /y.

4.83. Most of the fine sediment carried as suspended load moves quickly through the channel of the Río San Juan and on to Delta Costa Rica. Conservation of mass therefore dictates that the quantity input to the Río San Juan below Lake Nicaragua matches that supplied to the lower Río San Juan and Río Colorado at the Delta. The sediment budget for the Río San

Juan was therefore balanced by adjusting tributary catchment sediment yields estimated using the distributed model (as listed in Table 4.9) so that their sum matches the suspended sediment load of the Río San Juan immediately upstream of the Delta (excluding the sediment input from Lake Nicaragua), as must be the case to satisfy conservation of mass. In closing the budget, the time series-based sediment yields developed from measurements at the mouths of the Sarapiquí and San Carlos were used as controls and differences between the USLE-modeled and time series-based mean annual sediment loads were redistributed in proportion to sediment yields in the remaining basins. The results are listed in Table 4.18(a), followed by a summary of the sediment load estimates for the Río San Juan and contribution from the Road, in Table 4.18(b).

Table 4.17(a) Initial and adjusted suspended sediment yields for Study Area (from the 2014 ICE Report).

Basin	Drainage area (km^2)	Suspended sediment Yield ($t\ yr^{-1}$)	Adjusted suspended sediment Yield ($t\ yr^{-1}$)
Melchora	305	152 000	207 000
Sábalos	571	456 000	622 000
Santa Cruz	418	253 000	345 000
Barlota	219	45 000	62 000
Machado	352	42 000	57 000
Las Banderas	198	29 000	39 000
Frío	1577	666 000	907 000
Pocosol	1224	353 000	481 000
Infiernillo	609	239 000	326 000
San Carlos	2642	2 451 000	**2 928 000**
Cureña	353	78 000	106 000
Sarapiquí	2770	2 791 000	**2 342 000**
Chirripó	236	50 000	68 000
Study Area	11474	7 605 000	**8 490 000**
Lake Nicaragua	29067	---------	**588 000**

Note: Confidence is highest in values in bold; therefore, the difference between erosion-based and time series-based yields was distributed between the remaining catchments so that the sum of all sources matches the suspended load of the Río San Juan (excluding input from L. Nicaragua) = 8 490 000 ($t\ yr^{-1}$).

Table 4.17(b) Summary of estimated sediment loads and sediment inputs from the Road into the Río San Juan.

Source	Suspended Load (t/y)	Bedload (t/y)	Total Load (t/y)
Río San Juan	9,078,000	3,600,000	12,678,000
Río Lower San Juan	1,479,000	702,000	2,181,000
Road (ICE, 2014)	67,454 - 71,202	7,495 - 3,747	74,949
Road (Kondolf 2014)	--	--	177,020 - 250,500

4.84. ICE's data in Tables 4.17(a) and (b) were used to create a mean annual suspended sediment budget diagram for the study area of the San Juan basin (Figure 4.17). The budget is based on 90% of the flow in the Río San Juan flowing to the Río Colorado, but changing that to 85% or 95% would only slightly change the appearance of the diagram (see Figure 4.15).

4.85. A mean annual coarse load sediment budget diagram is also shown in Figure 4.17. As the bedload inputs for eleven of the fourteen tributaries are unknown (bedload input from Lake Nicaragua is probably small) only an estimated division of bedload at the Delta can be depicted in that diagram.

4.86. In Figure 4.18, the 'worst case' annual contribution of suspended sediment derived from the Road to each reach of the Río San Juan (taken from Table 4.17) is highlighted in red. In deriving the contributions of suspended sediment, it was necessary to subtract the coarse fraction from the overall contribution of Road-derived sediment. In the 2014 ICE Report, the division of the Road-derived sediment at the Delta was found to be insensitive to the percentage of coarse sediment that is assumed when this is varied across a range between 5 and 30%. Hence, the appearance of the red lines in Figure 4.18 does not change appreciably depending on the percentage of Road-derived sediment that is assumed to be coarse-grained.

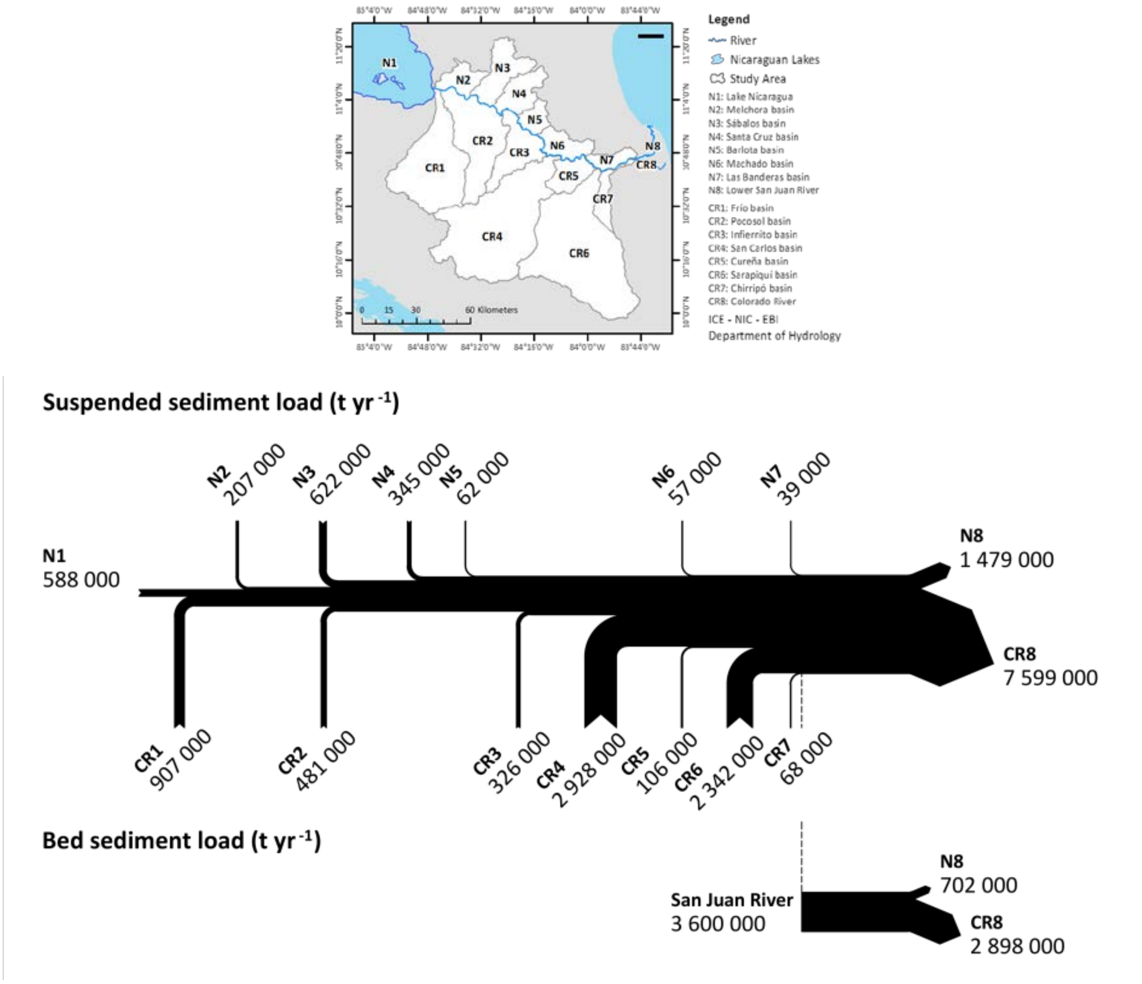


Figure 4.17 Suspended and bed sediment load budgets for the Río San Juan between Marker II and the Delta (values in t yr^{-1}) (from the 2014 ICE Report).

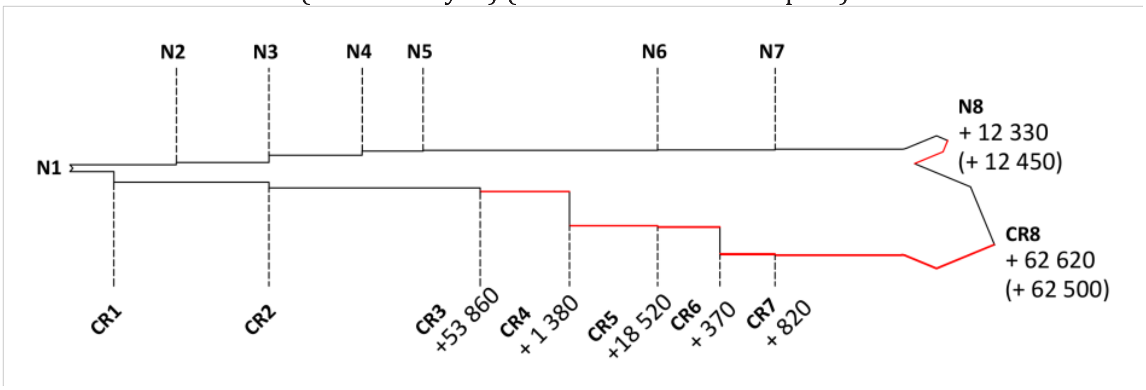


Figure 4.18 Suspended sediment budget for the San Juan-Colorado System with the contribution of fine-grained sediment from Route 1856 indicated in red at the lower edge of the diagram. Additional loads entering the lower San Juan and Colorado are based on the assumption that 5% of sediment derived from the Road is coarse-grained (values in parenthesis correspond to a 10% fraction of coarse material) (from the 2014 ICE Report).

4.87. Nevertheless, additions of Road-derived suspended load to the lower Río San Juan and Río Colorado are specified twice in Figure 4.18: first on the assumption that 5% of sediment derived from the Road that reaches the Delta is coarse-grained and second (with values in parenthesis) on the assumption that 10% is coarse-grained.

4.88. The contributions of Road-derived sediment to the mean annual suspended sediment load of the Río San Juan in each of the sub-reaches between Marker II and Delta Costa Rica listed in Table 4.17 are not just insignificant; they are indiscernible.

4.89. Inspection of Figure 4.18 shows that the same is also true of the contribution of Road-derived, fine-grained sediment to the suspended sediment load entering the lower Río San Juan.

4.90. Based on the data listed in Table 4.17, above, the 'worst case' annual input to the Río San Juan of Road-derived sediment is 44,880 m^3/y. In the 2013 Thorne Report (see paragraph 8.60, page 85) it was assumed that the bulk density of Road-derived sediment is about 1.67 t/m^3, and that 5 to 10% of that sediment is coarse. Applying these assumptions again here suggests that of the upper bound mean annual input of coarse sediment to the Río San Juan is 2,244 to 4,488 m^3/y, which is equivalent to 3,747 to 7,495 t/y. No data are available for the bedloads in the sub-reaches between Marker II and Delta Costa Rica, but ICE's lower bound estimate of the annual bedload of the River immediately upstream of the Delta is 799,000 t/y. ICE's best and upper bound estimates are much larger (3,600,000 and 7,191,000 t/y) reflecting very high variability and uncertainty in the equation-based bedload transport calculations necessary to estimate the bedload in this river.

4.91. Based on the upper bound assumption for the percentage of Road-derived sediment that is coarse-grained (10%) and using the lower bound estimate of bedload in the Río San Juan, the contribution of coarse-grained sediment from the Road would still be less than 1%. Given the high variability and uncertainties associated with these estimates, the contribution of Road-derived sediment to the mean annual bedload of the Río San Juan is therefore not just insignificant, it is also indiscernible.

4.92. On page 28 of the Andrews Report, Dr Andrews uses Dr Kondolf's estimates that the quantity of sediment delivered to the River annually due to erosion along the Road is between 106,000 and 150,000 m^3/y, depending on whether access roads are included.

4.93. Converting these estimates to t/y would suggest that, according to Dr Kondolf's estimates (which I do not accept), the contribution of Road-derived sediment to the Río San Juan is between 177,020 and 250,500 t/y, which would constitute just 1 to 2% of the mean annual total load (that is suspended load plus bedload) of the Río San Juan estimated by ICE, which is 12,678,000 t/y.

4.94. Using the UCR upper bound estimates of erosion and the Mende-ICE 'worst case' figure for delivery of Road-derived sediment to the River, which I believe to be more reliable, the contribution of Road-derived sediment to the load in the Río San Juan (44,880 m^3/y or 74,949 t/y) is an indiscernible 0.6% of the total load in that river, which is estimated by ICE to be 12,678,000 t/y.

4.95. Uncertainty in estimated bedloads in the Río San Juan is very high. To test whether uncertainties associated with the bedload are significant, the calculation above may be repeated with the bedload excluded. According to Dr Kondolf's estimates (which I do not accept) the contribution of Road-derived sediment to the Río San Juan is between 177,020 and 250,500 t/y, which would constitute just 2 to 3% of the mean annual suspended load of the Río San Juan (9,078,000 t/y) estimated by ICE.

4.96. On page 27 of his report, Dr Andrews suggests a *"mean annual supply of sediment to the head of the delta of about 13.7 million tons of suspended and bedload sediment"* which is similar to but somewhat greater than that estimated by ICE. If Dr Andrews' estimate of the mean annual total sediment load of the Río San Juan is accepted, and Dr Kondolf's estimates (which I do not accept) that the contribution of Road-derived sediment to the Río San Juan is between 177,020 and 250,500 t/y are applied, the contribution of the Road based on the data reported to the Court by Nicaragua's own experts is still just 1 to 2%.

4.97. Dr Andrews also calculates that 1,270 to 2,700 m^3/y of coarse sediment from Route 1856 would enter the lower Río San Juan (he assumes that 10% of Road-derived sediment is carried into the Lower Río San Juan and that 12 to 18% of the sediment load carried by the Río San Juan is relatively coarse).

4.98. While I do not accept these estimates, it is instructive to carry Dr Andrews' bedload analysis through to its logical conclusion. On page 27 of the Andrews Report, he writes that, *"The estimated mean annual transport of bed-material at the beginning of the Lower Río San Juan is approximately 120,000 tons/year or 75,000 m^3/year of relatively coarse sediment."*. It follows that, even using Dr Kondolf's estimates and Dr Andrew's analysis, which I do not accept, the input of coarse sediment from the Road constitutes only 2% to 4% of the coarse sediment load expected to enter the lower Río San Juan in an average year.

4.99. Commenting on the uncertainties associated with bedload measurements and calculations, on pages 23/24 of his report, Dr Andrews correctly observes that, *"Calculated bedload transport rates are particularly sensitive to errors or uncertainty in the fluid forces acting on the river bed at a given discharge. Fluid forces depend on hydraulic characteristics, such as flow depth, velocity, the presence of bedforms, and river slope. Relatively small errors in the estimation of fluid forces, e.g. +/- ten percent, will result in much larger errors in the calculated bedload transport rate, which varies rapidly as a function of the fluid forces. The effective exponent of the bedload transport rate versus fluid forces decreases from about 14 as river bed sediment begins to move and approaches a value of 1.5 at very high transport rates. Thus, a +/- 10 percent error in the calculation of fluid forces will result in errors of a few tens up to a few hundreds of percent in the calculated bedload transport rate."* Bearing this in mind, it is clear that a difference of 2% to 4% in the annual bedload would not only be insignificant but scientifically undetectable, ruling out even the possibility of demonstrating any causal relationship between construction of the Road and any change in the quantity of coarse bedload entering the lower Río San Juan.

4.100. Using the UCR-Mende-ICE estimates of erosion and sediment delivery from the Road set out in Table 4.18(b), which I believe to be more reliable, and ICE's estimate that 20% of the bedload in the Río San Juan passes to the lower Río San Juan (see Figure 4.5, above and paragraphs 5.23 and 5.24, below), the 'worst case' estimate of the contribution of Road-derived, coarse-grained sediment to bedload in the lower Río San Juan is 450 to 900 m^3/y or 750 to 1,500 t/y. This would constitute just 0.1 to 0.2% of the coarse load, which is estimated by ICE to be 702,000 t/y.

D. Potential impacts of a hurricane or tropical storm

4.101. On page 51 of his 2014 Report, Dr Kondolf expands on expert views advanced in his previous reports that erosion along the Road to date has been relatively low compared to that which will occur, "*during intense rains that will inevitably accompany tropical storms and hurricanes in the region"*. The consequences and inevitability of catastrophic erosion of the Road during a Hurricane or Tropical Storm are referred to on no less than six separate occasions (pages 1, 14, 28, 35, 51, as well as at length in Section 12, (pages 71 and 72), and they also feature in Sections 4.2.2 (page 8) and 7.2.3.2 (pages 43 and 44) of the Report by Golder Associates (Annex 6 in Nicaragua's Reply of August 2014) (the ***Golder Report***).

4.102. There is no doubt that heavy rainfall is associated with tropical cyclones and that widespread flooding, landsliding, destruction of property and, regrettably, fatalities are likely within affected areas. However, Dr Kondolf states that it is *inevitable* that the Road will be *catastrophically* eroded during a Hurricane or Tropical Storm and that delivery of sediment eroded from the Road during such an event would lead to unprecedented sediment loads and concentrations in the Río San Juan. It is in this context that Dr Kondolf's account of the certainty of extreme erosion in the area around the Road during future Hurricanes and Tropic Storms merits careful examination.

4.103. In this regard, the Director General of the Costa Rican National Meteorological Institute, Professor Juan Carlos Fallas Sojo (who is also Professor of Physics and Meteorology, at the University of Costa Rica) reviewed the 2014 Kondolf report insofar as it pertains to Hurricanes and Tropical Storms. He presented his comments in a report titled, 'Comments on the report by Dr Kondolf (as it pertains to hurricanes and tropical storms) in: Section 12 - Risks of Larger Contributions from Rte. 1856 [Annex 1, pages 71-74]' (the ***Fallas Report***). As I am not an expert in tropical meteorology, the explanations presented in this sub-section draw extensively on the Fallas Report.

4.104. Dr Kondolf is apparently unaware that there are separate naming conventions for Hurricanes in the Atlantic and Pacific Basins. This is evident from his statement on page 71 of the 2014 Kondolf Report that, *"The eyes of Hurricanes Irene and Olivia in 1971 both tracked just to the north of the Río San Juan".* As explained in the Fallas Report, Hurricanes Irene and Olivia were the same event. The Hurricane was called Irene as it passed through the Caribbean and entered Nicaragua. When the hurricane arrived in the Pacific Basin, it was renamed Olivia.

4.105. On page 71 of his 2014 report, Dr Kondolf challenges my statement (and presumably NASA's records, which provide the basis for it) that a Hurricane or Tropical storm has not struck Costa Rica during the period since records began. To support this he refers to, "*the tropical storm that occurred 6-11 May 2004*". As Professor Fallas points out in his review, "*The weather system that generated rainfall over the territory of Costa Rica was not a tropical storm, it was a much smaller disturbance in its intensity and persistence, called a tropical wave"*.

4.106. This is significant in the context of the wider point Dr Kondolf seeks to make because the fact that the event he selected to support his expert view is correctly named by NASA as a *"tropical easterly wave"* in the caption to Figure 32 on the very next page (page 72) of the Kondolf Report suggests that Dr Kondolf does not perceive any difference between a Tropical Storm and a Tropical Wave. This is incorrect. These types of weather phenomena are graded by their characteristics and intensity (from lowest to highest) as a Tropical Wave, Tropical Depression, Tropical Storm or Hurricane. Tropical Waves occur frequently in Costa Rica and, as I stated in my 2013 Report, the rivers of the region are well adapted to assimilate the associated rainfall intensities, durations and distributions.

4.107. A lay person would envisage that the rainfall intensities and durations associated with Hurricanes and Tropical Storms would exceed those associated with a Tropical Wave, and they would be correct. However, as the Fallas Report explains, there is one big difference between a Tropical Wave and the other weather phenomena listed above: the circulation of the air and resulting distribution of rainfall. A Tropical Wave is a cluster of thunderstorms (as is evident on inspection of Figure 32 in the 2014 Kondolf Report) with very little, if any, organized wind circulation. In contrast, Tropical Depressions, Tropical Storms and Hurricanes are *cyclonic*: that is, they feature a well-organised pattern of air circulation with very strong winds that rotate counter-clockwise around a single low pressure centre (Figure 4.19).

4.108. This strong, counter-clockwise circulation combines with Costa Rica's prominent mountain system to promote the orographic effect, which concentrates rainfall on the windward side of the mountains and creates a 'rain shadow' effect on the leeward side. This is evident from the distribution of rainfall generated by Hurricane Mitch (Figure 4.20, which is reproduced from the Fallas Report).

4.109. The fact is that the rainfall associated with a Hurricane or Tropical Storm would be much greater in catchments draining to the Pacific than in catchments draining to the Caribbean, such as that of the Río San Juan.

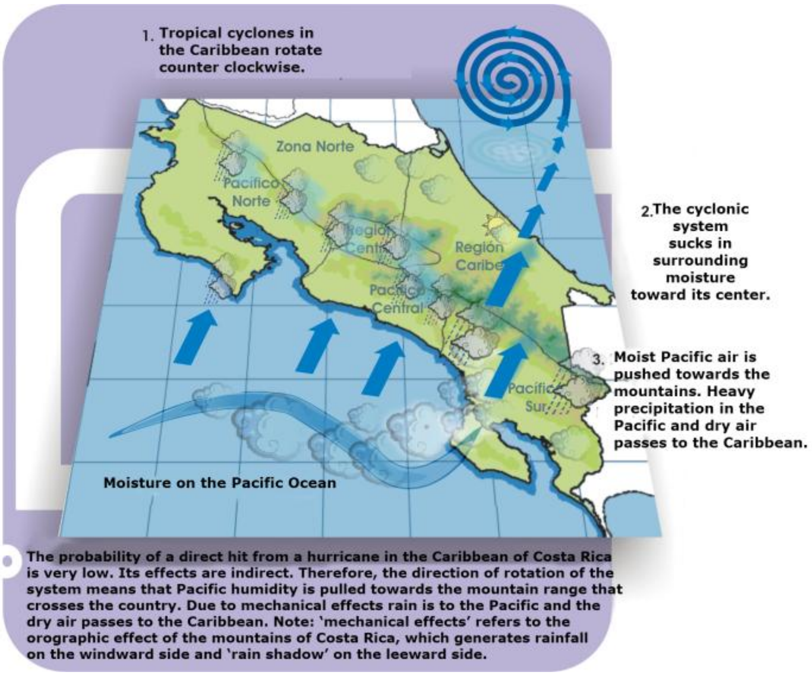


Figure 4.19 Distribution of wind and rain in Costa Rica due to a tropical cyclone near the Caribbean coast of Nicaragua (from the Fallas Report).

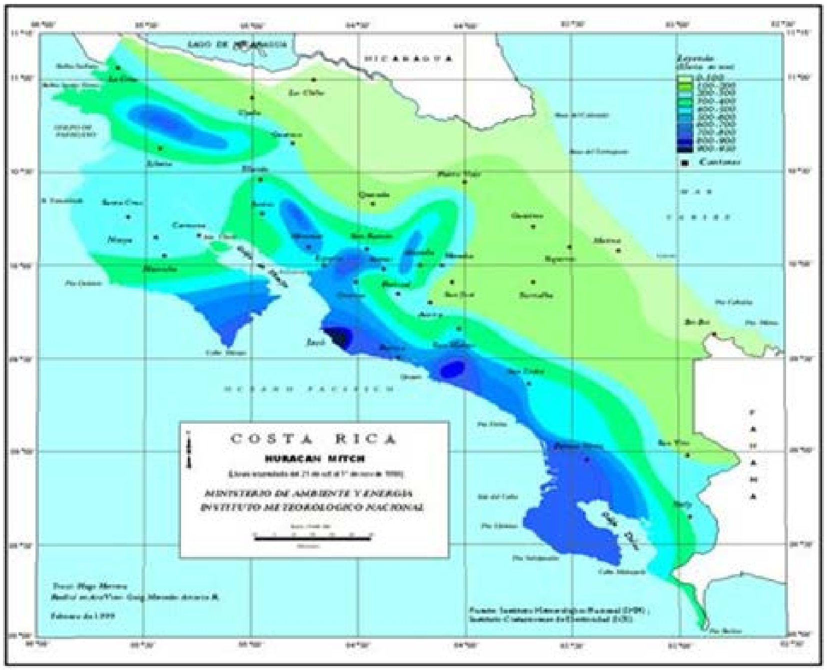


Figure 4.20 Rainfall distribution in Costa Rica recorded during Hurricane Mitch (from the Fallas Report).

4.110. When Dr Kondolf refers to seven fatalities caused by Hurricane Mitch in Costa Rica on page 72 of the 2014 Kondolf Report he is correct. But these fatalities did not occur in or near to the area around the Road. These deaths occurred in the Pacific drainage basin, on the other side of the continental divide. This is explained by Mitch's circulation (Figure 4.19) and rainfall distribution (Figure 4.20), which were those of a Tropical Cyclone. The deaths did not occur in the San Juan basin or even in the Caribbean drainage basin.

4.111. Based on Professor Fallas' expert meteorological review, and my understanding of rainfall-driven erosion, it is my conclusion that it is highly unlikely that the Road will be catastrophically eroded in the event that a future Hurricane or Tropical Storm affects Costa Rica and Kondolf is wrong when he suggests this on pages 1, 14, 28, 35, 51, 71 and 72 of his 2014 Report.

4.112. In my opinion as a geomorphologist, the risk of rapid erosion due to intense rainfall in the area around the Road is probably greater during the localised thunderstorms associated with a Tropical Wave than would be the case during a Tropical Cyclone. However, the frequency of localised downpours is high and their impacts limited because, to restate my position, *"the hydrology, sediment dynamics, morphology and environment of the River are fully adjusted to the effects of frequent and heavy rainstorms"* (2013 Thorne Report, paragraph 6.20).

E. The Natural Sediment Load of the San Juan River and how this may differ from that immediately prior to construction of the Road

4.113. In the Andrews Report, Dr Andrews states that, "*proper analysis of the impacts that the construction of Route 1856 has had and will have in the coming decades on the supply, transport and deposition of sediment to the Río San Juan must involve a comparison.*" The preceding sections provide the basis for just such a comparison: that of sediment budget of the Río San

Juan to a 'worst case' estimate of the annual volume of sediment input due to construction of the Road. That comparison demonstrates that the quantity of sediment eroded and delivered to the Río San Juan from the Road (estimated by ICE to be 74,949 t/y in the 2014 Report) is less than 1% of the mean annual suspended load (9,078,000 t/y, excluding bedload). This is indiscernible given the wide confidence band on the mean annual suspended sediment load, which varies between 8,286,000 to 9,997,000 t/y due to uncertainty in the division of flow at the Delta alone (without considering inter-annual variability and uncertainty in the sediment rating curves).

4.114. The Road's contribution would still be indiscernible using the much higher range of values for sediment delivery from the Road and its access roads proposed in the 2014 Kondolf Report (177,020 - 250,500 t/y), which I do not accept. Comparison of Dr Kondolf's estimated range with the best estimate of the mean annual suspended load of the River (9,078,000 t/y) indicates it to constitute 2 to 3% of the mean annual suspended load of the Río San Juan. This is still indiscernible given the inter-annual variability of the suspended sediment load carried by the Río San Juan and the uncertainties inherent to its estimation.

4.115. However, Dr Andrews avoids making that comparison by suggesting on page 6 of his Report that, "*The question is whether 61,000 to 240,000 tons per year is a relatively small or large amount of sediment in comparison to the natural sediment yield.*" and pointing out that, "*The answer to this question depends largely upon the basin-wide sediment yield that is determined to be 'natural.'*"

4.116. Before presenting my technical response, two over-arching issues arising from Dr Andrews' framing of the comparison should be highlighted. First, based on my understanding of the case before the Court, the comparison Dr Andrews suggests of, *"whether 61,000 to 240,000 tons per year is a relatively small or large amount of sediment in comparison to the natural sediment yield"* is not 'the question'. The scientific question, as I understand it, is whether construction of a Road in Costa Rica has caused harm to the environment or ecology Río San Juan de Nicaragua. This requires consideration of whether construction of the Road has had any significant impact on sediment processes, morphology, aquatic life, or navigation as they existed in and along the Río San Juan prior to construction of the Road. So far as I understand it (and this is obviously a matter for the Court), it has nothing to do with whether the sediment load of the Río San Juan is 'natural'.

4.117. Second, Dr Andrews' belief that the current load carried by the Río San Juan is unnatural puts him at odds with other sediment experts with good working knowledges of the River. For example, on page 10 of their independent report entitled, 'Morphological Stability of the San Juan River Delta, Nicaragua/Costa Rica' (submitted to the Court by Nicaragua in 2011 as Document 18 in its application for provisional measures), Professors van Rhee and de Vriend conclude that dredging is not likely to cause any measurable environmental harm, *"given the pre-existing high natural turbidity of the river."*

4.118. On page 11 of a further report entitled 'The Influence of Dredging on the Discharge and Environment of the San Juan River' (submitted to the Court in 2012 as Appendix 2 to Nicaragua's Counter Memorial in Certain Activities), Professors van Rhee and de Vriend restate their expert view, writing that, *"as explained in VRDV 2011* [the earlier report referred to above]*, the San Juan River is both naturally turbid and relatively stable"*.

4.119. Similarly, while Dr Andrews rejects statements I make in my 2013 Report concerning the natural load and turbidity of the River, other experts have explicitly accepted my opinion as it was expressed in my report submitted by Costa Rica as part of its Memorial in Certain Activities. For example, in a passage on page 10 of their 2012 Report that explains why dredging would not pose environmental problems in the lower Río San Juan, Professors van Rhee and de Vriend note that, *"Thorne actually confirms this conclusion, stating 'Natural high sediment and nutrient concentrations in the river are likely to limit impacts on turbidity and water quality that are customary associated with dredging (Thorne, p. vii)'"*.

4.120. Dr Andrews suggests that the environmental impacts of activities that affect sediments in the river should be judged against the 'natural' load of the Río San Juan and that the 'natural' load is only 170,000 to 420,000 tons per year (see page 10 of the Andrews Report). Incidentally, if this position is tenable, the environmental and ecological impacts of increased turbidity due to re-suspension of sediment associated with Nicaragua's substantial dredging operations (unavoidable according to Nicaragua's dredging experts) would be even more unacceptable.

4.121. I take the opportunity provided by Dr Andrews' posing of this question to explain why I believe his estimate of 170,000 to 420,000 tons per year as the natural sediment load of the Río San Juan (page 10 of the Andrews Report) to be unrealistically low and why, in paragraph 6.45, of the 2013 Thorne Report, I characterise the Río San Juan as having *"naturally high concentrations of suspended sediment";* a characterisation that is effectively endorsed by other experts (including Professors van Rhee and de Vriend).

4.122. On page 8 of his report, Dr Andrews states that, *"Without the benefit of useful gage records from the Río San Juan Basin to analyze the Basin's* *natural sediment yields, the best recourse is to search for data from comparable forested tropical river basins".* This is true, but it is crucial that, in Dr Andrews' words, the data should come from "*comparable forested tropical river basins*": the key word here being '*comparable*'.

4.123. Based on the sources that Dr Andrews selected as being *"forested tropical river basins with a wide range of precipitation, geology and topographical relief, including basins that, like the Río San Juan basin, contain areas of volcanic soil, steep slopes, and receive significant rainfall"* (page 8), he finds sediment yields reported in the literature (listed in his Table 1, also on page 8) to show that, "*sediment yields from tropical river basins with undisturbed primary forests vary from 1 to 120 tons/km^2–year"* and on that basis he concludes later on the same page that, *"sediment yields in the Río San Juan Basin prior to appreciable forest clearing and landscape disturbance were likely to fall between 20 to 50 tons/km^2 per year".*

4.124. However, according to Dunne (1979, page 292) - one of the sources cited in Dr Andrews' Table 1, *"The range of yields from the small Kenyan sample (~20 - 30 t km^{-2} yr^{-1}) therefore, seems to be representative of undisturbed, humid catchments under tropical forest in* <u>*tectonically stable*</u> *areas"* [my emphasis]. As pointed out in my 2013 Report (Sections 6.3 to 6.5) and expand on below, the Costa Rican tributary basins of the Río San Juan are certainly not tectonically stable.

4.125. Dr Allan Astorga has studied the geology of the basin of the Río San Juan in depth. In his 2014 Report (the ***Astorga Report***), he explains why sediment loads in the Río San Juan are both naturally high and highly variable, and demonstrates that this has been the case for at least the last 10 million years.

4.126. The Astorga Report describes the basin's complex geological history which is related to the tectonic evolution of the lithospheric blocks making up the Caribbean Tectonic Plate and the basin's location in the Central American back-arc area – which is characterized by multiple active faults (Figure 4.21) and live volcanoes, most of which form a chain extending along the basin's southern watershed in Costa Rica (Figure 4.22).

4.127. Figure 4.23 presents a synopsis of earthquakes with magnitudes greater than 6 and volcanic eruptions known to have generated mud flows in tributaries draining from the Costa Rican side of the basin during the last three centuries.

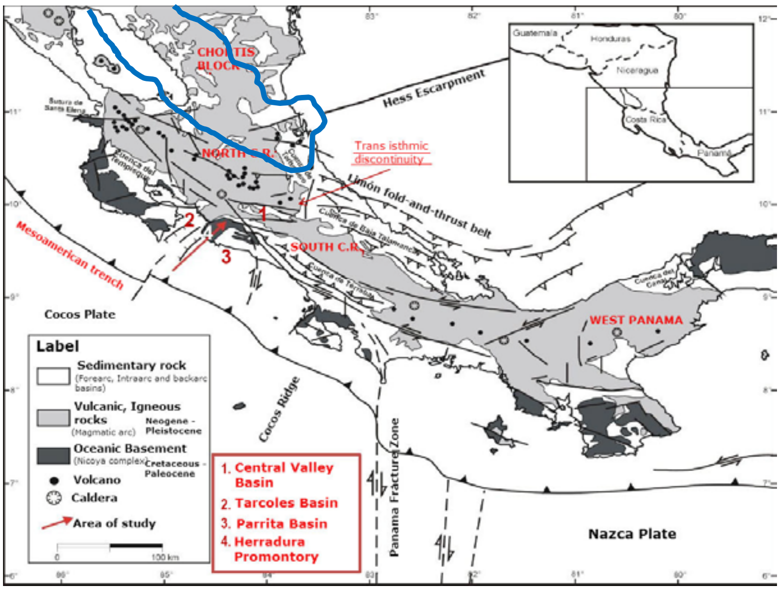


Figure 4.21 Tectonic map of South Central America, indicating the main tectonic and neotectonic elements affecting the San Juan basin (indicated by the blue line). The lower basin lies in an area of the central America back-arc (from the Astorga Report).

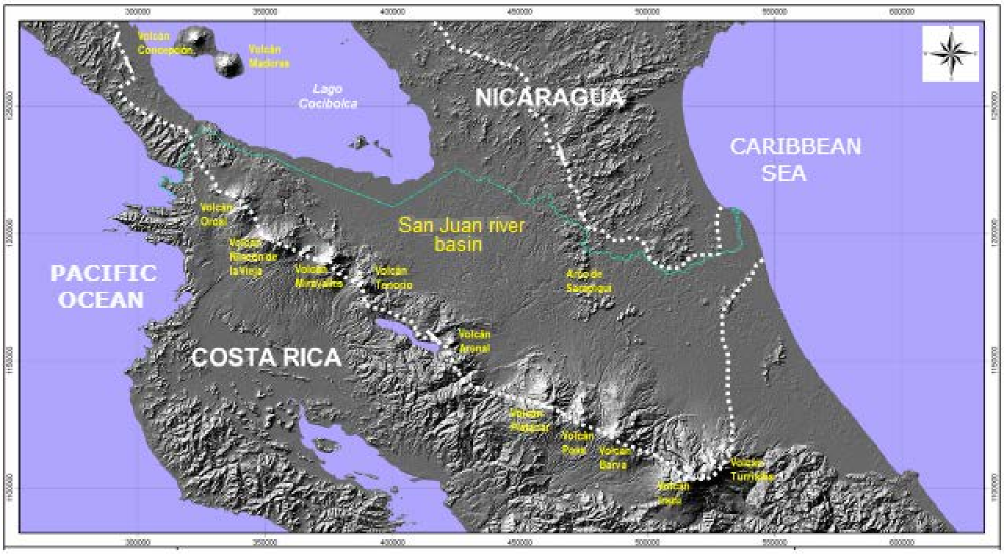


Figure 4.22 Volcanoes with heights of between 2,000 and 3,000 metres that periodically contribute extraordinary amounts of sediment to the San Juan drainage system (from the Astorga Report).

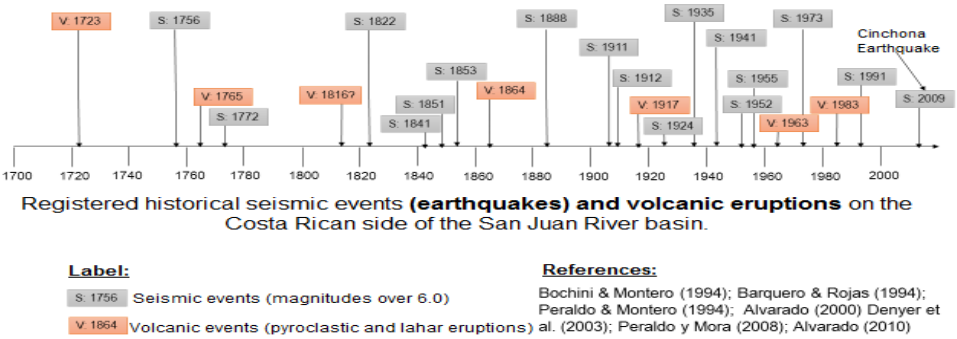


Figure 4.23 Historical record of earthquakes and volcanic eruptions inputting extraordinary amounts of sediment to the San Juan basin from the Costa Rican part of the basin (from the Astorga Report).

4.128. This record illustrates that there have been multiple earthquakes and volcanic eruptions per century in the basin, each capable of generating an extraordinary input of sediment to the drainage system.

4.129. For example, as recently as January 8, 2009, the Cinchona Earthquake (magnitude 6.1 Mw), occurred in the mountainous headwaters of the Río Sarapiquí. This single natural event generated thousands of landslides, 82% of which happened in areas covered by forest (Ruiz et al., 2011). In the area immediately surrounding the epicentre, 349 landslides disturbed 21.7 km² of formerly vegetated land (Alvarado 2010 and Figure 4.24) and delivered 2.5 to 3.5 million m³ of sediment (equivalent to 4 to 6 million tonnes) to the drainage systems affected – 95% of which entered Costa Rican tributaries to the Río San Juan. For comparison, the overall area disturbed by construction of the Road along its full 108 km length alongside the River is just 3.5 km² (an area confirmed by Dr Kondolf on page 62 of his 2014 Report) and, even by Dr Kondolf's estimate, which I do not accept, the quantity of sediment delivered to the River annually is at most a quarter of a million tonnes.

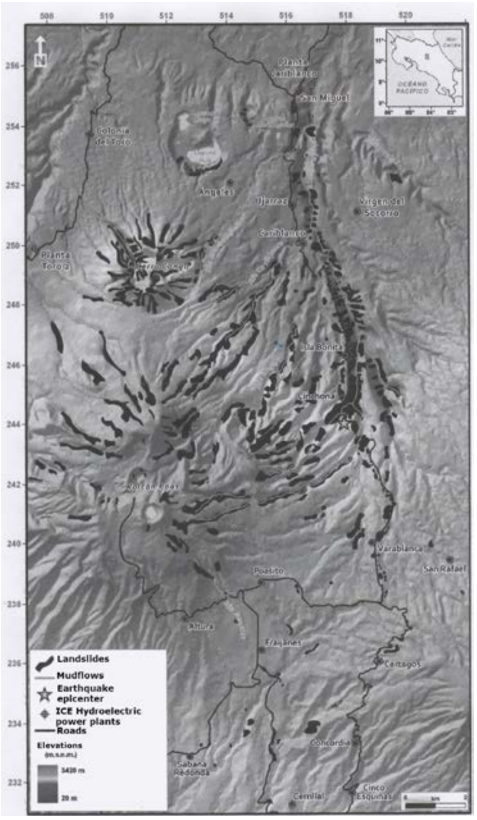


Figure 4.24 Map of landslides triggered by the 2009 Cinchona earthquake (from Alvarado, 2010).

4.130. Dr Andrews also sources data from a 1967 paper by Professor Ian Douglas, but does not mention Douglas' follow–up article titled, 'The impact of land-use changes on sediment yields in humid tropical Southeast Asia" (Douglas, 1996) in which he builds on his 1967 paper. In this follow-up article Professor Douglas notes that, *"Volcanic catchments in Java have high erosion rates even under forest, as the Cilutung catchment (the highest point in column C in Fig. 1) illustrates, at 2250 t km^{-2} $year^{-1}$ (Van Dijk & Vogelzang, 1948)"*. As well as the volcanic soils that are mentioned by Dr Andrews, the area of Costa Rica draining to the Río San Juan features nearly a dozen active volcanoes, as illustrated in Figure 4.22, above.

4.131. In summary, it is entirely inappropriate to deduce the 'natural' sediment yields of tributary basins of the Río San Juan in Costa Rica, known to be tectonically and volcanically active, based on rates measured in tectonically stable, non-volcanic basins. This is especially so for the San Carlos and Sarapiquí sub-basins, which have mountain headwaters with elevations exceeding 3,000 m. To explain why, consider that, as Professor Douglas states in his 1996 paper, *"The highest sediment yields occur in tectonically active areas, where earth tremors trigger frequent mass movements which supply large volumes of sediment to rivers. The lowest sediment yields are on old land surfaces of low relief and deep weathering profiles. The contrast quantitatively is the difference between yields of the order of 10 000 t km^{-2} $year^{-1}$ in mountains of New Guinea, Taiwan and the South Island of New Zealand (Pickup et al., 1981; Shimen Reservoir Authority, 1975; Griffiths,1979) and yields of around 100 t km^{2} $year^{-1}$ in Africa (Milliman & Meade, 1983)."*

4.132. Further insights into the 'natural' sediment yield of the basin can be gained from closer examination of the maps of sub-catchments, terrain, rainfall and the USLE factors land cover C, rainfall, R, and slope length LS (Figures 4.6 and 4.7, above) and the results of ICE's distributed soil-erosion model (Table 4.19 (data abstracted from Table 4.9, above) and Figure 4.25).

Table 4.18 Specific sediment yields in Nicaraguan and Costa Rican Basins (from the 2014 ICE Report)

Basin	Drainage Area (km^2)	Specific Sediment Yield ($t\ km^{-1}\ yr^{-1}$)	Total Sediment Yield ($t\ yr^{-1}$)
Tributary basins in Nicaragua			
Las Banderas*	198	145	29 000
Machado*	352	119	42 000
Barlota*	219	207	45 000
Santa Cruz	418	606	253 000
Melchora	305	497	152 000
Sábalos	571	799	456 000
Nicaragua Basins	2,063	473	977,000
Tributary Basins in Costa Rica			
Chirripó	236	211	50 000
Cureña	353	221	78 000
Pocosol	1224	288	353 000
Infiernillo	609	393	239 000
Frío	1577	422	666 000
5 Costa Rica Basins	3,999	346	1,386,000
San Carlos	2642	928	2 451 000
Sarapiquí	2770	1007	2 791 000
San Carlos & Sarapiquí	5,412	969	5,242,000
7 CR Basins	9,411	704	6,628,000
Study area	11,474	663	7,605,000

*the land cover map (Figure 5.25(f) below) illustrates clearly that vegetation in these three basins is predominantly undisturbed forest (Code = FORE).

4.133. The data reveal that despite the fact their primary forest cover is undisturbed, specific sediment yields in the Las Banderas (145 $t\ km^{-1}\ yr^{-1}$), Machado (119 $t\ km^{-1}\ yr^{-1}$) and Barlota (207 $t\ km^{-1}$ yr-1) tributary basins do not come close to supporting Dr Andrews' proposition that, *"sediment yields in the Río San Juan Basin prior to appreciable forest clearing and landscape disturbance were likely to fall between 20 to 50 tons/km^2 per year"*.

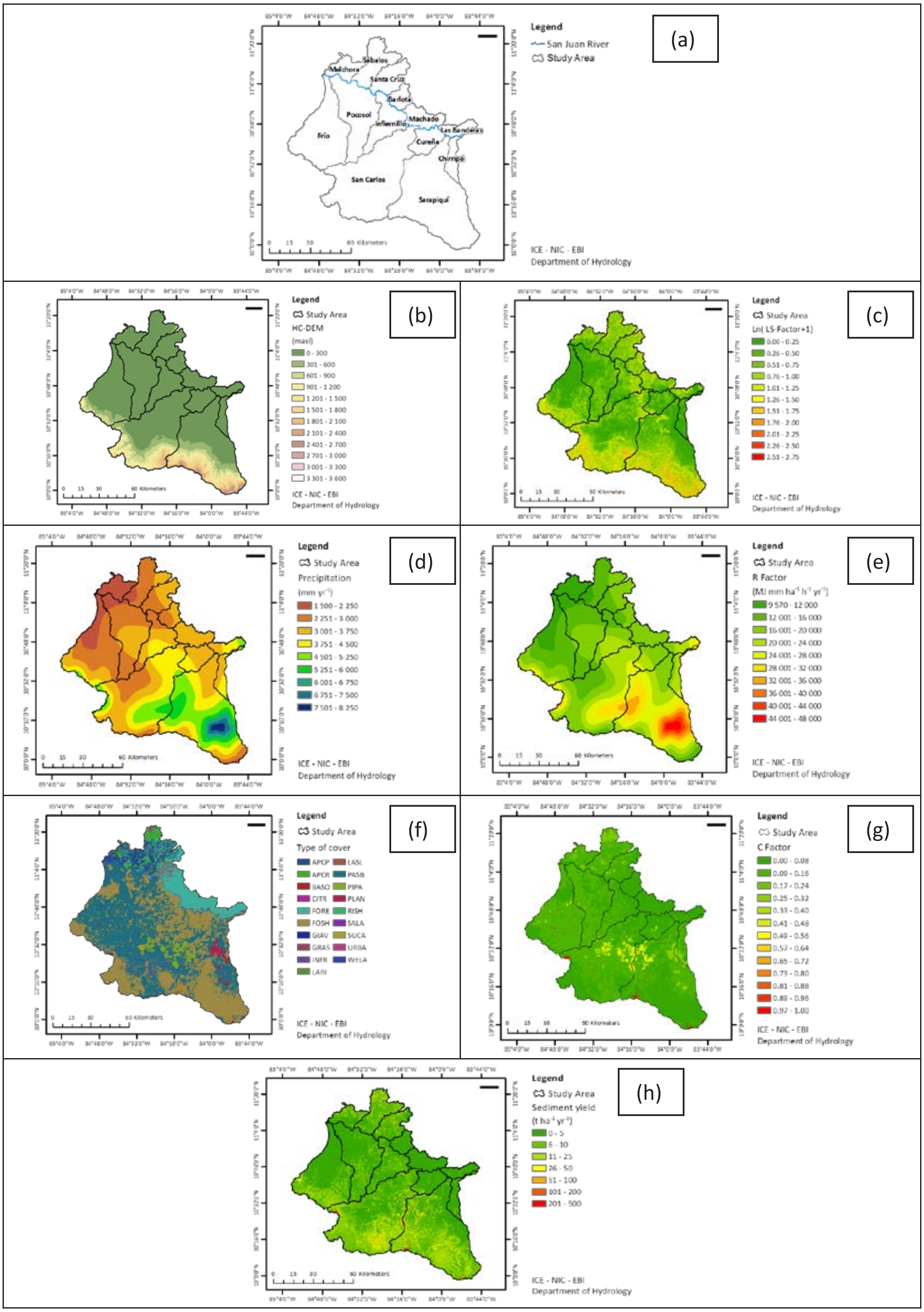


Figure 4.25 (a) tributary basins (b) digital elevation model (c) slope length factor LS (d) mean annual precipitation (e) rainfall erosivity factor, R (f) land cover (g) land cover factor, C and (h) calibrated specific sediment yields (E) in the study area.

4.134. With respect to the impacts of development in the San Juan basin, the average specific yield of basins in Nicaragua (473 t km^{-2} yr^{-1}) is comparable to, but somewhat higher than, that averaged for five of the seven tributary basins in Costa Rica (346 t km^{-2} yr^{-1}), while excluding the San Carlos and Sarapiquí basins.

4.135. The much higher yields in the San Carlos and Sarapiquí basins are explained by inspection of Figure 4.25, in which maps (a) and (b) show that high mountain terrains are found mostly in the headwaters of the San Carlos and Sarapiquí basins. This explains why the slope length and steepness factor, LS, shown in map (c) is much higher there than for the remainder of the study area. Map (d) reveals that the San Carlos and Sarapiquí basins receive much higher rainfall than any other basins in the study area, explaining why the rainfall erosivity factor, R, (map (e)) is also very high there. Map (f) shows that vegetation in the headwaters of the San Carlos and Sarapiquí basins is forest, trees and shrubs (code = FOSM), such that the land cover factor, C, is below average for the study area. Map (h) illustrates that the high values of LS and R outweigh the ameliorating effect of land cover C in the USLE, to produce very high specific sediment yields for the headwater basins of the San Carlos and Sarapiquí rivers. Local sediment yields in the headwaters (which are mostly undisturbed forest and shrubs within National Parks), are commensurate with, but lower than those in Professor Douglas' definitive statement quoted in paragraph 4.130, above.

4.136. In conclusion, I believe that Dr Andrews' estimate of 170,000 to 420,000 tons per year as the 'natural' sediment load of the Río San Juan is unsupported by the relevant literature, inconsistent with the geology of the San Juan Basin, and far too low. I reiterate here the statement I made in paragraph 6.45 of my 2013 Report, that the Río San Juan has "*naturally high concentrations of suspended sediment.*"

4.137. I also reject Dr Andrews' conclusion that, *"the present sediment load of the Río San Juan is unnaturally elevated due primarily to deforestation and associated land disturbance <u>in the Costa Rican parts of the basin</u>."* [my emphasis]. While I agree that deforestation and agricultural development will have increased specific sediment yields in the areas cleared, deforestation is certainly not confined to *"the Costa Rican parts of the basin."* The land cover map in Figure 4.25(f) indicates that forest has been widely disturbed in three of the six Nicaraguan sub-basins draining to the Río San Juan, and modelling results listed in Table 4.19 suggest that specific sediment yields in the Santa Cruz, Melchora and Sábalos basins may be higher than those in five of the seven sub-basins in Costa Rica.

4.138. Evidence that heavy suspended loads and high levels of turbidity occur in Nicaraguan as well as Costa Rican tributaries is not difficult to find. For example, Figure 4.26 shows highly turbid water entering the Río San Juan from the Río Santa Cruz and Río Sábalos on 23 December 2012. The plume of highly turbid water from the Río Sábalos is especially prominent and can be traced downstream in the Río San Juan for some distance.

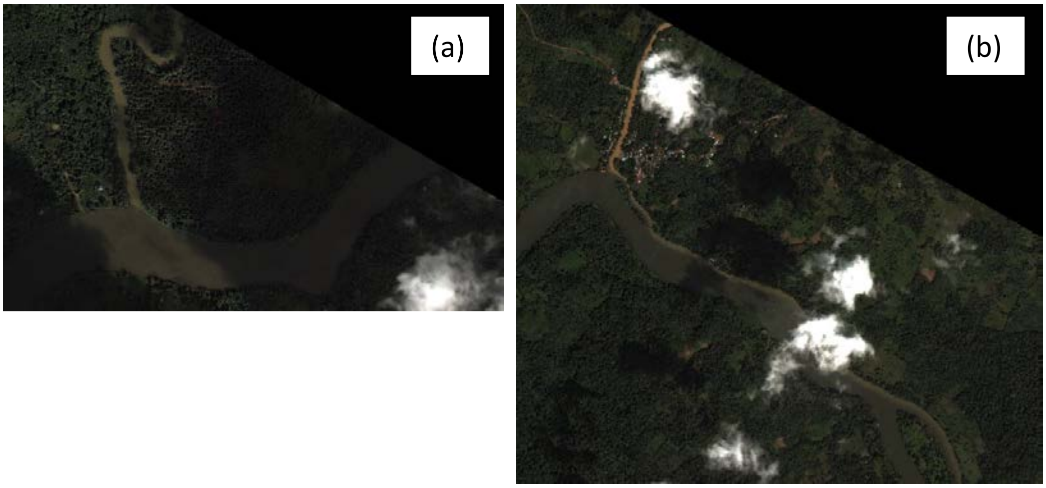


Figure 4.26 Turbid water draining to the Río San Juan from Nicaraguan tributaries on 23 December 2012 (a) Río Santa Cruz (b) Río Sábalos.

4.139. Sediment yields from the San Carlos and Sarapiquí basins are much higher than those in the other eleven sub-basins in the study area, but this is not primarily due to land use changes (which have occurred not only in the San Carlos and Sarapiquí basins, but in 10 of the thirteen sub-basins). It occurs because these rivers have steep, mountainous, headwater catchments that are tectonically-active and which feature active volcanoes that periodically supply extraordinary amounts of sediment to their fluvial systems and, hence, to the Río San Juan.

4.140. Dr Kondolf refers to sediment being regarded as a pollutant on page 63 of his 2014 Report. I agree that when sediment loads are increased as a result of anthropogenic activities, sediment is treated as a pollutant by environmental regulators. However, sediment is only regarded as a pollutant if its concentration or load is artificially increased above that expected given the natural of the watercourse and its catchment context. Hence, to be a pollutant, sediment concentrations and loads must be elevated compared to the natural sediment concentrations and loads in the river. Rivers draining tectonically active basins, and especially those with live volcanoes, are known to carry very heavy and highly variable sediment loads that persist over geological periods (i.e. millennia to millions of years), as pointed out in Douglas (1996). Sediment concentrations in the Río San Juan are high and highly variable because the basin experiences extraordinary sediment yields associated with earthquakes and volcanic eruptions that are a natural consequence of its geology (for reasons set out in the Astorga Report). The geology of the San Juan Basin dictates that sediment is not and cannot be regarded as a pollutant in the Río San Juan.

4.141. In attempting to challenge my assertion that the sediment load of the Río San Juan is naturally high, Dr Kondolf relies heavily on the evidence provided by Dr. Andrews. For example, in paragraph 3, on page 68 he states that, *"Dr. Andrews presents the evidence and literature regarding the land use that has resulted in such an unnaturally elevated load in the Río San Juan."* While uncertainties concerning sediment yields and loads in the San Juan Basin remain high, Dr Andrews' evidence does not appear plausible and this casts doubts on expert views in the 2014 Kondolf Report that rely on that evidence.

4.142. In Section *V.C* of the Andrews Report, Dr Andrews contends that the measurements of suspended load in the Río San Juan at La Trinidad made between 1974 and 1976 are too few in number to draw any meaningful conclusions. It is indeed unfortunate that only these limited records are available, but the fact remains that in 1974-76, 12 measurements were made using the best field methods then available, as part of a programme performed by jointly by Costa Rica and Nicaragua. It is, therefore, undeniable that these measurements provide at least indications of suspended sediment concentrations and loads transported by the Río San Juan during that period.

4.143. The annual suspended sediment load in the San Juan, at least during the measurement period in 1974-76, can be estimated by combining the measurements of suspended sediment concentrations with the volumes of water flowing through the River during the relevant period (referred to as the average annual hydrograph). On this basis, the average annual suspended sediment load for 1974-1976 was on the order of 8 million t/y. This is falls well within the confidence band for the annual suspended loads established by ICE in their 2014 Report (see Table 4.14, above), which accounts for uncertainty due to inter-annual variability and the scatter of measured data around the suspended sediment rating curve.

4.144. The measurements of suspended sediment concentration made in the 1974-76 joint programme are few in number, but they provide the only available indication of suspended concentrations and annual load transported prior to construction of the Road.

4.145. In the 2013 ICE Report, these measurements were compared graphically to those made by ICE at Station 11-04 on the Río Colorado immediately downstream of the Delta, in 2010-13. In Figure 3, on page 7 of the 2013 ICE Report, Costa Rica's experts used simple, linear regression to compare suspended sediment concentration records for 1974-76 and 2010-13, with the regression curves constrained to pass through the origin (that is point (0, 0) on the graph. On page 30 of the Andrews Report, Dr Andrews suggests removing this constraint because, as he states on page 31, this is the *"statistically proper"* thing to do. In Figure 3 on the same page, Dr Andrews presents alternative linear regression lines that are not constrained to pass through the origin. However, fitting regression lines that do not pass through the origin to data that express the suspended sediment concentration as a function of the discharge is physically nonsensical. This is the case because (as Dr Andrews' Figure 3 shows) the regression relationships that result indicate that in 1974-76 the suspended sediment concentration in the Río San Juan would be zero at low discharges, while in 2010-13 the river would carry a small but finite suspended sediment load even if it there were no flow whatsoever. These conditions are both physically implausible, which over-rides Dr Andrews' claim that not constraining the regression lines to pass through the origin is the *"statistically proper"* thing to do.

4.146. On page 16 of his Report, Dr Andrews states that, *"a couple of years of river flow and a few tens of suspended sediment samples are insufficient and cannot be relied upon"*. Yet on page 34 he applies logarithmic transformations to the 12 measurements at La Trinidad made in 1974-76 and the 31 made at Delta Costa Rica in 2010-13, and then fits power curves to these records which, in his Figure 4, he extrapolates over two log cycles (that is suspended sediment concentrations ranging from 10 to 1000 mg/l and discharges ranging from 10 to 1000 m^3/s). This is inappropriate and Figure 4 in the Andrews Report does not represent an improvement over Figure 3 in the 2013 ICE Report. Logarithmic transformation of suspended sediment concentration and discharge data is appropriate when constructing sediment rating curves, but it is not helpful when comparing a few measurements made in 1974-76 to a few more made in 2010-13.

4.147. In my opinion, the graph shown in Figure 3 of the 2013 ICE Report (reproduced as Figure 26 on page 63 of the 2013 Thorne Report) provides a suitably simple platform for comparison of the few available pre- and post-Road measurements of suspended sediment concentrations in the Río San Juan – Colorado system. As I stated in paragraph 8.5 the 2013 Thorne Report, I conclude that, *"If additional sediment from the Road had caused an increase in the rate of sediment transport in the Río San Juan, this would reflect in Figure 26 through increases in the SSCs measured since 2010 and a* *corresponding upward shift in the 2010-2013 suspended sediment rating curve compared to that for 1974-1976. It is clear from Figure 26 that this is not the case.”*.

5. Has Construction of Route 1856 had any significant impacts on channel morphology in the Río San Juan?

A. Reach scale impacts

5.1. In my 2013 Report I applied the Montgomery-Buffington (1997) classification system to the Río San Juan-Colorado fluvial system downstream of Lake Nicaragua (Figure 5.1).

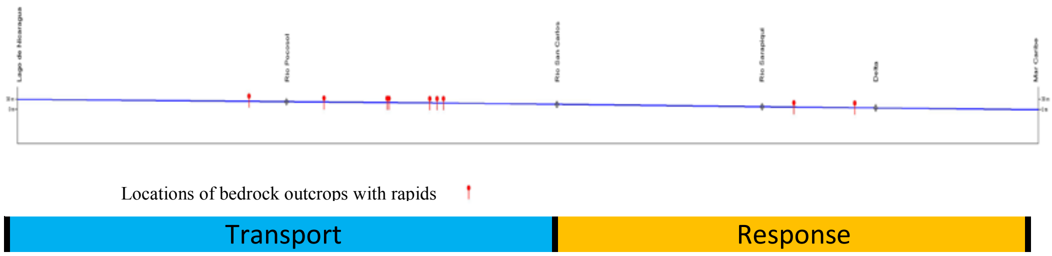


Figure 5.1 Designation of reaches of the Río San Juan according to the Montgomery-Buffington classification (from the 2013 Thorne Report).

5.2. On the basis of this assessment, I concluded that the addition of sediment from the Road would have no significant impacts on the morphology of the Río San Juan within the first (Lake Nicaragua to Río Pocosol) and second (Río Pocosol to Boca San Carlos) geomorphic reaches of the river because these are bedrock-controlled, 'transport' reaches with ample sediment transport capacity to carry any additional sediment input to them. This was not challenged by Dr Kondolf in his 2014 Report.

5.3. In my 2013 report, I further concluded that the addition of sediment from the Road would have no significant impacts on the morphology of the Río San Juan within the third and fourth reaches (Boca San Carlos to Boca Sarapiquí, and Boca Sarapiquí to the Delta) because, although these are alluvial, 'response' reaches, they receive volumes of sediment input from the San Carlos and Sarapiquí basins that dwarf any additional supply from the Road. Although the Andrews Report proposed that the very high sediment yields of the San Carlos and Sarapiquí basins are unnatural (a proposal that is unfounded, for reasons set out in section 4*E*, above), this was the only part of my explanation of sediment processes in the reaches between Boca San Carlos and the Delta that was challenged in the technical annexes that accompanied Nicaragua's Reply in the 'Construction of a Road' case.

5.4. As the classification of the geomorphic status of the Río San Juan between Lake Nicaragua and the Delta, together with my explanation of why that status negates the possibility of reach-scale morphological impacts due to construction of the Road presented in the 2013 Thorne Report, has not been challenged, I refer readers to that report.

5.5. While he makes no reference to reach-scale impacts upstream of the Delta, Dr Kondolf continues to contend that construction of the Road has had local morphological impacts by building or adding to sediment deltas at the mouths of at least eight small tributary streams draining from the Costa Rica between Marker II and Boca San Carlos (Appendix F in the 2014 Kondolf Report). In Section 5*B*, below, I focus on the degree to which these deltas and their morphological impacts can be attributed solely to construction of the Road. Aquatic organisms living on and between gravel particles forming these deltas were sampled by Nicaragua's experts. The results were presented in the Rios Report and discussed in the 2014 Kondolf Report. I address the ecology of the deltas in Section 6*A,* below.

5.6. The fifth reach is the lower Río San Juan below the Delta. This is a Response reach (Figure 5.1). I explained in my 2013 report that the regional, neotectonic uplift of the Chortis Block (which lies to the north of the Santa Elena - Hess Fault) dictates that the discharge of water and the transport capacity of the lower Río San Juan naturally decrease gradually through time, to drive a long-term, depositional trend (as explained in

Section II.2.1 of the 2011 Thorne Report that accompanies Costa Rica's memorial in the *Certain Activities* case). This explanation has been accepted by other experts. For example, Professors van Rhee and de Vriend state in the 2012 Report (Appendix 2 to Nicaragua's Counter Memorial in Certain Activities) that, *"As Thorne correctly notes, river discharges to the Lower San Juan River will gradually decrease without dredging due to the geological trends in the area (Thorne, p. II-10)".* Professors van Rhee and de Vriend go as far as to use my explanation to justify continued dredging along the entire length of the lower Río San Juan. The Río Colorado also constitutes a Response reach, although regional tectonic subsidence south of the Santa Elena - Hess Fault means that flows and the sediment transport capacity of the Río Colorado naturally increases gradually through time. None of this was challenged by Dr Kondolf in his 2013 Report.

5.7. However, both the 2014 Kondolf Report and the Andrews Report continue to argue that additional coarse sediment supplied to the lower Río San Juan from the Road presents a serious hazard to navigation that necessitates continued dredging, at least in the first 3 kilometres downstream of the Delta. In Section 5*C*, below, I focus on the degree to which aggradation in the lower Río San Juan can be attributed to construction of the Road. Navigational aspects of aggradation in the lower Río San Juan are addressed in Section 6*B*.

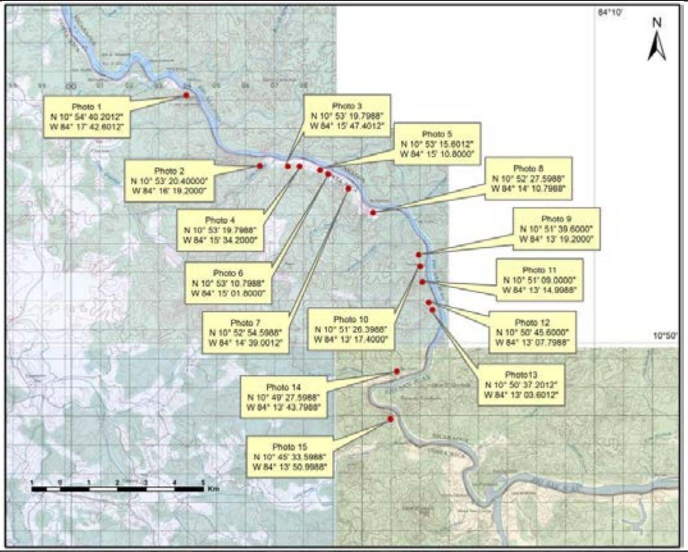
B. The Tributary Deltas

5.8. On page 69 of the 2014 Kondolf Report in the section on *'Morphological Impacts of Rte 1856'*, Dr Kondolf describes how and why tributary streams build sediment deltas at the point where they confluence with the Río San Juan. I agree with Dr Kondolf's general description, but not the conclusions he bases on that description that are specific to tributary deltas along the south bank of the Río San Juan.

5.9. In my 2013 Report, I pointed out that deltas similar to, but sometimes larger than, those along the south bank of the Río San Juan also exist on the Nicaraguan bank of the River. I substantiated this observation with photographs of thirteen north bank deltas. No GPS was available when those photographs were taken, and so I was unable to record coordinates for the deltas observed in May 2013. Hence, on receipt of a request from Nicaragua for the coordinates in 2014 (note of 25 March 2014, reference HOL-EMB-046) another flight, with GPS available, was arranged to meet that request and a new set of photographs was supplied to Nicaragua on 21 May 2014 (reference ECRPB-071-14). Despite these photographs having been supplied to Nicaragua, Dr Kondolf does not address them in his 2014 Report. On the second flight, two additional north bank deltas were observed and all 15 deltas are shown in Figure 5.2.

5.10. From the air, the Nicaraguan deltas appear very similar to, though perhaps larger than, those on the south bank, even allowing for seasonal changes in river stage that influence the proportion of each delta that is exposed. My general conclusion is that, in terms of their morphological impacts on the river, there is no significant difference between tributary deltas found along the north and south banks.

5.11. I have been unable to establish whether the deltas recorded by Dr Kondolf in Annex F of his 2014 Report existed prior to construction of the Road because the cloud free, high-resolution satellite images necessary to ascertain whether sediment deltas were present prior to 2011 are not available for many of the locations. That said, cloud-free images for two locations (Figure 5.3) establish that at least two deltas definitely pre-date the Road and I cannot rule out the possibility that this is actually the case for most, if not all, of them.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W 84° 17' 42.6012"
Photo 2
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Photo 4
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W 84° 15' 01.8000"
Photo 7
N 10° 52' 54.5988"
W 84° 14' 39.0012"
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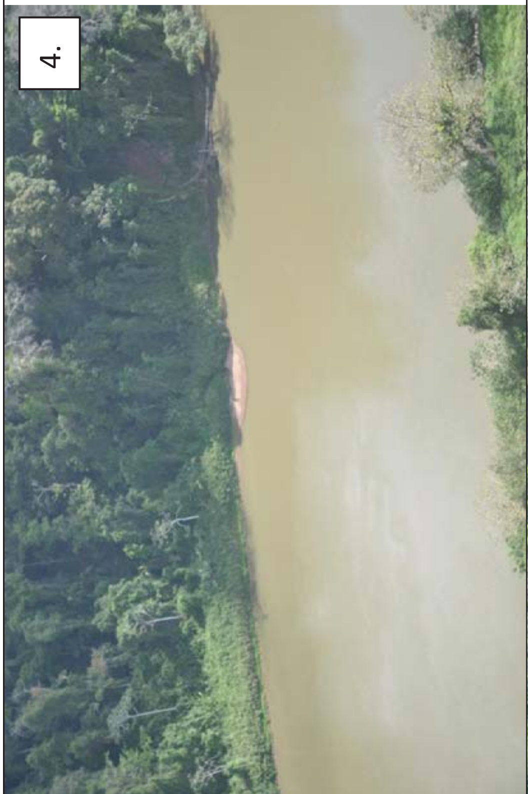

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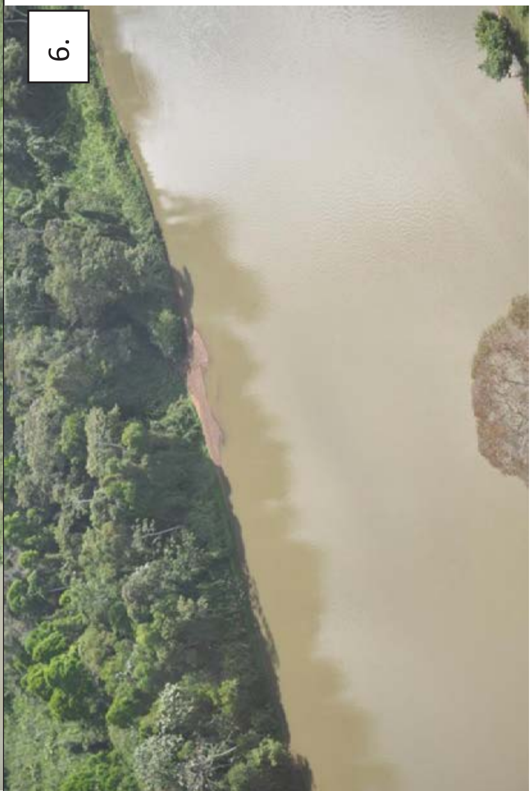

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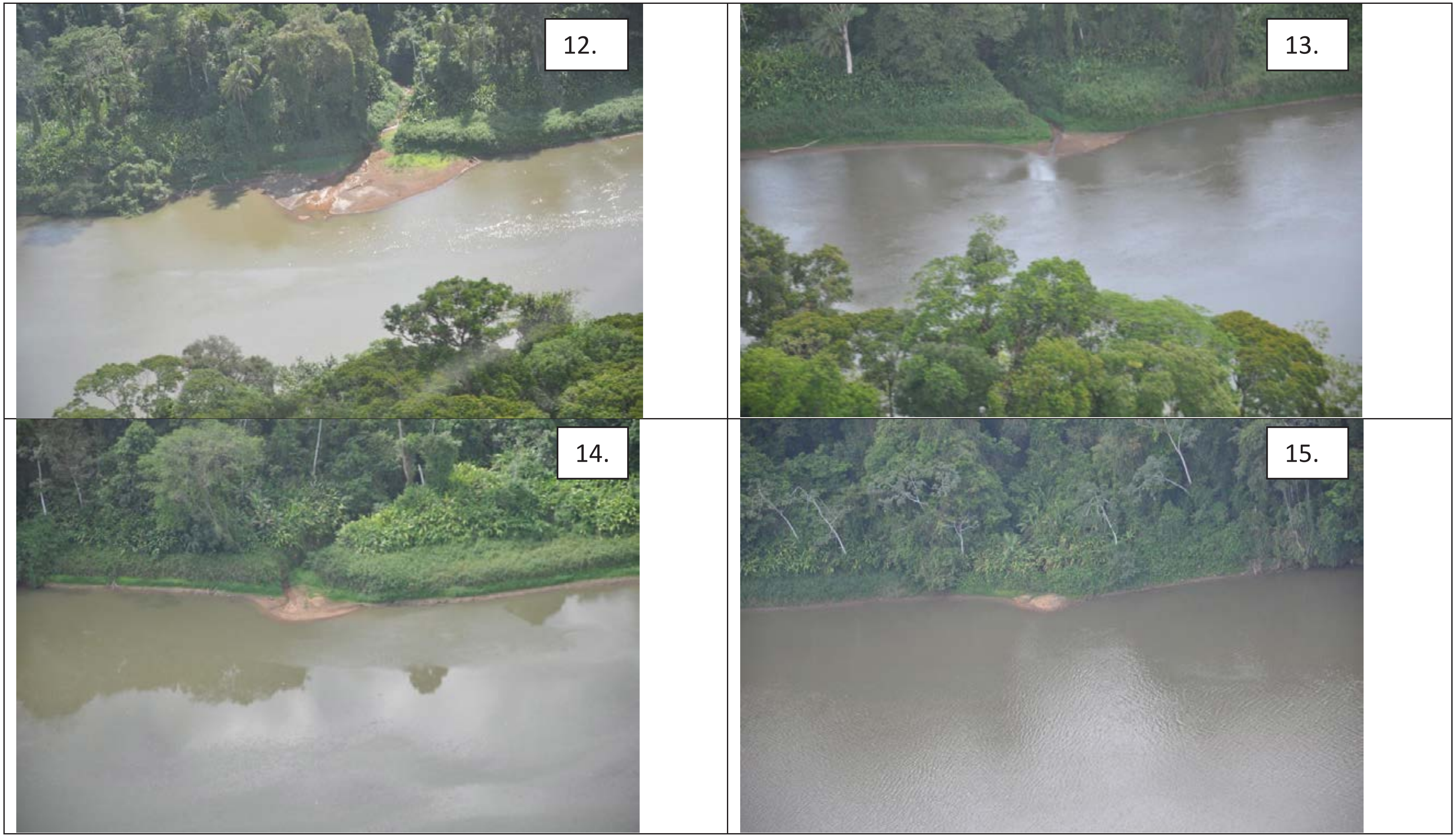

Figure 5.2 Fifteen north bank deltas photographed from Costa Rican airspace in April 2014. These deltas are formed in sediment eroded from Nicaragua and some are considerably larger than any of those photographed by Dr Kondolf along the south bank. The size and morphology of these deltas should be compared to those shown in Appendix F of the 2014 Kondolf Report, which were also taken at conditions of low flow in the Río San Juan.

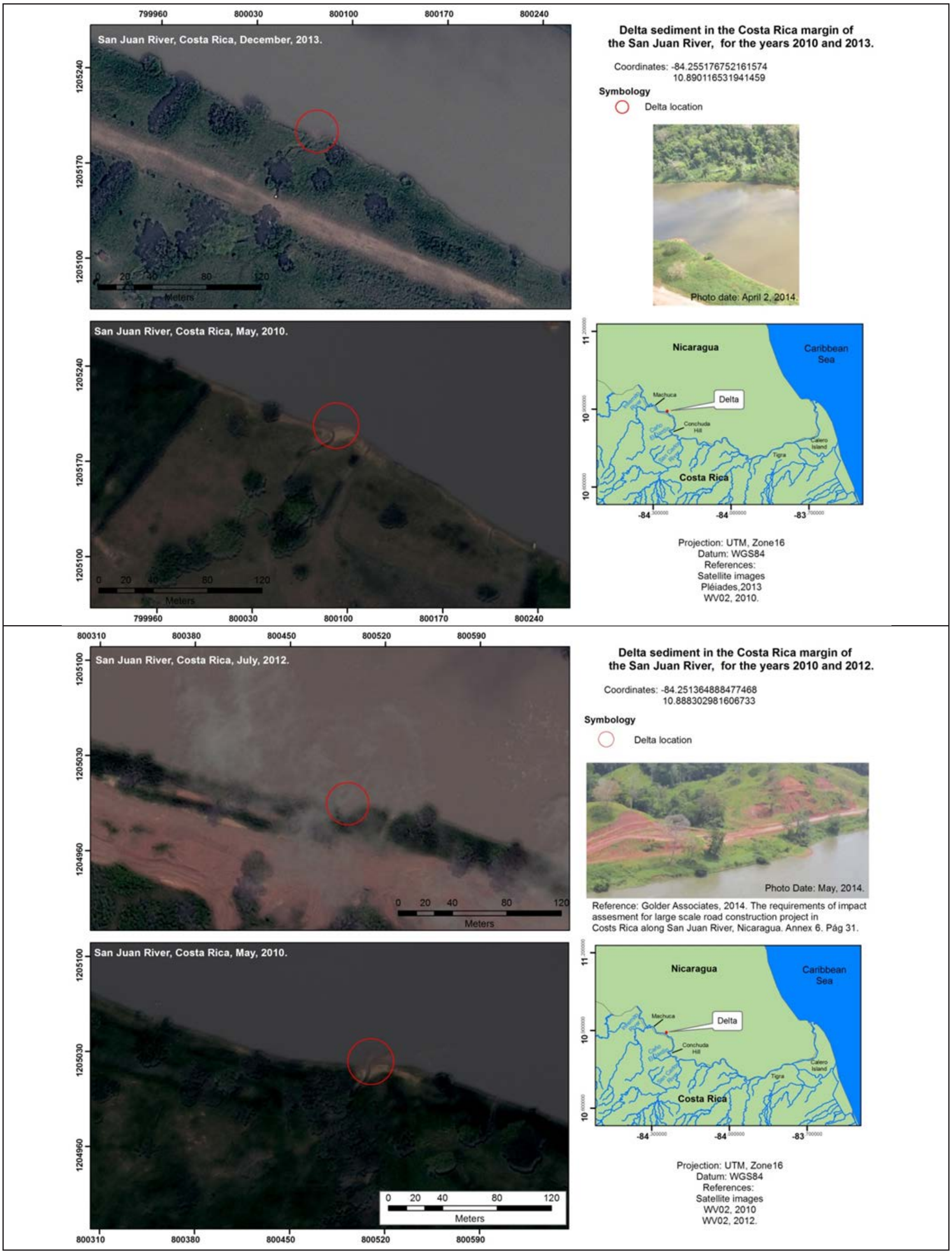

Figure 5.3 Pre- and Post-Road satellite images establishing that at least two of the eight south bank deltas identified as being formed from sediment derived from the Road were present prior to construction of the Road.

5.12. Notwithstanding the overall similarity of deltas on the north and south banks when viewed at a distance, Dr Kondolf's closer, on the ground inspection led him to differentiate between stream and Road-derived sediments within the deltas, based on three characteristics of the individual grains. In the third paragraph on page 70 of his 2014 Report, he observes that sediment from the Road is, "*reddish in color and is easily-crumbled (what we have previously referred to as 'angular, friable clasts'), reflecting the deeply-weathered hillslope from which the sediment recently came. These clasts are distinct from the more rounded, competent gravels that one typically encounters in a natural stream, and which dominate the deltas on the northern bank of the River."* This may sound like inconsequential detail, but it is actually revealing for three reasons:

1. the fact that Road-derived clasts are friable indicates that they will quickly weather down to rounded, gravel-sized particles, similar to those that would have formed deltas along the south bank of the Río San Juan prior to construction of the Road;

2. the fact that deltas along the north bank are formed in, "*more rounded, competent* [i.e. less crumbly] *gravels"* indicates that these deltas are formed from stream bed material that has been transported considerable distances from its eroding source, that these grains do not crumble, and that they will remain too large for the Río San Juan to transport downstream for years or decades; and

3. the fact that the Road-derived gravel particles (*clasts*) are angular despite being friable (*easily-crumbled)* indicates that they have only recently entered the fluvial system.

5.13. With respect to south bank deltas, Dr Kondolf points out in paragraph 3 on page 69 of the 2014 Kondolf Report that, *"Some are pre-existing deltas of* *natural streams on which road-derived sediment has deposited, while some are completely new features built of sediment eroded from the road".* In the last paragraph on page 70, he states that the new deltas are formed "*by a 'lag deposit' of coarser sediments*": which suggests that these deltas only exist due to the relatively large size of the Road-derived sediment that forms them. It is likely therefore that at least some of them will decrease in size as the friable clasts break-up.

5.14. Based on Dr Kondolf's own observations concerning the friability of Road-gravel clasts it is likely that the half-life of their residence on deltas will be measured in months rather than years. This is the case because these clasts will quickly crumble to sizes easily entrained by rainy season discharges in the Río San Juan. Once entrained in the flow, any Road-derived clasts will wear down (through attrition and corrosion) to highly mobile fine sand, silt and clay sizes that are easily absorbed within the existing load of the Río San Juan.

5.15. Where sediment derived from the Road has accumulated on a pre-existing delta at the south bank, any local, small-scale impacts will be transitory and short-lived. In contrast, the 'competent gravels' making up the north bank deltas (and, presumably, the pre-existing south bank ones too) will not crumble, so that these stable and persistent morphological features will continue to provide morphological diversity and environmental benefits to the River.

5.16. If Road-derived sediment has formed any entirely new deltas, these will be removed by the Río San Juan as the mitigation works choke off the supply of new clasts, those currently forming the delta disintegrate, and the River entrains and transports the crumbling clasts away, quickly wearing them down to sand, silt and clay-sized particles in the process.

5.17. In short, the friable nature of the "lag deposits" formed by clasts derived from the Road means that any contribution they make to morphological features in the River is insignificant due to their spatially restricted extent and because their existence in the channel will be short lived.

C. Has coarse sediment eroded from the Road affected bed elevations in the lower Río San Juan?

5.18. On the very first page of the 2014 Kondolf Report, Dr Kondolf considers the possibility that Road-derived sediment is causing the bed of the lower Río San Juan to aggrade faster than would otherwise be the case. His concern is that sediment contributions from the Road are causing morphological changes because, *"the Lower San Juan is already overloaded with sediment from Costa Rica's other high contributions, such that additional inputs are likely to aggrade and accrete"*. Having stated this, he does not further explore the issue, though it is addressed by Dr Andrews, in Annex 3 to Nicaragua's Reply.

5.19. As I explained in Section II.2.1 of the 2011 Thorne Report and reiterated in the 2013 Report, long-term aggradation of the lower Río San Juan is inevitable due to neotectonic uplift of the Chortis Block (which lies to the north of the Santa Elena - Hess Fault), which dictates that the discharge of water and transport capacity of this distributary channel will naturally decrease gradually through time, to drive a long-term, depositional trend. This explanation has been accepted by other experts. For example, Professors van Rhee and de Vriend stated in their 2012 Report (Appendix 2 to Nicaragua's Counter Memorial in Certain Activities) that, *"As Thorne correctly notes, river discharges to the Lower San Juan River will gradually decrease without dredging due to the geological trends in the area (Thorne, p. II-10)".*

5.20. While there is no question that the majority of sediment supplied to the lower Río San Juan is sourced from Costa Rica; this is to be expected given that the Costa Rican tributary basins are much larger than those draining from Nicaragua and because they have mountainous headwaters, receive heavier rainfall, and experience seismic events and volcanic eruptions. Thematic mapping (Figure 4.25(f)) establishes that deforestation and agricultural development have taken place in Nicaragua as well as Costa Rica, and specific sediment yields estimated using distributed soil erosion modelling for the Santa Cruz, Melchora and Sábalos basins are actually higher than those in five of the seven sub-basins in Costa Rica (Table 4.19).

5.21. My conclusion is that Dr Andrews is wrong to state in paragraph 3 on page 27 of his Report that, *"Poor land-use practices in Costa Rica over recent decades have greatly increased the supply of sediment to the Río San Juan Delta area."*. As explained in paragraphs 4.124 and 4.130 above, and in the Astorga Report, sediment yields from some Costa Rican tributaries have been high, and highly variable, for millennia because their basins have steep, mountainous, rainy, headwater catchments that are tectonically-active and feature live volcanoes that periodically supply huge amounts of sediment to the Río San Juan between Lake Nicaragua and the Delta.

5.22. Dr Andrews criticizes my 2013 Report for ignoring the bedload transport capacity of the lower Río San Juan when estimating the increase in bed elevation that could occur should sand from the Road be deposited rather than passing to the Bay of San Juan del Norte. I agree that when determining the net rate of river bed aggradation it would be preferable to consider both the supply of sediment and the rate of sediment transport through the reach. In my 2013 Report, I considered only the supply of sediment in order to remove the uncertainty associated with attempting to calculate the bedload transport capacity of the lower Río San Juan, by assuming it to be filled by coarse sediment from sources other than the Road – making my estimate of the thickness of the layer that might be deposited by sediment derived from the Road conservative. I prefer to stick to that assumption, simply because the uncertainty associated with estimates of bed material transport made using un-calibrated sediment transport equations is notoriously high (see for example, Gomez and Church, 1989), a point stressed by Dr Andrews on pages 23 and 24 of his Report.

5.23. As set out in Table 4.17, under a 'worst case' rainfall scenario, the mean annual input to the Río San Juan of Road-derived sediment is 44,880 m^3/y. As in the 2013 Thorne Report (see paragraph 8.60, page 85), again assuming that 5 to 10% of that sediment is coarse (i.e. sand moving as bed material load) suggests that the 'worst case' mean annual input coarse sediment to the Río San Juan is 2,244 to 4,488 m^3/y. Based on 90% of the discharge of the Río San Juan flowing to the Colorado and 10% to the lower Río San Juan, ICE's bedload computations suggest that, on average, 20% (450 to 900 m^3/y or 750 to 1,500 t/y) passes to the lower Río San Juan (see Figure 4.15, above).

5.24. Supposing that, as Dr Andrews suggests, all of the additional coarse sediment (450 to 900 m^3/y) were to be deposited within 3 km of the Delta, which I believe to be unrealistic (for reasons set out in paragraphs 5.26 to 5.29, below). Spread across a channel 90 m wide and 3,000 m in length, this would cause the bed to rise by an average of 1 to 3 mm, annually. Such a rise would simply be unmeasurable even using the most sophisticated hydrographic survey equipment. I agree that the actual distribution of sedimentation would be spatially and temporally complex – making it in practice impossible to separate the contribution to changes in bed level attributable to the coarse fraction of Road-derived sediment from continuous bed level changes associated with the migration of ripples (with amplitudes of 10 to 30 mm), dunes (with amplitudes of 10 to 50 cm) and bars (with amplitudes greater than 1 to 2 m). In this context the hypothetical addition of 1-3 mm is trivial. Also, this annual rate would not be sustained because erosion from the Road will decrease as mitigation takes effect, disturbed areas revegetate and slopes relax geomorphologically, as expected according to the 'rate law' (Graf 1977).

5.25. In fact, sand deposition is not restricted to the first three kilometres of the lower Río San Juan, but is distributed along its entire length. This is evident for three reasons.

5.26. First, the lower Río San Juan has a mobile sand bed throughout its length. This was established through bed material sampling performed as part of the environmental impact study for Nicaragua's dredging programme. In the EIA report submitted to the Court in 2011 as Annex 7 in Volume II of Nicaragua's Counter Memorial in the Certain Activities case, the bed of the lower Río San Juan is defined as being made up of:

(a) Delta – San Juanillo: gross to fine sand, with diameters 0.58 mm to 0.90 mm.

(b) San Juanillo – Mouth: fine to large sand, with diameters 0.45 to 0.68 mm.

5.27. Second, continued growth of the micro-delta 30 kilometres downstream of the Delta indicates that the lower Río San Juan has the capacity to transport sand throughout its length.

5.28. Third, more than 20 sites where the bed has been dredged to remove accumulating sand during Nicaragua's dredging programme are located downstream of the first three kilometres of the lower Río San Juan (see sketch map 5.1 on page 229 of Costa Rica's Memorial in the Certain Activities case).

5.29. Further reasons that it would be difficult, if not impossible, to demonstrate a causal relationship between the addition of relatively small amounts of coarse sediment derived from the Road and bed elevation change in the lower Río San Juan include: (1) complexity in the sediment transfer system, (2) the time lag between coarse sediment input and downstream response caused by the relatively slow transfer of bedload through the fluvial system and (3) temporal variability in coarse loads supplied from sources other than the Road.

5.30. Uncertainty in estimates of the quantity of bedload that enters the lower Río San Juan at the Delta is extremely high for reasons set out in the ICE Report that are summarized in Section 4*C*, above. To understand why this is the case consider that uncertainty stems from three different sources:

(a) time series variability due to inter-annual variability in sediment loads;

(b) scatter in the data used to develop the sediment rating curves;

(c) the division of flows between the lower Río San Juan and Colorado at the Delta, which is likely to vary seasonally.

5.31. To understand the impacts of these uncertainties on estimates of the mean annual bedload in the lower Río San Juan, it is only necessary to consider the confidence intervals listed in Table 4.14 (which is reproduced in part below, for ease of reference).

Table 4.14 Mean Annual bedloads in the lower Río San Juan for a range of percentage discharges flowing from the Río San Juan to the Río Colorado (from 2014 ICE Report).

PRSJ	Qa ($m^3 s^{-1}$)	Annual sediment load ($t yr^{-1}$)				
		Mean	TLCI	TUCI	SSRC LCI	SSRC UCI
				Bedload		
95	1055	323 000	80 000	566 000	169 000	638 000
90	1114	**702 000**	174 000	1 230 000	359 000	1 418 000
85	1180	1 152 000	286 000	2 018 000	575 000	2 382 000

Note:
PSJR = Percentage of Río San Juan discharge flowing to the Río Colorado;
Qa = Mean annual discharge;
TLCI = lower 95% confidence interval due to time series variability;
TUCI = upper 95% confidence interval due to time series variability;
SSRC LCI= lower 95% confidence interval due to uncertainty in SRC;
SSRC UCI= upper 95% confidence interval due to uncertainty in SRC.

5.32. As Dr Andrews points out in the last paragraph on page 22 of the Andrews Report, *"the relative portions of annual flow in the delta distributary channels cannot be determined with any confidence"*. For this reason, ICE tested the sensitivity of estimates of the bedload entering the lower Río San Juan based on bedload measurements in the Río Colorado for scenarios in which 85, 90 or 95% of the flow in the Río San Juan approaching the Delta passes to the Río Colorado. The results indicate that depending on the choice of scenario alone (and without even considering uncertainties associated with time series variability and uncertainty in the sediment rating curve for Station 11-04), the mean annual bedload estimated to be entering the lower Río San Juan ranges between 323,000 and 1,152,000 t/y (Table 4.15), which represents a range of -54% to +64% around the best estimate for a 90:10% scenario, which is 702,000 t/y. The additional sand load from the Road (591 to 1,181 t/y) constitutes 0.1 to 0.2% of the estimated mean annual bedload for a 90:10% scenario, which is inconsequential in the context of the range in estimated bedloads associated with uncertainty in the division of flow at the Delta. When inter-annual variability in the time series of measured loads and uncertainty in the sediment rating curve are also considered, the range of possible loads expands to from eighty thousand to over two million tonnes per year and the impossibility of proving that the Road has had any appreciable impact on bed loads and changes in bed elevation in the lower Río San Juan becomes clear.

5.33. Were I to accept Dr Kondolf's 2014 estimate that the quantity of sediment derived from the Road plus all the access roads delivered to the River annually is between 116,000 and 150,000 m^3, which I do not, and applying Dr Andrews' assumptions that 10% of that sediment is carried into the Lower Río San Juan and that 12 to 18% of it is relatively coarse, then 1,390 to 2,700 m^3 of sand from Route 1856 plus its access roads would be added to the non-Road related coarse load. If all of this were to be deposited within 3 km of the Delta, which I believe to be unrealistic, this would still only cause the bed to rise by an average of 5 to 10 mm. Hence, by Dr Andrews' calculation, any change in average bed elevation would still be unmeasurable. Also, sedimentation would be time-limited because any supply of sand from the Road would decrease as mitigation takes effect, disturbed areas revegetate, and slopes relax towards equilibrium according to the geomorphological 'rate law' (Graf 1977).

5.34. In any case, as Dr Andrews points out, division of discharges (and hence division of coarse sediment load) at the Delta, "*cannot be determined with any confidence*", precluding the possibility of establishing a causal link between construction of the Road and changes in bed level in the lower Río San Juan until such time as the data necessary to determine the divisions of discharges and sediment loads at the Delta have been collected.

5.35. On this basis, while it is almost certain that coarse sediment derived from erosion of the Road *cannot* have had any discernable impact on either sediment loads or bed elevations in the lower Río San Juan immediately downstream of the Delta, it would be impossible to prove that it *has* had any such impact.

5.36. Turning to the fine load, on page 29 of his Report Dr Andrews opines that, *"The finer sediment particles – fine silt and clay, which comprise a majority of the river's sediment – will be transported downstream along the delta channels until the fresh river water begins to mix with tidal surges of ocean water"* and that consequently, *"The vast majority of the relatively fine sediment will be deposited within the delta and not carried into the ocean as Thorne states"*.

5.37. Dr Andrews' opinion is contradicted by the available field data and satellite imagery. In the 'Environmental Impact Study for Improving Navigation on the San Juan de Nicaragua River (September 2006)' that was submitted as Annex 7 in Volume II of Nicaragua's Counter Memorial in the Certain Activities case, the bed material of the lower Río San Juan at its outlet to the Caribbean Sea is defined on page 10 as consisting of, *"clean, fine sand grains, with diameters from 0.31 to 0.58 mm"*. No mention is made of either silt or clay being present in the bed – on the contrary, the description of the sand as 'clean' indicates that fine sediment is not deposited within the delta channel.

5.38. Dr Andrews' opinion might be correct for a delta building into a marine water body that experiences frequent *"tidal surges"*. But the Caribbean has a micro-tidal regime, with a diurnal tidal amplitude averaging only about 20 cm (Kjerfve, 1981). This explains why most of the fine sediment carried by the lower Río San Juan is not deposited within the delta but is carried into the Caribbean Sea, as I indicated in my 2013 Report and as illustrated in typical, rainy season satellite images (Figure 5.4), that show plumes of turbid river water extending into the Bay or San Juan del Norte and the littoral zone of the Caribbean Sea.

Figure 5.4 Satellite images showing that flow from the lower Río San Juan carries turbid water with a high concentration of fine sediment into both the Bay of San Juan del Norte and the littoral sediment system of the Caribbean Sea. Image dates (a) 13 December 1997 (b) 26 November 2013.

6. Has Route 1856 had any significant impacts on ecology or fishery of the Río San Juan, or any impact on navigation?

A. Comments on Fish and other Aquatic Life in the Río San Juan by Nicaragua's Experts

6.1. On pages 63 to 65 of the 2014 Kondolf Report, Dr Kondolf sets out the negative impacts that increased delivery of coarse and/or fine grained sediment can have on aquatic species and habitats. Taking particular issue with the assertion on page 50 of the 2013 Thorne Report that, *"Fish and other aquatic organisms in the Río San Juan do not find high turbidity problematic because they are fully adapted to it"*, he notes that I presented no citations to scientific literature to support my assertion.

6.2. To counter my assertion, Dr Kondolf cites papers drawn from the literature concluding that, *"What the literature actually demonstrates is that some of the most prevalent fish known to exist in the Río San Juan (as reported in Procuenca 2004 and the EDA, Annex 10), such as Cichlids, members of the family Mugiliidae, and Poecilids, are vulnerable to increases in turbidity and suspended sediment"*.

6.3. With respect to other aquatic life in the Río San Juan, Dr Kondolf concludes that *"The heavy loads of suspended sediment have a negative effect on algal and macroinvertebrate communities in the Río San Juan, as evidenced by differences in ecological communities established on deltas on the north bank, at the mouths of streams draining forest preserve in Nicaragua, which are not affected by Rte 1856, contrasted with those established on the south-bank deltas, which are affected by sediment eroded from the road".* He relies for this conclusion on a field investigation performed by Dr Blanca Rios entitled, 'Ecological Impacts of Rte 1856 on the San Juan River (2014)' (the ***Rios Report***), which is Annex 4 in Nicaragua's Reply.

6.4. As a river scientist, I take it to be self-evident that species in the Río San Juan that are not adapted to high turbidity would have either:

(a) been extirpated, given that according Dr Andrews' explanation (which I reject) turbidity has been high due to deforestation for half a century; or

(b) had time to adapt to high turbidity (accepting my explanation that the sediment load of the River is naturally high and has been so for millennia).

6.5. Also, I note that on page 66 of the 'Environmental Impact Study for Improving Navigation on the San Juan de Nicaragua River (September 2006)' that was submitted to the Court in 2011 as Annex 7 in Volume II of Nicaragua's Counter Memorial in the Certain Activities case, in the section describing planktonic and benthonic organisms in the Río San Juan, Nicaragua's ecologists reported that, *"A low density of organism was noted both in the water and in the sediment, with the predominance of species that are tolerant and adapted to adverse conditions*" noting that, *"the locations where the samples were taken is located at the outlet of the San Juan River where the majority of the contaminants have been carried, as well as gross sediment, which translates into the presence of tolerant species."*

6.6. However, I am not a specialist in aquatic biology and, while I have a good working knowledge of river ecology, neither am I an expert in fish or macroinvertebrates. For these reasons I draw here on an independent report by Professor Ian Cowx (the ***Cowx Report***).

B. Fish

6.7. The independent expert report by Professor Ian Cowx, an internationally recognized leader in the management of inland fisheries and aquatic resource, deals primarily with fish and the fishery of the Río San Juan. It directly addresses Dr Kondolf's overall conclusion (on page 66 of the 2014 Kondolf Report) that, *"Professor Thorne's unsupported assertion that "Fish and other aquatic organisms in the Río San Juan do not find high turbidity problematic because they are fully adapted to it" is not only inconsistent with the literature on the species of fish and macroinvertebrates known to exist in the San Juan River, but also inconsistent with recent aquatic ecology sampling in the San Juan River itself."*

6.8. Professor Cowx finds statements presented in the 2014 Kondolf Report to be either over-generalised, fundamentally flawed or to misinterpret the peer reviewed literature. He finds expert opinions stated in the 2014 Kondolf Report that pertain to the possible impacts of sediment derived from the Road on fish to be unsupported by empirical evidence from the San Juan itself, while those based on the published literature are taken out of context.

6.9. Professor Cowx notes that the annual hydrograph of the Río San Juan exhibits a wet season flood pulse typical of tropical rivers and that its sediment load is consistent with this, being naturally high and variable (Bussing 2002). He finds that fishes of the San Juan are well adapted to high and variable sediment loads, being accustomed to high and variable turbidity (Bussing 2002).

6.10. With respect to the species of fish living in the river adjacent to the Road, Professor Cowx points out that these have not been explicitly defined by Nicaragua's experts, who describe their characteristics at family level rather than providing information that is specific to species actually present in the Río San Juan. He notes that it would require intense research using specialist equipment over a protracted period to identify the species-specific adaptations of fish living in the River.

6.11. With respect to commercially valuable species (the fishery), Professor Cowx finds it likely that the coastal fishery is more productive than inland fishery, mostly due to exploitation of snook and sport fisheries for tarpon. In his opinion, the coastal fisheries are unlikely to be adversely impacted by any additional sediment loading from the Road.

6.12. Professor Cowx closes the first part of his report (dealing with fish and the fishery) by stating that, *"My literature review, together with close inspection of literature cited in the 2014 Kondolf Report, provides the basis to evaluate Dr Kondolf's general statement on page 64 that, What the literature actually demonstrates is that some of the most prevalent fish known to exist in the Río San Juan (as reported in Procuenca 2004 and the EDA, Annex 10), such as Cichlids, members of the family Mugiliidae, and Poeciliids, are vulnerable to increases in turbidity and suspended sediment*".

6.13. Professor Cowx goes on to conclude that, *"What the literature actually demonstrates is that Dr Kondolf's statement is a gross over-generalisation. While some members of the families of fishes he names are vulnerable to increases in turbidity and suspended sediment, others members of those families are adapted to high sediment loading and this is illustrated through the species specific review summarised herein and reported in detail in the references cited."*

6.14. He further notes that, *"Empirical data on the species impacted with particular reference to the San Juan River are required to justify and substantiate claims of any long-term impact of construction of Route 1856 on the fish and fisheries of the river. No such data have been provided by*

Nicaragua's experts. The examples used as evidence are general and unspecific to the San Juan River and the species that inhabit it."

6.15. Professor Cowx therefore concludes that, *"**there is no evidence that the fish and fisheries of the San Juan have or will be impacted by construction of Route 1856.**"* [his emphasis through use of bold text].

6.16. An expert literature review on fish in the Río San Juan was performed as part of the 2014 ecological assessment by the Tropical Science Center (CCT). This report, titled 'Fish Fauna in the San Juan River', was authored by the Costa Rican fish expert, Arturo Angulo Sibaja, (the ***Angulo Report***).

6.17. The Angulo Report is a technical treatise that draws on examples from multiple rivers in Costa Rica. Although no data are available for the Río San Juan in the reach adjacent to the Road, Angulo reports data for the Río Colorado (which is the downstream extension of the Río San Juan, receiving about 90% of its flow). Despite its high and variable sediment load, the Río Colorado has one of the most diverse freshwater fish assemblages found in Central America (Bussing 1998, Angulo et al. 2013), with about 115 species, which is 46% of those found in Costa Rica (Angulo et al. 2013).

6.18. Information on fish species living in tributaries to the Río San Juan that carry suspended sediments at concentrations even greater than those in the main river is also germane. For example, at the Terrón hydrometric station located on the Río San Carlos, Angulo cites a specific sediment yield of 817 t/km^2/y and ICE report an annual suspended sediment load of 1,175,000 t/y (see Table 4.10). Yet the Río San Carlos is home to no less than 54 fish species (including Cichlidae (n = 15), Poeciliidae (n = 10) and Characidae (n = 8)) that apparently do not find problematic the high turbidity associated with such heavy loads of suspended sediment.

6.19. In the Reventazón basin, which like the Río San Juan, drains to the Caribbean Sea, specific sediment yields of up to 1,159 $t/km^2/y$ have been measured (Jimenez et al. 2005). Even so, the river supports a diverse fish population with 65 species including Cichlidae (n = 15), Poeciliidae (n = 6) and Characidae (n = 5) (Molina 2011).

6.20. In the Angulo Report, it is concluded that, *"The presence of these taxa in rivers with high sediment yields might suggest high levels of tolerance, as various authors have proposed (Bussing 1998, Tiffer-Sotomayor 2005, Rojas and Rodriguez 2008, Saenz et al. 2009), and is supported by the presented revision."*

6.21. In the Cowx Report, Professor Cowx endorses the findings of the Angulo Report, writing that his report, *"acknowledges and builds on the insightful comments made by Arturo Angulo Sabaja".*

C. Invertebrates

6.22. In section 3 of the Cowx Report, Professor Cowx re-examines evidence presented in the Ríos Report related to the impact of the Road on macroinvertebrates in the Río San Juan and reviews statements made in the 2014 Kondolf report that rely on the outcomes of the Ríos Report.

6.23. Professor Cowx finds that, while the Ríos Report appears to show differences between macroinvertebrate communities (and associated parameters) on deltas at the north and south banks of the Río San Juan River, these findings are compromised by the fact that the drainage areas of the northern bank deltas are systematically larger than those of the south bank deltas. Also Dr Ríos does not consider or account for the effects of natural vegetation and catchment land use on stream water quality and delta habitat. He contends that these confounding factors may account, at least in part, for the differences that both Dr Ríos and Dr Kondolf attribute to sedimentation from the Road. This point is also stressed in a review of the Ríos Report conducted by Bernald Pacheco Chaves, an aquatic ecologist at the Tropical Science Center (CCT) (the ***Pacheco Report***).

6.24. Professor Cowx draws attention to low abundance, low richness and high within site variability in macroinvertebrate assemblages, which suggest that conditions at all of the sample sites are dynamic and variable. He notes that while multiple patterns and differences are reported by Dr Ríos, these may be attributed to differences in the areas, natural vegetation and land use in the catchments draining to the deltas, which are not controlled for in the statistical analyses. Professor Cowx notes that the same conclusion is arrived at in the statistical review by Gutiérrez (2014) (the ***Gutiérrez Report***).

6.25. I have reviewed the Gutiérrez Report: though I am a user of statistics, and am familiar with the appropriateness, strengths and weaknesses of alternative parametric and non-parametric tests, I am not an expert in that field. Therefore I am not well placed to judge the degree to which the errors highlighted therein undermine Dr Rios' conclusions. That said, setting Gutiérrez's comments alongside those of Professor Cowx inevitably reduces confidence in the value of the statistical support used to justify Dr Rios' conclusions, and the statements by Dr Kondolf that rely on them.

6.26. Professor Cowx summarises his re-examination of the Ríos Report thus, *"I consider that the Ríos (2014) Report does not provide the evidence necessary to prove that construction of the Road has adversely impacted the benthic macroinvertebrates living in sediment deltas along the southern bank of the San Juan River."*

6.27. The Pacheco Report comes to the same conclusion, viz., *"It is considered that the study of Rios Touma (2014) does not provide valid evidence to demonstrate significant degradation of aquatic communities in the San Juan river due to sediment discharge by works in Route 1856"*. I note that the Pacheco Report reaches that conclusion on the basis of a deeper technical treatment than that performed by Professor Cowx.

6.28. Pacheco drills into issues associated with contrasts in land cover, land use and riparian vegetation in sub-catchments draining to the north and south banks. He points out that 14 of the 16 sites sampled by Dr Ríos are located in a single, short reach between the mouths of the Infiernito and San Carlos tributaries (Figure 6.1).

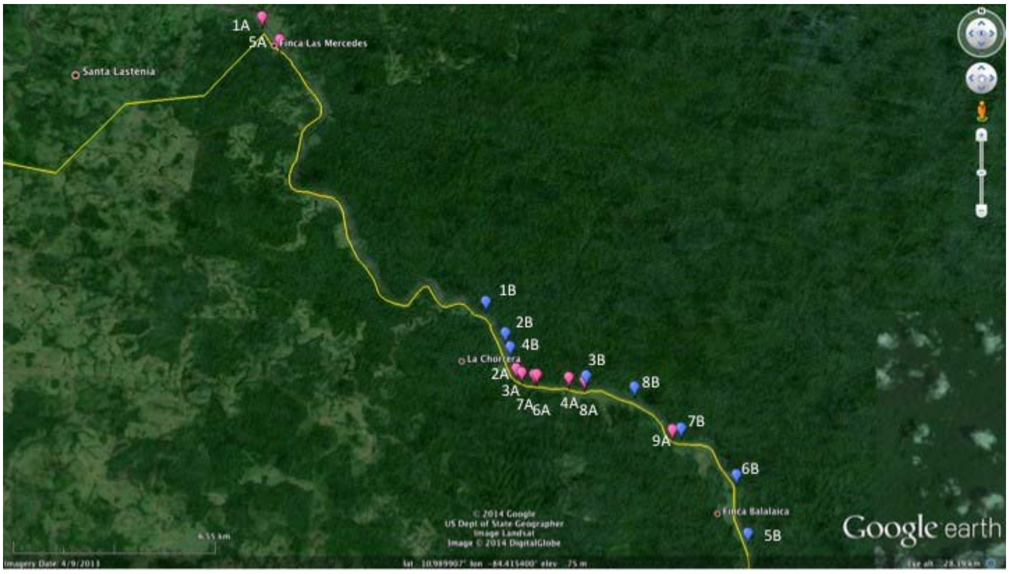

Figure 6.1 Sampling Points along the San Juan River between El Castillo and Boca San Carlos. Each point corresponds to a delta formed by a creek draining to Río San Juan (This is Figure 1 in the Ríos Report).

6.29. Pacheco notes that this short reach features what is probably the highest local concentration of cut slopes and large fill prisms anywhere along the Road, making it highly atypical of conditions more generally. Yet, the results of the Ríos study are presented as though they represent the entire length of the Road, or at least that between Marker II and Boca San Carlos.

6.30. Professor Cowx criticizes Dr Kondolf for citing examples of sediment intolerance in fish that were made at family level, and drawn from literature for species found in rivers other than the Río San Juan, rather than using examples specific to species known to live in the Río San Juan. Similarly, Pacheco criticizes Dr Ríos for mentioning taxa found to be sensitive to sediment based on studies in the United States (Zweig & Rabeni 2001; Carlisle et al. 2007).

6.31. Pacheco points out two major flaws in this regard. First, the studies that Dr Ríos uses as reference do not correspond to the Río San Juan, Costa Rica, Central America or even the Tropics. Environmental conditions found in temperate areas are obviously different to those in the Tropics, and macroinvertebrates are known to respond differently to environmental stimuli even in different regions of the same country (Heino 2014). Second, the level of taxonomic resolution used by Dr Ríos reaches only to the family and gender level, which is normal because taxonomic identification to species level in macroinvertebrates is often not possible with the scientific literature published to date and requires a high degree of taxonomic expertise.

6.32. For this reason, it is very difficult to know whether or not the species studied in the literature that Dr Ríos cites in her references correspond to species present in Río San Juan. Although some species may occur both in the rivers cited in the literature and in the Río San Juan, this is unlikely. The point here is that the tolerances to sediments of macroinvertebrates may vary depending on the taxonomic resolution used (Bailey et al. 2001), and may vary even between different species within the same genus

(Flowers 2009), making it unreliable to use macroinvertebrates as bio-indicators of environmental and water quality deterioration on the basis of family and gender-level taxonomic resolution – which is precisely what Dr Ríos does in her Report.

6.33. Pacheco points out that Dr Ríos concludes that construction of Route 1856 has had no impact on deltas along the north bank of the Río San Juan. This indicates that, even if construction of the Road were to have had any significant impact on aquatic life in the River (which I do not accept), that impact would be restricted to a few deltas along the Costa Rican bank, contained within a short reach of the River.

6.34. If erosion and delivery of sediments from the Road had caused a significant increase the concentration and load of sediment in the River then, as Pacheco points out, this would be expected to have altered conditions throughout the aquatic environment, impacting not only isolated spots along the near bank, but also the bed and the opposite bank - especially given that the channel in Dr Ríos' study reach is less than 200 m wide.

6.35. In Pacheco's opinion, Dr Ríos' finding that the north bank of the river has been unaffected by construction Route 1856 contradicts statements by Nicaragua and Nicaragua's experts to the effect that the Road has done significant harm to aquatic life in the Río San Juan.

6.36. Turning to the 2014 Kondolf Report, Professor Cowx writes that, in his expert opinion, in using macroinvertebrate fauna as indicators of environmental degradation (see page 65), Dr Kondolf misses the point that macroinvertebrates are better bio-indicators of adverse impacts of water quality than they are of deterioration of hydromorphology (Bonada et al. 2006, Resh 2008). Consequently, Professor Cowx questions the reliability of using macroinvertebrate studies in the Río San Juan River to infer that the Road has had significant hydromorphic impacts on the River.

6.37. In this context, Professor Cowx points out that, on page 65 of his 2014 Report Dr Kondolf concludes that, *"The heavy loads of suspended sediment have a negative effect on algal and macroinvertebrate communities in the Río San Juan, as evidenced by differences in ecological communities established on deltas on the north bank, at the mouths of streams draining forest preserve in Nicaragua, which are not affected by Rte 1856, contrasted with those established on the south-bank deltas, which are affected by sediment eroded from the road"*. To support his conclusion, Dr Kondolf cites evidence from the Ríos Report, which found *"much higher EPT abundance and richness, on deltas on the north side of the Río San Juan, than on the south-bank deltas impacted by sediment from the road."* Dr Kondolf explains the significance of the EPT results thus; *"EPT refers to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), which are known to be sensitive to sediment and other pollutants, and thus are important indicators of water quality."*

6.38. EPT fauna are indeed important indicators of water quality, but they are less reliable in indicating hydromorphological impacts due to the dynamic nature of hydromorphological features such as sediment deltas. Professor Cowx's point is that not only are the EPT richness and abundance scores very low for all the deltas studied (to the point that they lack statistical robustness, as discussed in the Gutiérrez Report), but also differences between northern and southern bank deltas can be attributed to differences in water quality in streams draining to the deltas that are attributable to contrasts in basin areas, vegetation and land use. The failure of Dr Ríos' study to control for confounding factors such as the effects of agricultural development thereby becomes doubly significant.

6.39. Professor Cowx concludes his independent review by stating that; *"Evidence provided in the Ríos Report that compares environmental bio-indicators for deltas on the northern and southern banks is largely inconclusive and fails to provide the robust empirical data necessary to prove that sediment eroded from the Road has adversely impacted the aquatic ecology of the San Juan River."* He adds; *"It is therefore unsound for Dr Kondolf to conclude that Road-derived sediment has had negative effects [on] invertebrate communities in the San Juan River."*

6.40. In paragraphs 5.13 to 5.18, above, I set out my interpretation of the significance of sedimentological differences between Road-derived and stream-bed sediments identified by Dr Kondolf during his field inspections of deltas on the north and south banks of the Río San Juan. I explain below why the specific properties of the Road-derived sediment observed by Dr Kondolf mean that any influence it may have on periphyton and macroinvertebrate assemblages is localised and temporary.

6.41. In the 2014 Kondolf Report, Dr Kondolf accepts my proposition that fresh sediments provide new substrate for periphyton (algae and other organisms growing on the surfaces of gravel and rock) and macro-invertebrates to colonise.

6.42. Recognizing this, the important point is that Road-derived sediment deposits do not provide habitat that is intrinsically inferior or of lower quality, but that Road-derived clasts are larger, fresher and cleaner than older stream gravels, having only recently been sourced from newly-exposed bodies of sedimentary rock. The issue is that such clasts are *too clean* to support abundant and diverse microbial ecosystems and they have not been in the fluvial system long enough to develop the rich periphyton that is the base of the food chain. But this is a transitory condition. Given time, energy and a supply of nutrients, the larger, fresher clasts lose their angularity, grade from cobble to gravel sizes (due to their friable composition) and grow a slimy coating – the periphyton that provides the food source necessary to support succession towards richer and more diverse macroinvertebrate communities. That said, and as Professor Cowx points out, sampled macroinvertebrate richness, diversity and EPT scores are low for north as well as south bank deltas. This reflects the morphodynamic nature of the deltas, which accumulate sediment derived from the streams that feed them during localized rainstorms, but which are periodically disturbed by floods in the main river that re-entrain and distribute the stream-deposited tributary delta material along the bank and across the bed of the Río San Juan. All of this is a consequence of the naturally high sediment load of the River, as explained in paragraphs 4.109 to 4.128, above.

6.43. Professor Cowx criticizes the 2014 Kondolf Report for placing too much emphasis on the use of macroinvertebrate fauna as indicators of environmental degradation. Dr Kondolf also interprets periphyton and macroinvertebrates as bio-indicators of water quality, stating on page 71 that the new deltas, *"are also subject to unnaturally high and deleterious suspended sediment loads, which result in communities of algae and macroinvertebrates that reflect deteriorated water quality conditions"*. But this statement is not supported by any evidence.

6.44. On page 11 (paragraph 2) of his Third Report, Dr Kondolf reports suspended sediment concentrations in three samples of muddy-water in plumes in the River, which had entered the River following a 15-minute downpour. The samples had SSCs of 364, 459 and 483 grams per cubic metre. Dr Kondolf describes these SSCs as '*high*'. He also took two samples of River water, both of which had SSCs of 8 grams per cubic metre.

6.45. The 2013 Thorne Report includes a graph (Figure 18 in the 2013 Thorne Report, reproduced here as Figure 6.2) showing 2,409 individual measurements of suspended sediment concentration in tributaries to the Río San Juan and the Río Colorado at the Delta – which carries about 90% of the flow in the Río San Juan immediately upstream.

6.46. SSCs measured in this large data set vary from less than 10 parts per million to more than 10 000 parts per million, clearly illustrating the extreme natural variability in sediment concentrations, and associated levels of turbidity, characteristic of rivers in the Río San Juan – Colorado system.

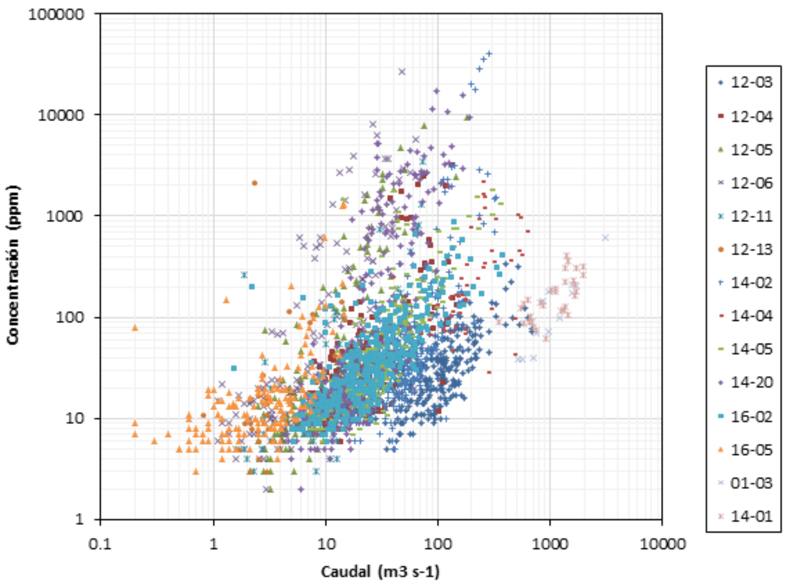

Figure 6.2 Suspended sediment concentration as a function of discharge for 2,409 samples taken from the Río Colorado, Río San Juan and its Costa Rican tributaries. Note: Station 11-04 is the Delta Colorado (Station) which receives about 90% of the flow in the Río San Juan immediately upstream (from the 2013 Thorne Report).

6.47. The background SSC in the Río San Juan at the time it was measured by Dr Kondolf was indeed low – as I have pointed out, SSCs and suspended sediment loads are extremely variable and May is the low water season. However, sediment concentrations in the plume of muddy-water he sampled are not '*high'* in the context of SSCs routinely observed in runoff draining to the Río San Juan, or even in the River itself (as represented by Station 11-04 in Figure 6.2).

6.48. It is unsurprising that a 15-minute rainstorm in May produced a striking contrast between SSCs in local runoff and the receiving water because under these circumstances the source of sediment is localised to the area of the rainstorm, while discharge and background SSCs in the River (which in May is at its lowest (base flow) discharge) are at their lowest. However, judging from the existence of deltas at their tributary confluences, plumes with similarly high SSCs will be associated with local storm runoff from streams confluencing at the north as well as the south bank.

6.49. In his Fourth Report, Dr Kondolf accepted that the sediment concentrations he measured in the muddy plume, *"were not very high compared to concentrations measured in the river and its large tributaries during high flows."*[1] In doing so, he effectively retracted the statement in his Third Report that these measurements showed, *"that the runoff from the road carried high suspended sediment contributions"*.[2] Dr Kondolf went on to state in his Fourth Report that the measurements *"demonstrate the essential fact that sediment from the road is entering the Río San Juan."*[3] I agree, but the central point remains this: in order to assess whether the concentrations of suspended sediment measured in runoff from the Road have harmed or may in future cause harm to life in the River, it is necessary to consider them within the context of sediment concentrations that aquatic plants and animals in the river system experience routinely

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1 Fourth Kondolf Report, p. 11.

2 Third Kondolf Report, p. 11.

3 Fourth Kondolf Report, p. 11.

and to which they are well adapted. The measured data in Figure 6.2 show that concentrations in tributaries to the Río San Juan often exceed 500 grams per cubic metre and so those measured in May 2013 (364, 459 and 483 grams per cubic metre) have not damaged, and will not damage life in the River.

6.50. For these and all the other reasons set out in the Cowx and Angulo Reports, the wide range of SSCs and seasonal and local variability therein are not a water quality problem and suspended sediment cannot be considered as a pollutant. High SSCs during the annual flood pulse and associated individual rainstorms (which occur throughout the year) are, as I wrote in my 2013 Report, *"a long-standing fact of life to which the River's aquatic and riparian ecosystem is fully adapted".*

D. Navigation

6.51. In its Memorial in the *Construction of a Road* case, Nicaragua claimed that constructing the Road had involved *"Dumping of trees and soil along the route of the road into the river flow, making more difficult and risking the navigation in its waters"*. This claim of adverse impacts on the navigability of the Río San Juan due to construction of the Road clearly applies to the reach along the route of the Road between Marker II and Delta Costa Rica.

6.52. Nicaragua's experts have made no mention of trees or sediment from the Road causing risks to navigation in the Río San Juan between Marker II and Delta Costa Rica and neither have I seen any evidence that this has, or is likely to, happen during any of my fieldtrips and overflights. On the contrary, I have observed Nicaraguan vessels navigating the Río San Juan between Marker II and Delta Costa Rica without difficulty on multiple occasions, during the low water as well as the high water season.

6.53. In any case, in-stream deposition of trees and soil is part of the natural functioning of the Río San Juan. This is not only my opinion but is also documented in the 'Environmental Impact Study for Improving Navigation on the San Juan de Nicaragua River (September 2006)' that was submitted to the Court in 2011 as Annex 7 in Volume II of Nicaragua's Counter Memorial in the Certain Activities case. On page 10 of this document, in reference to a bar in the Río San Juan at the point where the channel widens as it approaches the Delta, it is stated that, *"During probes of this section, the remains of organic material were found, including trees 0.6 meters in diameter buried under the riverbed up to the depth of 3.00 meters."* The authors go on to explain that the origin and functioning of these deposited trees writing that they, *"come downstream during periods when the river is very high go downstream, bumping against the islands, which retain them, serving as energy dissipaters, retaining some sediment which, upon accumulation during the year increases the size of the islands or causes new, small islands to be created…".* This passage confirms that large woody debris was present in the Río San Juan long before construction of the Road and that it plays a natural role in the geomorphic and environmental functioning of the River.

6.54. In his 2012 Report, Dr Kondolf referred to *"significant damage to aquatic and wetland environments and navigability of the lower Río San Juan through causing excessive sedimentation"*. This claim refers not to navigation in the reach alongside the Road, but to navigation in the lower Río San Juan, downstream of Delta Costa Rica.

6.55. Based on the reasoning explained in paragraph 5.29 above, and supposing that, as Dr Andrews suggests, all of the Road-derived sand that might reach Delta Costa Rica and enter the lower Río San Juan were to be deposited within the first 3 km downstream of the delta, which I believe to be unrealistic for the reasons set out above, in paragraphs 5.26 to 5.29, this would cause the bed to rise by an average of 5 to 10 mm.

6.56. Even allowing for deposition being concentrated on bars, deposition of all the Road-derived sand in the first three kilometres of the lower Río San Juan would be insufficient to significantly affect navigation. In any case, variability in the sediment loads entering the lower Río San Juan would make it, in practice, impossible to discern the contribution to increasing bed or bar heights attributable to Road-derived sand from long-term trends of aggradation, bar building during floods and the continuous changes in bar elevations resulting from seasonal and event-driven variability in flows and sediment loads, and other morphological adjustments in the fluvial system.

6.57. If sedimentation does pose a problem for navigation during the dry season, this is attributable to an aggradational trend that affects the entire river, being driven by natural tectonic and fluvial processes that, for the reasons explained in the Astorga Report, have operated in the lower Río San Juan for millennia. This, geological, explanation for aggradation in the lower Río San Juan is endorsed by other experts. For example, Professors van Rhee and de Vriend wrote in their 2012 report (Appendix 2 to Nicaragua's Counter Memorial in Certain Activities) that, *"As Thorne correctly notes, river discharges to the Lower San Juan River will gradually decrease without dredging due to the geological trends in the area (Thorne, p. II-10)."*

6.58. I conclude that any navigation problems in the lower Río San Juan are associated with long-term aggradation driven by natural processes. The addition of Road-derived sand to the sediment load of the lower Río San Juan cannot in itself have impeded navigation, nor can it be proven to have caused the bed elevation in the river to rise by any measurable amount.

7. What effect have Costa Rica's Mitigation Works had, and how have they progressed since late-2013?

A. CODEFORSA's Reforestation and Slope Recovery programmes

7.1. In April 2012, as part of implementation of the Environmental Management Plan for the Road, the Commission for Forestry Development in San Carlos (Comisión de Desarrollo Forestal De San Carlos or CODEFORSA) was contracted to plant and maintain 25,000 trees at 12 sites along Route 1856 between Marker II and Boca San Carlos. In 2013, the contract was extended to add a further 19 sites, with provision to plant and maintain 24,000 more trees. To date, a total of 50,709 trees have actually been planted, covering an area of around 46 hectares, 98% of which lies between the Road and the south bank of the Río San Juan. These trees are currently aged between 2 and 28 months and range between 50 cm and 7 m in height.

7.2. Full details of this programme of reforestation and revegetation may be found in reports authored by CODEFORSA and titled, 'Consulting Services for the Development and Implementation of an Environmental Plan for the Juan Rafael Mora Porras Border Road' (the ***2014 CODEFORSA Report***) and 'Restoration and rehabilitation of ecosystems affected by the construction of the Juan Rafael Mora Porras border road, Ruta 1856' (the ***CODEFORSA Quarterly Report for November 2014***).

7.3. Here, I focus on responding to Dr Kondolf's dismissal of the reforestation programme on page 42 of the 2014 Kondolf Report, where he wrote, *"Annex 2 includes photographs of a tree-planting program, but does not provide essential information such as whether the plantings will actually address slope stability issues (the answer in most cases will be no, because the failure planes of landslides would be deeper than the rooting depth of* *plants), and whether the plants have survived since planting (in our observations from the river, it appeared that most have died)"*.

7.4. With regard to provision of essential information concerning the reforestation programme, the 2014 CODEFORSA Report provides thorough accounts of both phases, plus a two-page information sheet for each of the 31 sites that documents the location, planting date, maintenance activities and current status of the trees and which includes a time sequence of site photographs. These sites are not restricted to the first 15 km of the Road downstream of Marker II.

7.5. Dr Kondolf is right to surmise that, "*the failure planes of landslides would be deeper than the rooting depth of plants*" and inspection of the 2014 CODEFORSA Report confirms that trees have not been planted on slopes prone to instability due to deep-seated landsliding. In fact, other steps are being taken to improve the stability of cut and fill slopes that are high and steep, as is described in detail in the ***2014 CONAVI Report***, CODEFORSA's Quarterly Report for November 2014, and in summary below.

7.6. Areas designated for reforestation (including gentle but not steep slopes) were selected based on their being locations where trees can effectively:

(a) reduce the erosivity of rainfall by intercepting precipitation;

(b) reduce the erodibility of the soil by decreasing soil moisture levels through evapotranspiration and by providing root reinforcement;

(c) reduce the generation of overland flow by increasing infiltration;

(d) intercept surface runoff along concentrated flow paths by increasing surface roughness and ground permeability, to protect the soil and downslope areas from sheet, rill or gully erosion;

(e) intercept surface runoff that might otherwise reach the Río San Juan; and,

(f) create valuable wildlife habitat.

7.7. When I first read the 2014 Kondolf Report in August 2014, I was surprised by Dr Kondolf's questioning of, *"whether the plants have survived since planting"* and that, *"(in our observations from the river, it appeared that most have died)"*. In fact, my own observations in April 2014 indicated that the vast majority of the trees and grasses planted by CODEFORSA up to that time had survived and were, indeed flourishing.

7.8. Having now visited the reforestation sites three times in 2014, having spoken at length to CODEDFORSA's forestry experts and having reviewed the CODEFORSA Reports, I am convinced that Dr Kondolf's statements are groundless.

7.9. Both the phase 1 and 2 contracts awarded to CODEFORSA included provision for two years of post-planting maintenance, with activities specified to include:

(a) Monitoring of planted areas (including the health of the trees);
(b) Mowing;
(c) Spot herbicide treatment around trees;
(d) Fertiliser application;
(e) Removal of suckers;
(f) Maintenance of the fences; and
(g) Follow-up visits to the planted areas.

7.10. In CODEFORSA's contract, the number of trees growing at the end of the contract period is specified rather than the area to be covered. Consequently, throughout phase 1 of the project, CODEFORSA identified and replaced lost trees within the maintenance programme. This is also happening during phase 2 (which is on-going).

7.11. Table 7.1 lists data from mortality reports for maintenance visits performed between 2012 and 2014.

Table 7.2 Mortality report for the CODEFORSA reforestation programme (from the 2014 CODEFORSA Report).

Phase 1 (26,575 TREES PLANTED)							
NAME OF THE PARTY	TREES PLANTED	MORTALITY IN 2012		MORTALITY IN 2013		MORTALITY IN 2014	
		N	%	N	%	N	%
Escuela Delta Costa Rica	325	28	8,6%	25	7,7%	0	0,0%
Escuela y Policía	500	0	0,0%	25	5,0%	0	0,0%
Tito Hernández Ferreto	366	14	3,8%	5	1,4%	0	0,0%
María Hilaria Miranda Rivas	500	30	6,0%	20	4,0%	0	0,0%
Felix Hernández Jarquín	260	17	6,5%	15	5,8%	0	0,0%
Fabio Vargas	407	52	12,8%	10	2,5%	0	0,0%
Escuela Boca La Ceiba	117	10	8,5%	5	4,3%	0	0,0%
Melis Góngora Moraga	252	25	9,9%	5	2,0%	0	0,0%
Iglesia Boca La Ceiba	225	30	13,3%	7	3,1%	0	0,0%
Fredy Ulate Castro	3180	150	4,7%	0	0,0%	0	0,0%
Fabio Cedeño G. (F. Ochoa)	5345	329	6,2%	345	6,5%	0	0,0%
Fabio Cedeño G. (San Antonio)	1600	57	3,6%	50	3,1%	0	0,0%
Marcelo Méndez Morales	1.870	75	4,0%	25	1,3%	0	0,0%
Daniel Jiménez Berrocal (El Guabo)	1.907	125	6,6%	30	1,6%	0	0,0%
Daniel Jiménez Berrocal (Alonso)	200	20	10,0%	0	0,0%	0	0,0%
Daniel Jiménez Berrocal (Slopes)	1.000	40	4,0%	20	2,0%	0	0,0%
Olman Quesada Campos	650	26	4,0%	5	0,8%	0	0,0%
Daniel Jiménez Berrocal (Lote Pilo)	950	95	10,0%	4	0,4%	0	0,0%
Daniel Jiménez Berrocal (Bismark)	1.280	78	6,1%	8	0,6%	0	0,0%
William Cortés Madrigal	1.460	150	10,3%	25	1,7%	0	0,0%
German Díaz Ruiz	4.095	274	6,7%	100	2,4%	0	0,0%
Edgar Salazar Ramírez	86	0	0,0%	5	5,8%	0	0,0%
TOTAL	26.575	1.625	6,6%	734	2,8%	0	0,0%

Phase 2 (24,134 TREES PLANTED)							
NAME OF THE PARTY TO THE AGREEMENT	N TREES PLANTED	MORTALITY IN 2012		MORTALITY IN 2013		MORTALITY IN 2014	
		N	%	N	%	N	%
Fabio Cedeño González (Ochoa)	3.100					150	4,8%
Melis Góngora Moraga	220					5	2,3%
Tito Hernández Ferreto	570					55	9,6%
Edwin Segura Retana	2.610					270	10,3%
Marcelo Méndez Morales	1.345					255	19,0%
Eylin Cruz Campos	3.550					40	1,1%
Frits Perera Jiménez (Palo Seco)	2.500					50	2,0%
Porfirio Rodríguez Campos	920					150	16,3%
Fabio Vargas Vargas (Chachalaca)	4.050					250	6,2%
Daniel Jiménez Berrocal (El Almendro)	2.463					0	0,0%
Daniel Jiménez Berrocal (La Laguna)	256					0	0,0%
Frits Perera Jiménez (Pindongo)	2.550					0	0,0%
TOTAL	24,134					1.225	6.0%

7.12. The main causes of mortality in the first year were: dry conditions (several rainless days immediately after planting), the volunteers' initial lack of experience in planting techniques, local water-logging around some of the newly planted trees, grazing by ruminants and equines gaining access to the planted area, and application of inappropriate herbicides for weed control at some sites. These issues were addressed as the project proceeded and mortality was much lower in the second year. Consequently, in the survey at the end of the phase 1, no dead trees were found in the planted areas. The outcome is expected to be similar for the trees planted in phase 2, which has yet to be completed.

7.13. CODEFORSA are also engaged in a coordinated programme of slope stabilization performed in conjunction with CONAVI. In this programme, CONAVI address potential slope instability with respect to deep-seated landsliding (which is the mechanism highlighted by Dr Kondolf in his 2014 report). Measures to prevent deep-seated landslides include slope terracing, re-profiling and drainage improvements. These are described in detail in the ***2014 CONAVI Report*** and, in summary, below in section 7*B*.

7.14. CODEFORSA undertake a range of related measures to protect slopes from erosion by raindrop impact, manage drainage to prevent erosion by sheet erosion and gullying, and improve stability with respect to shallow landslides. Together, the efforts of CONAVI and CODEFORSA constitute an integrated programme of erosion mitigation.

7.15. CODEFORSA have so far completed mitigation work at multiple slopes in the area around Tiricias, and more near Boca San Carlos, deploying pocketed geofabrics and sowing vetiver grass (*Chrysopogon zizanioides*) using the "adobe" approach, in which the survivability of the grass clumps is vastly improved by providing them with a body of fertile soil around the roots (Figure 7.1).

Figure 7.1 Examples of slope preparation and planting to provide surface protection by CODEFORSA along the Road between Marker II and Boca San Carlos

7.16. As with the reforestation programme, slopes planted by CODEFORSA are monitored and maintained as necessary to ensure satisfactory plant survival. Figure (7.2) is an example taken from the 2014 CODEFORSA Report, showing a sequence of photographs taken at slope 9, near Tiricias.

Figure 7.2 Slope 9 (near Tiricias) in February 2014, following treatment by CODEFORSA for surface protection (example taken from 2014 CODEFORSA Report)

7.17. CODEFORSA's current efforts centre on cut and fill slopes between the Río Infiernito and the community of Chorreras, the area around Caño Cureñita, where erosion had not been mitigated at the time that Dr Kondolf and his team inspected the Road in preparation for writing their 2014 Reports. Measures currently being implemented in that area by CODEFORSA include:

(a) surface protection using geofabrics and revegetation using native species of grasses and trees;

(b) digging small drainage channels to intercept runoff above, on and below treated slopes;

(c) installation of cross-drains to manage runoff on the Road; and,

(d) construction of sediment traps to catch and retain eroded sediment on site.

Implementation of these measures is scheduled for completion early in 2015.

7.18. CODEFORSA's efforts do not end when implementation is completed, however. CODEFORSA are contracted up to the end of September 2016 to deliver a programme of monitoring and maintenance during which the performance of all measures is appraised, any elements that fail are replaced and adaptive management is practiced to ensure that erosion and sedimentation are effectively mitigated at all treated sites. The CODEFORSA Quarterly Report for November 2014 report describes and illustrates these measures in detail, locating all slopes treated and scheduled for treatment using their geographical coordinates and the slope referencing system developed by Dr Mende.

7.19. Based on my discussions with CODEFORSA personnel and review of the 2014 CODEFORSA Reports, I conclude that substantial efforts led by experienced foresters and expert bioengineers have been made to reforest over forty hectares of land and protect and revegetate the cut and fill slopes along the Road between Marker II and Boca San Carlos. CODEFORSA pay special attention to maintaining as well as implementing erosion mitigation measures and planting trees and grasses and I am convinced that they are committed to ensuring the success of their efforts in mitigating erosion and soil loss.

B. CONAVI's Mitigation work at slopes and watercourse crossings

7.20. In December 2014, CONAVI delivered a report updating works performed to mitigate erosion along the Road between Marker II and the community of Chorreras, including the stretch of Road around Caño Cureñita (the ***2014 CONAVI Report***). This report presents photographs of over forty mitigation sites, 'before' and 'after' treatment that extend well beyond the first 15 km downstream of Marker II. Specific measures undertaken include:

(a) Surfacing the Road with gravel to stabilise and protect it from surface erosion;

(b) Reprofiling and terracing steep slopes to stabilise those susceptible to deep-seated landslides;

(c) Compaction and terracing and of loose fill slopes;

(d) Protection of cut anf fill slopes from surface erosion using coconut fibre and hydroseeding;

(e) Clearing and safe disposal of slumped soil accumulated at the base of slopes;

(f) Management of concentrated runoff using berms and concrete-lined ditches, with energy dissipaters where necessary;

(g) Placement of silt fences and traps to intercept and retain eroded sediment;

(h) Installation of culverts with concrete head and tail structures to stabilise small watercourse crossings;

(i) Replacement of log bridges with modular bridges at larger watercourse crossings.

Work is currently on-going, but is scheduled for completion early in 2015.

C. My Personal Observations in 2014

7.21. I visited the Road on three occasions in 2014. In this section I update the over-arching impressions of the Road as it was in 2013 (which are reported in the 2013 Thorne Report). I also paid close attention to mitigation works, (some completed, others in progress), along the Road between Marker II and Boca San Carlos.

7.22. While inspecting the works, I spoke to senior engineers from CONAVI (http://www.conavi.go.cr/) who are in charge of mitigation and Meco (http://constructorameco.com) who lead installation of the structures, and I took the opportunity to discuss lessons learned from implementation of mitigation works performed in 2013 and plans for completion of remaining mitigation works. I continue to be impressed by the way the engineers appreciate the challenges posed by erosion control, their broad experience, and their determination to complete the work necessary to stabilise slopes, manage runoff and make good the watercourse crossings along the Road.

7.23. In his 2014 Report, the examples Dr Kondolf uses and the majority of the photographs he includes in the body of the text are drawn from the 41.6 km stretch of the Road between Marker II and Boca San Carlos. He pays much less attention to the stretch between the mouths of the San Carlos and Sarapiquí (including just a handful of 'Severely Eroding Sites' and photographs thereof) and ignores the stretch between Boca Sarapiquí and the Delta.

7.24. To explain why this is the case, it is only necessary to consider the distribution of slopes and watercourse crossings provided in the 2014 Mende Report (Table 7.2).

Table 7.3 Distribution of slopes and watercourse crossings (from the Mende Report).

Stretch of Road	Length (km)	Slopes		Crossings	
		Nunber	%	Number	%
Marker II - Boca San Carlos	41.4	**126**	**63**	**77**	**60**
Boca San Carlos - Boca Sarapiqui	43.6	66	33	42	32
Boca Sarapiqui - Delta Costa Rica	22.6	9	4	10	8
Totals	107.6	201	100	129	100

7.25. As I stated in my 2013 Report, I understand why Dr Kondolf focuses on short, selected stretches of the Road and emphases erosion at sites he describes as 'severely eroding' within those stretches. The fact remains that the sites and stretches Dr Kondolf selects are atypical and Dr Kondolf's coverage gives an unrepresentative impression of both the propensity for, and extent of, road-related erosion at cut and fill slopes, and likewise the potential for road-derived sediment to be delivered to the Río San Juan via streams and ditches crossed by the Road.

7.26. My impression of the Road gained in 2014 is not that erosion has "visibly worsened" (as Dr Kondolf states on page 11 of his 2014 Report) but, on the contrary, that it has slowed. This is partly due to the natural recovery of stability that follows disturbance of a landscape: the geomorphic 'rate law' which predicts that rates of change decrease exponentially with time since disturbance (Graf, 1977), but is also thanks to the concerted efforts of CONAVI and CODEFORSA in mitigating erosion at multiple sites, including those between the Río Infiernito and Boca San Carlos and especially those east of the Río Infiernito (which have also been mitigated since Dr Kondolf wrote his 2014 Report). For these reasons, Dr Kondolf's equating of trends in erosion along the Road with those reported by Ramos-Scharron and McDonald (2005) on the island of St John (on page 44 of his 2014 Report), is inapt.

7.27. In 2014 I visited several of the sites reforested and slopes revegetated by CODEFORSA and I inspected many of the crossings and slopes where erosion has been mitigated by CONAVI working in cooperation with CODEFORSA. Summary statistics provided in the 2014 Mende Report indicate that considerable progress has been made in mitigating erosion at both slopes and crossings.

7.28. Work ongoing at Las Crucitas, La Chorera and El Jardín is now making real progress and the situation is far better than when Dr Kondolf and his team took the photographs included in the 2014 expert reports. Data listed in Table 7.3 indicate that this progress is not restricted to those locations: mitigation is already complete, underway or unnecessary at over 70% of slopes and is scheduled at the remaining 30% of sites.

Table 7.4 Mitigation status of slopes (from the 2014 Mende Report).

Mitigation Status	**Slopes**	
	(number)	**(%)**
Mitigated	25	12
Mitigation in progress	107	53
Mitigation scheduled	58	29
No mitigation necessary	11	6
Totals	201	100

Data listed in Table 7.4 indicate that mitigation is complete, underway or unnecessary at over two thirds of watercourse crossings and that work is scheduled for the remaining quarter of crossings where mitigation is required.

Table 7.5 Mitigation status of watercourse crossings (from the 2014 Mende Report).

Mitigation Status	Watercourses	
	(number)	(%)
Mitigated	28	22
Mitigation in progress	23	18
Mitigation scheduled	31	24
No mitigation necessary	24	19
Other	21	17
Totals	127	100

7.29. To support these statements and statistics I include below:

(a) photographs of the Road between the Delta and Boca San Carlos taken during an overflight of on November 17, 2014 (Figures 7.3 and 7.4);

(b) photographs at sites being reforested by CODEFORSA taken by the author in 2014 (Figure 7.5);

(c) photographs of slopes being revegetated by CODEFORSA taken by the author in 2014 (Figure 7.6); and

photographs taken by the author in November 2014 of erosion mitigation works on slopes and crossings around Caño Cureñita being undertaken by CONAVI with assistance from CODEFORSA (Figure 7.7).

Figure 7.3 Photographs representative of conditions along the Road between Boca Sarapiquí and the Delta observed from the air by the author on 17 November, 2014.

Figure 7.4 Photographs representative of conditions along the Road between Boca San Carlos and Boca Sarapiquí observed from the air by the author on 17 November 2014

Figure 7.5 Condition of some of the CODEFORSA reforestation sites visited in 2014. Photographs by author.

Figure 7.6 Condition of some of the slopes revegetated by CODEFORSA that were visited in 2014. Photographs by the author.

Figure 7.7 Condition of additional CONAVI erosion mitigation works inspected by the author in 2014: left watercourse crossings, and right slopes. Photographs by author.

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Figure 7.8 Large scale mitigation works by CONAVI on-going at sites around and Caño Cureñita, inspected in November 2014. Photographs by author.

7.30. During my overflight on 17 November 2014, I observed sediment entering the Río San Juan in appreciable quantities at five separate landslides along the north (Nicaragua) bank (for example, see Figure 7.9). The existence of these natural features demonstrates how sediment delivered to the River generates its high sediment load and turbidity, especially during the rainy season.

Figure 7.9 Natural landslide at the north (Nicaragua) bank of the Río San Juan observed from Costa Rican airspace at coordinates W 084o 03' 58.5'' N 10º 45' 31.5'' on 17 November, 2014. Note the temporary delta formed by sediment and fallen trees delivered directly to the river by the landslide. Sediment and trees enter the river due to natural processes to give Río San Juan naturally high sediment and debris loads and high turbidity, especially during the rainy season. Four other similar landslides were also observed during a single overflight that day. Photograph by author.

7.31. In August 2014, I took the opportunity to drive along some of the access roads linking Route 1856 to the wider road network to the south. Most of these roads pre-existed construction of Route 1856 and were practically unchanged, other stretches were new or had been improved (Figure 7.10).

7.32. Bearing in mind the stable condition of the access roads, their remoteness from the River and the scarcity of streams linking them to the River, in my opinion it is highly unlikely that sediment from these access roads reaches the Río San Juan in any appreciable quantities.

Figure 7.10 Typical views of access roads traversed during the field visit on 29 August 2014. Photographs by author.

7.33. In 2014, I revisited five mitigation sites that featured in the 2013 Thorne Report. The first site was near Marker II, where the Road approaches the Río San Juan from the west. In February 2013 the Road corridor featured extensive areas of bare soil and a developing gully along the inboard edge (Figure 7.11a). In May the area had been transformed by recently completed erosion mitigation measures including a concrete-lined, in-board ditch to convey water draining off a relatively steeply sloping stretch of the road while preventing concentrated flow erosion, and coconut matting to protect the bare soil areas from raindrop, sheet and rill erosion, while allowing it to re-vegetate naturally (Figure 7.11b). On 23 April 2014, all mitigation measures had survived the rainy season intact and by 29 August 2014 vegetation was well established along both margins of the road, colonising the areas protected using coconut matting (Figures 7.11c and d). I detected no visible erosion of the gravel road surface at this location.

Figure 7.11 The Road near Marker II (a) prior to mitigation work on 15 February 2013 (b) on 7 May 2013 with mitigation measures in place: note in-board drainage channel and extensive biodegradable, erosion control matting (c) on 23 April showing that all mitigation measures survived the rainy season and (d) on 29 August showing that vegetation has stabilized both margins of the road bed and was spreading across the areas protected by coconut matting. Photographs by author.

7.34. On 15 February 2013 I observed a gully eroding into a fill prism located to the west of Marker II (Figure 7.12a). When I revisited the same site on 7 May 2013 a culvert had been installed to convey runoff from the micro-basin beneath the road and a concrete-lined channel had been constructed to carry it down the fill slope. The surrounding fill slope surface had been protected from raindrop impact, sheet and rill erosion by extensive deployment of coconut matting (Figure 7.12b). In 2014, visits in April and August revealed that the culvert and drainage channel were performing as intended and that vegetation had re-colonised much of the area protected using coconut matting (Figure 7.12c and d). However, there was a small gully beneath the matting at one point that needed attention and the final section of the concrete channel had cracked due to uneven settlement and required repair. The need for follow-up maintenance was brought to the attention of CONAVI and maintenance was scheduled.

Figure 7.12 View down a large gully in a fill prism created by concentrated runoff from the Road draining to Costa Rican territory to the west of Marker II (a) in February when it was actively eroding and (b) in May when the gully had been back-filled and stabilized using a culvert and concrete drainage channel, with coconut matting used to protect the surrounding fill slope from sheet and rill erosion. Subsequent visits in (c) April and (d) August showed the culverted crossing to be intact after the rainy season and vegetation to be recolonizing the surrounding area. Photographs by the author.

7.35. The third location where erosion had been noted during the February field visit was about 6.4 km east of Marker II where runoff from a relatively steep stretch of road had created two gullies on the out-board slope and initial attempts at erosion control using geofabric had been unsuccessful.

Also, runoff was eroding the unlined in-board ditch. If left untreated, there was a risk that scour in the inboard ditch might undercut the toe of a cut slope at the top of hill and might trigger a landslide (Figure 7.13a). During the May visit I observed that extensive concrete drainage channels had been constructed to convey both out-board and inboard runoff down the steeply sloping stretch of road (Figure 7.13b). The channels were functioning as intended and there had been no further toe erosion of the cut slope, which appeared to be stable and unchanged from February. As the photographs taken in April and August show, erosion at this site was successfully mitigated in 2014, and vegetation is recolonizing both the fill and cut slopes (Figure 7.13a and d).

Figure 7.13 Road at East 497867, North 325463 about 6.4 km east of Marker II (a) on 15 February when failure of geotextile slope protection had allowed concentrated out-board runoff from the Road to create two gullies and in-board runoff was undercutting a cut slope (b) on 7 May 2013 after construction of concrete-lined out-board and in board ditches (c) and (d) in 2014 erosion has been effectively mitigated, the gullies have healed and both cut and fill slopes are revegetating. Photographs by author.

7.36. In February 2013, I observed a network of rills and gullies on an outboard slope about 6.6 km east of Marker 2 (Figure 7.14a). Soil eroded from the gullies had accumulated on the terrace surface but on 15 February 2013 no Road-related sediment appeared to have reached the Río San Juan. By 7 May 2013, there had been extensive mitigation work (Figure 7.14b). The gullies had been replaced by an engineered drainage system, silt fences had been installed to prevent overland flow and a sediment trap had been constructed to prevent sediment from reaching the river bank. On 23 April 2014, the area had largely revegetated and local erosion appeared to have ceased (Figure 7.14c). On 29 August 2014, I observed that the gully, rill and sheet erosion measures were still in place and functioning as intended. The watercourse crossing had also been replaced, with a larger culvert installed lower in the channel and the loose fill prism replaced by compacted soil-cement mixture to stabilize the crossing (Figure 7.14d).

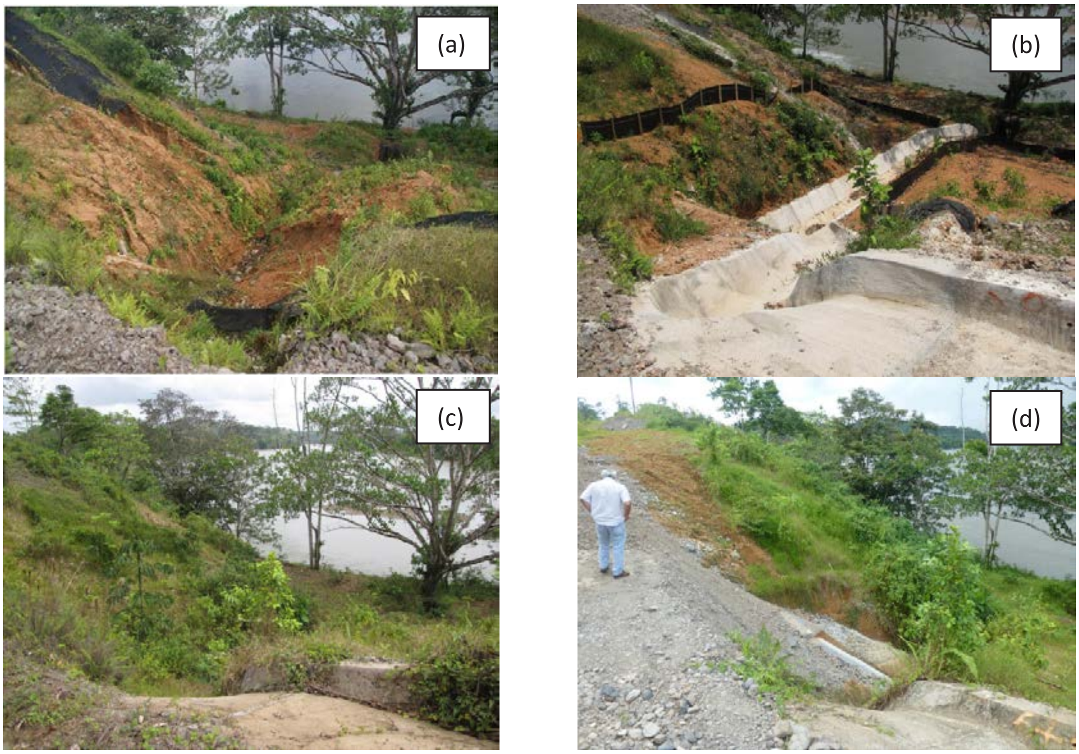

Figure 7.14 Road at East 498072, North 325345, about 6.6 km east of Marker 2 (a) on 15 February 2013 showing a network of gullies on an outboard slope and sediment accumulated as a run-out deposit on the flat terrace surface (b) on 7 May 2013 showing mitigation works (concrete channels, drop structures, silt fences and sediment trap to prevent sediment reaching the River (c) by April 2014 local erosion had ceased and the slopes had revegetated and (d) in August the undersized culvert and fill prism beneath the road at the watercourse crossing had been replaced by a larger culvert with head and exit works, covered by a compacted soil-cement mixture. Photographs by author.

7.37. In February 2013, I observed evidence of sheet and rill erosion adjacent to the road bed on a relatively steeply sloping stretch of the Road close to the Río Infiernito (Figure 7.15a). Although the lower part of the rilled area was re-vegetating naturally, I was concerned that this may not happen quickly enough to stabilize the slope during the 2013 wet season. In the event, the risk of serious future erosion at this site was reduced through a multi-element, engineering solution designed to manage surface water runoff from the road bed and adjacent disturbed slopes in an integrated manner (Figure 7.15b). In April 2014, vegetation was recolonizing previously eroding slopes though silt fences were showing signs of distress (Figure

7.15c). In August 2014, revegetation was effectively complete and the reforested area between the road and the river (not visible in the previous photographs) was flourishing. No visible erosion of the gravel road could be detected (Figure 7.15d).

Figure 7.15 Road at East 502480, North 321561, close to the Río Infiernito (a) on 15 February when surface unmanaged runoff from the road bed and surrounding slopes disturbed during construction had caused sheet and rill erosion of bare soil surfaces. (b) The same stretch of road on 7 May 2013 after protection of the road surface using crushed rock, installation of silt fences to prevent sheet and rill erosion while directing down-slope surface runoff into concrete-lined outboard and inboard ditches (c) in April silt fences were showing wear and tear, but vegetation was spreading fast and by August (d) erosion mitigation had been successful at this site. Photographs by author.

7.38. The final site between Marker II and Boca San Carlos visited on the ground on 15 February was at Crucitas just east of the crossing on the Río Infiernito. That was then as far as Route 1856 was accessible by conventional 4-wheel drive vehicle. It was possible to observe the path cleared in preparation for construction of the Road to the east. The exposed soil surface was subject to sheet and rill erosion (Figure 7.16a). On 7 May 2013, erosion had been controlled using integrated runoff management measures (Figure 7.16b). Nothing had changed significantly at this site when it was visited in April 2014 (Figure 7.16c). In August the site was photographed from the air (Figure 7.16d) as access by road was not possible due to failure of the log bridge over the Río Infiernito. It was observed that erosion mitigation continued to be successful and no sediment from this site was entering the Río San Juan. The Río Infiernito crossing site is scheduled for an engineered bridge in 2015.

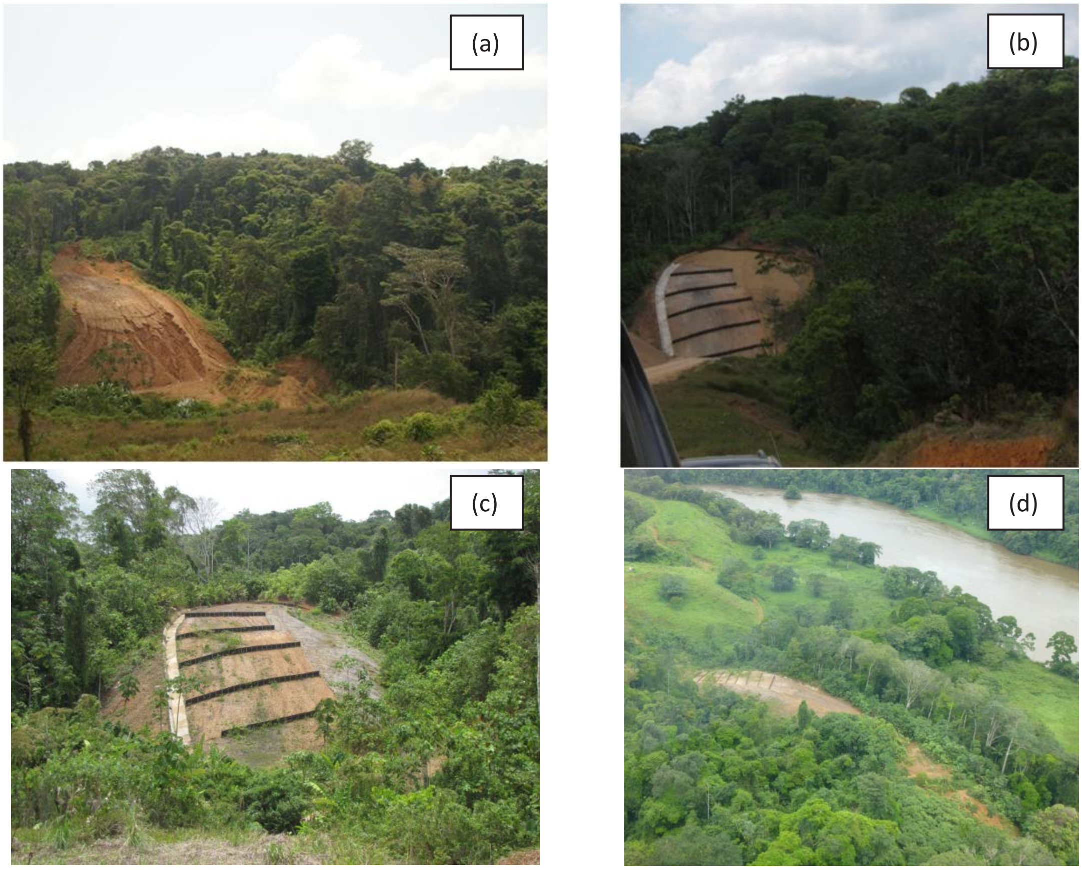

Figure 7.16 Path cleared for the Road near Crucitas, just east of the Río Infiernito (a) on 15 February when unmanaged runoff from the path cleared in preparation for construction of the road bed had caused sheet and rill erosion (b) The same area on 7 May 2013 after installation integrated measures to manage runoff involving regrading, silt fences, and concrete-lined outboard ditch (c) in April 2014, nothing had changed significantly and in August 2014 it was apparent that erosion mitigation continued to be successful and that no sediment from the site was reaching the Río San Juan. Photographs by author.

8. Conclusions

8.1. Based on the scientific and technical studies reported in this document and those to which I refer within it, I conclude that the Road has had no significant impact on the hydrology of the Río San Juan.

8.2. The Road has had no significant impact on sediment transport in the Río San Juan because the quantity of additional sediment derived from the Road is tiny compared to the heavy sediment load that was already being carried by the Río San Juan prior to construction of the Road. Also, the additional load from the Road is indiscernible due to high seasonal and inter-annual variability in sediment supplies from other sources and complexity in sediment transport processes.

8.3. In the reach upstream of Boca San Carlos the morphology of the Río San Juan is insensitive to changes in the sediment load because its morphology is controlled by bed rock rapids that fix the channel form, bed elevation, long profile and slope. The morphological impacts of Road-derived sediment are restricted to deposition of coarse clasts on small sediment deltas along the south bank that are concentrated in a short reach upstream of Boca San Carlos. Morphologically similar, but generally larger deltas also exist along the Nicaraguan side of the River. Downstream of Boca San Carlos, the Río San Juan is responsive to changes in sediment supply, but the sediment regime is dominated by naturally high inputs, particularly from the mountainous, tectonically and volcanically-active San Carlos and Sarapiquí basins.

8.4. There is absolutely nothing to suggest that the Road has adversely impacted the water quality, fishes or fisheries in the River or the coastal area around its outfalls. This is to be expected as expert opinion and evidence from other rivers in the region suggest that fish species in the Río

San Juan are well adapted to high and seasonally variable sediment loads and concentrations.

8.5. Differences in communities of periphyton and macroinvertebrates sampled in deltas along the banks of the Río San Juan may be attributed to contrasts in drainage area, vegetation and land use in micro-basins draining to deltas along the north and south banks that were not controlled for in the study by Dr Rios. Differences between the periphyton and macroinvertebrate communities associated with large, friable clasts of Road-derived sediment and those associated with older, rounded stream gravels probably result from the short time that Road-derived sediment has been in the fluvial system and cannot be taken as evidence of pollution or habitat degradation.

8.6. There is no scientific justification for '*active efforts, including dredging, to maintain the capacity and quantity of the river's waters*' in the lower Río San Juan on the pretext of having to remove Road-derived sediment. Coarse load and deposition calculations using an upper bound estimate of the amount of Road-derived coarse sediment entering the lower Río San Juan suggest that this is indiscernible compared to pre-existing coarse load, especially when allowance is made for uncertainty concerning estimation of the bedload carried by the River and the proportions in which flow and sediment are divided when flow bifurcates at the Delta.

8.7. Sediment continuity dictates that even if all of the coarse Road-derived sediment supplied to the lower Río San Juan in one year according to Dr Andrew's estimate (which I do not accept) were to be deposited on the bed of the channel within the first three kilometres downstream of the Delta it would, on average, raise the bed of the river by less than 5 to 10 mm.

8.8. In fact, sand deposition is not restricted to the first three kilometres of the lower Río San Juan, but is distributed along its entire length. This is evident because:

(a) the lower Río San Juan has a mobile sand bed throughout its length;

(b) the micro-delta at the end of the lower Río San Juan (30 kilometres downstream of the Delta) continues to grow; and

(c) Nicaragua's dredging programme includes more than 20 sites downstream of the first three kilometres of the lower Río San Juan where the bed has been dredged to remove accumulating sand (see sketch map 5.1 on page 229 of Costa Rica's Memorial in the Certain Activities case).

8.9. Even according to Dr Kondolf's over-estimate (which I do not accept) the contribution of sediment from the Road is tiny (less than 3% of the mean annual sediment load in Río San Juan). Using the more reliable upper bound estimates reported herein the contribution is probably less than 1% of the mean annual load of the River. In either case, this contribution would in practice be indiscernible, due to uncertainty and naturally variability in quantity of sediment carried by the Río San Juan.

8.10. The Road has not caused harm to the hydrology, sediments, morphology, environment, or ecology of the River, all of which are well-adapted to the heavy load and highly variable sediment regime this River has experienced for millennia due to its geology and climate.

8.11. Based on Professor Fallas' expert meteorological review, and my understanding of rainfall driven erosion, it is highly unlikely that the Road will be catastrophically eroded in the event that a future Hurricane or Tropical Storm affects Costa Rica. This is the case because the cyclonic nature of the wind pattern associated with a Hurricane or Tropical Storm, coupled with the existence of high mountains to the west and south of the San Juan Basin mean that rainfall amounts and intensities in the area of the Road would probably not be exceptionally high even should a Hurricane or Tropical Storm affect Costa Rica. Dr Kondolf is incorrect to suggest that the occurrence of a Hurricane or Tropical Storm would result in unprecedented sediment loads and concentrations of sediment being input from the Road to the Río San Juan.

8.12. The area of the basin disturbed construction of the Road is much smaller than those disturbed by earthquakes and volcanic eruptions that are known to have delivered exceptional quantities of sediment to the Río San Juan drainage system frequently during the last three centuries. For example, the area of landslides documented in the immediate vicinity of the Cinchona earthquake of December 2009 was nearly 22 km^2. While the overall area disturbed during construction of the Road in 2011 was only 3.5 km^2.

8.13. Dr Andrews' estimate of the natural load of the river is based on data from tectonically-stable basins and it is therefore entirely inapplicable to the San Juan Basin.

8.14. The exceptionally high sediment loads associated with seismic and volcanic events do not cause harm to the hydrology, sediments, morphology, environment, or ecology of the River and the far smaller contribution from the Road has no potential to do so whatsoever. For example, according to Alvarado (2010), the Cinchona earthquake alone supplied 2.5 to 3.5 million m^3 of sediment (equivalent to 4 to 6 million tonnes) to the Río San Juan drainage system. Even if Dr Kondolf's over-estimate of sediment delivery from the Road and its feeder roads

(116,000-150,000 m^3 - equivalent to 194,000 to 250,000 t) were accepted (and it is not), by his reckoning the contribution from the Road would still be 3 to 6% of that from a *single seismic event*.

8.15. The concerted effort being made by CONAVI and CODEFORSA to mitigate erosion along the Road is making progress and will continue. At the time of writing the 2013 Thorne Report, mitigation had taken place around Marker II and in the vicinity of Tiricias. In 2014, dozens more sites have been mitigated, at locations along the length of the Road alongside the River between Marker II and Delta Costa Rica that include several of those that were classified earlier in 2014 by Dr Kondolf as 'severely eroding'. Planning for completion of Route 1856 is now well advanced and the Road should be constructed to the highest standards and as quickly as possible to provide a permanent solution to erosion issues along the Road.

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10. Statement of Independence and Truth

10.1. I affirm the statement of independent and truth given in my Report of December 2014, which is Appendix A to Costa Rica's Rejoinder.

10.2. The opinions I have expressed in this Report represent my true and complete professional opinion. Where I have relied on the outputs of field and analytical work performed under my supervision by the technical team or facts supplied to me by those instructing me, I have noted this in my Report.

10.3. I understand that my overriding duty is to the Court, both in preparing this Report and in giving oral evidence, if required to give such evidence. I have complied and will continue to comply with that duty.

10.4. I have set out in my Report what I understand from those instructing me to be the questions in respect of which my opinion as an expert is required. I have done my best, in preparing this Report, to be accurate and complete. I have mentioned all matters that I regard as relevant to the opinions that I have expressed. I consider that all the matters on which I have expressed an opinion are within my field of expertise. I have drawn the attention of the Court to all matters, of which I am aware, which might adversely affect my opinion.

10.5. In preparing this Report, I am not aware of any conflict of interest actual or potential which might impact upon my ability to provide an independent expert opinion.

10.6. I confirm that I have not entered into any arrangement where the amount or payment of my fees is in any way dependent on the outcome of this proceeding.

10.7. In respect of matters referred to which are not within my personal knowledge, I have indicated the source of such information.

10.8. I have not, without forming an independent view, included anything which has been suggested to me by others, including the technical team and those instructing me.

10.9. At the time of signing this Report I consider it to be complete and accurate subject to any qualifications noted herein. I will notify those instructing me if, for any reason, I subsequently consider that the Report requires any material correction or qualification.

10.10. I understand that this Report will be the evidence that I will give, if required, under oath, subject to any correction or qualification I may make before swearing to its veracity.

10.11. The substance of all facts and instructions given to me which are material to the opinions expressed in this Report or upon which those opinions are based are reflected in my Report.

10.12. I confirm that I have made clear which facts and matters referred to in this Report are within my own knowledge and which are not. Those that are within my own knowledge I confirm to be true. The opinions I have expressed represent my true and complete professional opinion.

…………………………………………

Professor Colin Thorne
2 Parker Gardens,
Nottingham,NG9 8QG, UK

February 2015

Certification

I have the honour to certify that the documents annexed to this Rejoinder are true copies and conform to the original documents and that the translations into English made by Costa Rica are accurate translations.

Ambassador Sergio Ugalde
Co-Agent of Costa Rica

List of annexes

Vol II: Technical and Environmental Reports

Vol III: Technical and Environmental Reports

Vol IV: National Legislation, Diplomatic Correspondence, Minutes of meetings, Affidavits, Media Reports, Other Documents and Photographs

VOLUME II

VOLUME III

VOLUME IV

Minutes

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Other Documents

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