# CERTAIN ACTIVITIES CARRIED OUT BY NICARAGUA IN THE BORDER AREA

# (COSTA RICA V. NICARAGUA)

# COUNTER-MEMORIALOF THE REPUBLIC OF NICARAGUA

## ON COMPENSATION

# Annexes

## LIST OF ANNEXES

# Annex 1

Cymie R. Payne & Robert E. Unsworth, Report on Environmental Damage Valuation

26 May 2017

International Court of Justice

Case Concerning Certain Activities Carried Out by Nicaragua in the Border Area

Compensation

Costa Rica v. Nicaragua

# Report on Environmental Damage Valuation

Professor Cymie R. Payne, J.D.,

Rutgers University

and

Robert E. Unsworth,

Industrial Economics, Incorporated

26 May 2017

## EXECUTIVE SUMMARY

Costa Rica seeks USD 2,880,745.82 in compensation for environmental damage as one component of the compensation for material damages owed by Nicaragua. The damage claimed includes several ecosystem services: loss of standing timber, raw materials (fibre and energy), gas regulation/air quality, natural hazards mitigation, soil formation/erosion control, and habitat and nursery services.

International law, and many domestic legal regimes, recognize environmental damage as compensable. The UN Compensation Commission (UNCC), in particular, developed substantive and procedural approaches to assessing, verifying and valuing such claims. Claims for environmental damage, like Costa Rica's, are subject to the requirements of demonstrating actual loss that is causally related to the illegal act, and subject to the injured State's duty to mitigate the harm. Both restitution and compensation are appropriate means of reparation for environmental damage.

As the scope of compensable damage includes both resources that have an ascertainable market value and pure environmental damage, valuation methods for the latter have been developed. For its valuation of environmental services, Costa Rica uses an analysis performed by Fundacion Neotropica which applies an "ecological economics" approach to estimate monetary damages associated with Nicaragua's construction of two caños and clearing of trees and vegetation in the Costa Rican territory on Isla Portillos. This approach involved the identification of six "ecosystem services" that were provided by the habitat at this site prior to Nicaragua's actions. These six services are then valued using existing value estimates from past work and the ecological economics literature addressing values of services at other locations.

It is our opinion that the monetary valuation approach used by Neotropica is not consistent with accepted practice in the field of natural resource damage assessment, and that the damage estimate they generate using this method is not reliable or appropriate for assigning damages. Specifically,

- Services are valued which were not lost (e.g., soil formation and natural hazards mitigation).
- Capitalized value estimates are treated as annual values, and thus these values are counted multiple times over the analysis period (e.g., the value of the timber that was cut is included for each of the 50 years of the analysis).
- No recovery of services is assumed for 50 years.
- Values from the literature addressing very dissimilar circumstances are used to represent values in this case.
- Mistakes are made in how the stock values of environmental services are combined with flow values.

To provide a more reasonable measure of the monetary damage in this case, we estimate losses using the approach selected by Neotropica, correcting the errors contained in that analysis and its unsupportable assumptions. This results in a corrected "ecosystems services" valuation of USD 84,000.

We separately assess the environmental damage in question using a more appropriate monetization technique, which involves calculating the cost of conservation actions to off-set the harm as described by Costa Rica. Applying this approach, it is our opinion that the monetary value of harm in this case is on the order of USD 27,034 to USD 34,987, which reflects the funds required to support a 20- to 30-year replacement program based on the cost of purchasing conservation credits.

## QUALIFICATIONS OF THE AUTHORS

*Cymie Payne* is Associate Professor at Rutgers University, The State University of New Jersey, where she teaches courses in environmental law, climate change law and international environmental law. Her areas of research focus on international law relating to environment and natural resources. She was a team leader and legal officer for the environmental claims program of the United Nations Compensation Commission in Geneva, Switzerland, throughout the claims review and for the Follow-up Programme for environmental awards. She has appeared as legal counsel on behalf of the International Union for Conservation of Nature (IUCN) before the International Tribunal for the Law of the Sea in its deep seabed mining and fisheries advisory opinion cases. Currently, she is legal advisor to the IUCN delegation to the preparatory committee for development of an international legally binding instrument under the UN Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction. She was Director of the Global Commons Project and Associate Director of University of California Berkeley's Center for Law, Energy and the Environment. She practiced natural resource and environmental law with the U.S. Department of the Interior and the law firm of Goodwin, Procter. She serves on the World Commission on Environmental Law of the IUCN, the International Law Association Committee on Sustainable Natural Resource Management for Development and is a former member of the American Society of International Law Executive Council. She holds a J.D. from University of California Berkeley School of Law and a M.A. from the Fletcher School of Law and Diplomacy.

*Robert Unsworth*, a Principal and Director with Cambridge, Massachusetts based Industrial Economics, Incorporated (IEc), is an internationally recognized expert in the field of natural resource economics and environmental damage assessment. His practice focuses on identifying appropriate methods for valuing environmental change in the context of complex environmental litigation, regulatory development, natural resource management, and public policy decision making. In his 32 years of experience he has addressed the full-range of issues encountered in natural resource damage assessment and subsequent environmental restoration. He has published on this topic in professional journals, including the seminal paper on Habitat Equivalency Analysis. He has served as an expert witness in cases involving claims for environmental damage caused by wildland fires, legacy hazardous waste releases, and illegal ecosystem alteration. He has authored guidance documents on best practices for natural resource and environmental valuation, including approaches for assessing damages to wetlands, forested ecosystems, and aquatic systems; indigenous community impacts; cultural and recreational resources; and groundwater.

Mr. Unsworth's experience relevant to this opinion includes assisting the United Nations Compensation Commission in the identification and review of available methods for valuing environmental damages

resulting from the 1990-1991 Gulf War. This effort included developing briefings for the Commission on available economic valuation and costing methods, including the strengths and weaknesses of these methods in the context of environmental claims. He served as an expert economist for State and Federal agencies acting as Natural Resource Trustees in negotiations with BP over damages resulting from the *Deepwater Horizon* oil spill. He was an expert reviewer of proposals and work product related to the development of methods for determining compensation for environmental harm under the European Union's Environmental Liability Directive. For the World Commission on Dams, he authored a report describing the potential uses of welfare economics for sound assessment of the environmental and social impacts of world-scale hydropower dam projects. He recently presented at an invited seminar on the Protection of the Environment in Relation to Armed Conflict, sponsored by the Permanent Missions to the United Nations of Sweden, Denmark, Finland, Iceland and Norway, in support of ongoing work of the United Nations International Law Commission.

Mr. Unsworth holds a Master of Forest Science degree from Yale University (focus on natural resource and environmental economics), and a Bachelor of Science *magna cum laude* in Forestry (focus on forest economics) from the State University of New York, College of Environmental Science and Forestry. He has lectured on the topic of environmental damage assessment at Tufts University, Yale University, Boston College Law School, and the University of Houston Law Center, and at numerous professional seminars.

Curricula vitae can be found in Appendix B.

## I. INTRODUCTION

We have been asked to provide our expert opinion on the legal and technical aspects of assessing and valuing compensation for environmental damage resulting from construction of two *caños* and clearing of trees and vegetation in the Republic of Costa Rica (Costa Rica) by the Republic of Nicaragua (Nicaragua) in 2010 and 2013. We were also asked to assess whether the monetary valuation of damages contained in the report by Fundación Neotropica (Neotropica) for Costa Rica is consistent with accepted practice in the field of natural resource damage assessment, and whether the monetary damage estimate they present is reliable and appropriate for assigning damages. Finally, we were asked to provide our independent opinion of damages in this matter.

In developing this opinion, we reviewed the Neotropica Report,[1] various documents related to Costa Rica's claim,[2] published and unpublished authorities on international and international environmental law, and related environmental and ecological economics literature.

Below we first discuss the legal principles of environmental reparations and the economic standards and principles of sound environmental damage assessment. We then compare the approach taken by Neotropica against those standards and principles, provide a detailed review of the assumptions and calculations used by Neotropica, and present a corrected estimate of loss based on their approach. Finally, we provide our opinion as to a reasonable monetary measure of loss in this matter, based on standard environmental valuation methods.

## II. LEGAL PRINCIPLES FOR ENVIRONMENTAL REPARATIONS

Evaluating a State's obligation to provide reparations for damage to natural resources requires application of the international law of reparations to the relatively novel subject matter of environmental harms. Providing compensation for environmental injury has become increasingly common. International bodies like the UN Compensation Commission (UNCC),[3] regional entities like the European Union, and national legal systems

---

[1] Fundacion Neotrópica, Report on Monetary Valuation, 3 June 2016, Costa Rica Memorial, Vol I, Annex 1.

[2] Costa Rica Memorial, Vol. I and Vol. II. Kondolf, G. Mathias, 2012 Distributary Channels of the Río San Juan, Nicaragua and Costa Rica: Review of Reports by Thorne, UNITAR, Ramsar, MEET, and Araya-Montero Kondolf, G. Mathias, 2014. Erosion and Sediment Delivery to the Río San Juan from Route 1856.

[3] The UN Compensation Commission was established by UN Security Council Resolution 687; it reviewed 168 claims for environmental losses caused by Iraq's illegal invasion and occupation of Kuwait 1990-1991. Of USD 85 billion claimed, the Commission awarded USD 5.3 billion for 109 successful claims. All environmental awards have been fully paid to the claimants. It has been said that "the Environmental Programme carried out with UNCC award funds and partly overseen by the UNCC may be the largest and most complex environmental cleanup project in human history."

including the 27 member states of the EU[4] and the United States, provide remedies for both market and non-market environmental losses as urged by Stockholm Declaration Principle 22.[5] The most extensive practice in this area is found in the work of the UNCC's environmental program and in U.S. natural resource damage remedies.[6] The European Union's Environmental Liability Directive (ELD), based on the "polluter pays" and sustainable development principles, establishes minimum standards for environmental liability and compensation.[7] The International Oil Pollution Compensation Funds operate somewhat differently.[8] Those civil liability treaties, amongst the first, were created with a stronger emphasis on risk-spreading to facilitate the financial viability of maritime shipment of persistent oil while providing a measure of recovery for victims of oil spills that sometimes result.[9]

---

UNCC, Post-Conflict Environmental Restoration (2013) 3, available at uncc.ch.

[4] European Commission, Report from the Commission to the Council and the European Parliament under Article 18(2) of Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage (2016) 2.

[5] Report of the United Nations Conference on the Human Environment, Stockholm, 5-16 June 1972. See also, Rio Declaration, Principle 13, Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992, vol. I: Resolutions adopted by the Conference, resolution 1, annex I.

[6] U.S. Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 U.S.C. Sec. 9601 et seq.; U.S. Oil Pollution Act of 1990, 33 U.S.C. 2701 et seq.; Federal Register: The Daily Journal of the United States, Consumer Price Index Adjustments of Oil Pollution Act of 1990 Limits of Liability—Vessels, Deepwater Ports and Onshore Facilities, 80 Fed. Reg. 72342 (2015) (U.S. Oil Pollution Act is intended to deter incidents and breaches of law under the "polluter pays" principle).

[7] EU Council Directive 2004/35/EC of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, OJ L143/56 (2004), as amended by Council Directive 2006/21/EC, OJ L102, Council Directive 2009/31/EC, OJ L140, and Council Directive 2013/30/EU, OJ L170, Preamble (14), Article 2(1); hereinafter EU ELD.

[8] International Convention on Civil Liability for Oil Pollution Damage, 1992; International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1992. The scope of this report does not allow for discussion of other international agreements the provide for environmental liability and compensation, such as the 2001 International Convention on Civil Liability for Bunker Oil Pollution Damage (Bunker Oil Convention), IMO document LEG/CONF.12/DC/1, or the 1963 Vienna Convention on Civil Liability for Nuclear Damage, 2 ILM (1963) 727 and its Protocol.

[9] Having evolved from the 1969 International Convention on Civil Liability for Oil Pollution Damage, the Funds define compensable pollution damage to exclude pure environmental damage. 1992 Civil Liability Convention, Articles I(6), III. Inconsistent with current international decisions, this can also conflict with the national law of countries where incidents occur, as for example, when the French Cour de Cassation awarded €4.3 million for pure environmental damage as a result of the Erika oil spill. IOPC Funds, IOPC/APR13/3/3 – Incidents involving the IOPC Funds - 1992 Fund: Erika, sections 4.12, 5.2, 5.5 (2013), available at: http://documentservices.iopcfunds.org/meeting-documents/download/docs/3688/lang/en/ *See*, Joe Nichols, Scope of Compensation for Environmental Damage under the 1992 Civil Liability Convention and the 1992 Fund Convention, in Marine Resource Damage Assessment, Liability and Compensation for Environmental Damage, 59–66 (F. Maes (ed.) Springer, 2005).

## *A. Assessment of environmental damage compensation*

This section of the report will discuss the assessment of environmental damage compensation, drawing primarily on the UNCC practice.

Any environmental damage claim is subject to the requirements of demonstrating actual loss that is causally related to the illegal action. Sufficient evidence of the circumstances and amount of the damage or loss must support a claim for compensation of environmental loss.[10] Given the context—international reparations in the aftermath of a major armed conflict—the UNCC took an active fact-finding approach by engaging its own expert consultants, which eased the burden on the claimants to some extent. Nonetheless, failure to provide sufficient evidence of the fact of damage, the extent of damage, the location of damage, the causal link to Iraq's illegal acts, and the value of damage were the most common reasons for the UNCC to deny or reduce the amount of an award.[11] The reductions, taken for various reasons including evidentiary gaps, were substantial: the total amount awarded, USD 5.3 billion, was about six percent of the total amount claimed, USD 85 billion.

Quantification of environmental damage is often challenging because it ideally requires both baseline measurements of the aspects of the environment that are subsequently harmed, and current measurements of conditions at the time of adjudication; the natural recovery that usually begins immediately after injury should be taken into account. This kind of information is frequently not readily available.[12]

As illustration of the kinds of information that are required, Iran sought USD 900 million for remediation of cultural heritage resources that it claimed had been damaged by pollution from the oil well fires in Kuwait, but the claim failed because, the UNCC report states, it did not "clearly describe or identify the nature and extent of the damage to the cultural heritage artefacts and sites that are the subject of the claim … Iran [did]

---

[10] UNCC, Governing Council decision 10 (Provisional Rules), S/AC.26/1992/10 (2010) art. 35(3)(claims of governments "must be supported by documentary and other appropriate evidence sufficient to demonstrate the circumstances and amount of the claimed loss"); Governing Council Decision 7, S/AC.25/1991/7/Rev.1 (1991, rev. 1992), para. 37 ("Since these claims will be for substantial amounts, they must be supported by documentary and other appropriate evidence sufficient to demonstrate the circumstances and the amount of the claimed loss"); Governing Council Decision 46, S/AC.26/ 46 (1998). In U.S. law, "injury" is defined as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service", therefore evidence of such a change would be required to obtain a natural resource damage award. 15 C.F.R. §990.30, 43 C.F.R. §11.14(v).

[11] For example, UNCC F4 third instalment, paras. 38, 39.

[12] UNCC, Report and Recommendations made by the Panel of Commissioners Concerning the First Instalment of "F4" Claims, U.N. doc. S/AC.26/2001/16 (2001) para. 34, hereinafter, UNCC F4 first instalment.

not present[ ] sufficient evidence identifying the specific locations, materials, and the extent of contamination of the cultural heritage sites that it claims were damaged."[13]

Claims for expenses incurred in relation to environmental losses remain subject to standard evidentiary requirements. Thus, the UNCC made no award for groundwater pollution monitoring studies because Kuwait did not provide documentary evidence for the costs, such as invoices and receipts, although the claims were otherwise sufficiently supported.[14]

Claims for compensation for environmental damage are also subject to the injured State's duty to mitigate the harm. The UNCC environmental panel explained that the duty of injured states to mitigate environmental losses is "a necessary consequence of the common concern for the protection and conservation of the environment, and entails obligations towards the international community and future generations."[15] It found that "the failure of Kuwait to take the necessary measures in the face of a clear risk of damage [from improperly stored ordnance] was the direct cause of the resulting damage, and this broke the chain of causation so as to relieve Iraq of liability for the loss."[16] The UNCC also found that, in situations where a claimant faced multiple threats of severe environmental harm, exceeding its ability to address them all, the reasonableness of the measures taken must be assessed in the context of the circumstances.[17]

The International Law Commission's Draft Articles on State Responsibility, Articles 34, 35, 36 and 37, indicate that, in order of preference, restitution, compensation, and satisfaction are to be provided for full reparation. The UNCC was structured to provide only financial compensation. However, in other environmental damage regimes, the responsible party is often not only allowed but required to undertake

---

[13] UNCC, Report and recommendations made by the Panel of Commissioners concerning the fifth instalment of "F4" claims, S/AC.26/2005/10 (2005), paras. 204, 207, hereinafter UNCC F4 fifth instalment.

[14] UNCC F4 first instalment, paras. 381-383.

[15] UNCC, Report and recommendations made by the Panel of Commissioners concerning the third instalment of "F4" claims, UN Doc. S/AC.26/2003/31 (2003) para. 42, hereinafter, UNCC F4 third instalment. See also, UNCC Governing Council Decision 15, S/AC.26/1992/15 (1992) para. 9(d); Peter H. Sand, Environmental Principles Applied, in Gulf War Reparations and the UN Compensation Commission: Environmental Liability (CR Payne and PH Sand, eds. Oxford University Press 2011)186-187, hereinafter Payne & Sand; David D. Caron, The Profound Significance of the UNCC for the Environment, in Payne & Sand, 271-272.

[16] UNCC, Report and recommendations made by the Panel of Commissioners concerning part one of the fourth instalment of "F4" claims, U.N. Doc. S/AC.26/2004/16 (2004) paras. 206 and 216 (Kuwait sought USD 653.8 million for the two claims, no award was made), hereinafter, UNCC F4 fourth instalment, part 1.

[17] UNCC F4 third instalment, para. 43.

remediation activities itself.[18] States could cooperate to the extent that restitution would be possible, where the responsible State would undertake environmental restoration activities in the injured State. This can be the most efficient and effective approach; frequently in the United States, natural resource damage cases are resolved through settlements that produce more environmental benefits at lower cost than a court judgment would have provided.

When the breach of an obligation results in harm to the environment, reparations may be owed for several aspects of the damage. Under UNCC Governing Council decision 7, paragraph 35, these included: response costs for abatement and prevention of environmental damage; monitoring and assessment of the damage undertaken for the purpose of "evaluating and abating the harm and restoring the environment"; reasonable measures already taken or future measures which can be documented as reasonably necessary to clean and restore the environment; public health monitoring; and depletion of or damage to natural resources.[19]

Similarly, the U.S. Oil Pollution Act provides compensation for the cost of: restoring, rehabilitating, replacing, or acquiring the equivalent of the damaged natural resources to return the resource to "baseline" condition;[20] the diminution in value of those natural resources pending restoration; plus the reasonable cost of assessing those damages.[21]

Comparable terms are used in the EU Liability Directive, which provides for remediation of the injured environment (primary remediation); and "complementary" and "compensatory" remediation for environmental losses when remediation has not fully restored the injury, sometimes called interim losses (secondary remediation), as well as "costs of assessing environmental damage, an imminent threat of such

---

[18] "In line with the polluter-pays principle, the liable operator must take the necessary preventive or remedial action and must bear all costs. Damage is considered to be remedied once the environment has been returned to its pre-damage state." European Commission, Report from the Commission to the Council and the European Parliament under Article 18(2) of Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage, COM/2016/0204 (2016) 2. *See also*, REMEDE, Deliverable No. 7: Assessment of Current Practice Regarding Environmental Liability in Member States (2007) Table 3.4.

[19] UNCC, Governing Council decision 7, para. 35.

[20] Baseline is the condition of the resource before the injury. Although not derived from the *Factory at Chorzów* standard, this is consistent with it.

[21] Oil Pollution Act, 33 USC 2706. The implementing regulations further define restoration as, "Any action . . . or combination of actions . . . to restore, rehabilitate, replace, or acquire the equivalent of injured natural resources and services. Restoration includes: (a) Primary restoration, which is any action, including natural recovery, that returns injured natural resources to baseline; and (b) Compensatory restoration, which is any action taken to compensate for interim losses of natural resources and services that occur from the date of the incident until recovery." 15 C.F.R. §990.30.

damage, alternatives for action as well as the administrative, legal, and enforcement costs, the costs of data collection and other general costs, monitoring and supervision costs."[22] For the UNCC, these collectively constituted a remedy consistent with the ILC Draft Articles on State Responsibility and the reparation standard of the *Factory at Chorzów* case.[23]

Examples from the UNCC illustrate these heads of damage: monitoring and assessment; primary remediation; and compensatory remediation. Among the 107 claims for the cost of monitoring and assessing "environmental damage, depletion of natural resources, monitoring of public health, and performing medical screenings" that the UNCC reviewed, the Kingdom of Saudi Arabia (Saudi Arabia) submitted several monitoring and assessment claims.[24] In one of these, Saudi Arabia—whose Persian Gulf coast was contaminated by the majority of the 6-12 million barrel oil spill from the conflict—sought compensation to monitor and assess the damage to its coastal and marine resources from the oil spills.[25] It received an award for a detailed shoreline study, which was promptly conducted; the study indicated that more than 600 kilometres of coastline had been contaminated by oil from the conflict and that this caused severe, persistent environmental damage to ecological function in the intertidal zone.[26]

Based on this and other information, the UNCC made a finding that the harm did in fact result from the conflict[27] and awarded compensation to Saudi Arabia based on the cost of a primary remediation program to clean and restore its injured coastal environment.[28] The work was projected to take on the order of 25-40 years to restore the coastline, in part because the UNCC found that active remediation would cause further damage and natural recovery was ecologically more sound—the kind of situation that gives rise to interim

---

[22] ELD, Article 2(16), Annex II(1); Ministry of the Environment, Finland, Remediation of Significant Environmental Damage Manual on Procedures (Helsinki, 2012) 55, hereinafter, Manual on Procedures, Finland.

[23] *Case Concerning the Factory at Chorzów, Germany v. Poland*, Permanent Court of International Justice, Series A, No. 17 (1928) 47; Commentary on articles 31 and 36 of the Draft Articles on State Responsibility for Internationally Wrongful Acts, in Report of the International Law Commission on the Work of its Fifty-third Session, UN GAOR, 56th Sess., Supp. No. 10, UN Doc. A/56/10 (2001).

[24] UNCC F4 first instalment, para. 3; Thomas H. Mensah, Foreword, in Payne & Sand, xviii-ix ("as a means for environmental protection and the basis on which such activities may legitimately be compensated"). Thomas Mensah was the chair of the Panel of Commissioners reviewing the environmental claims.

[25] UNCC F4 first instalment, para. 538.

[26] UNCC F4 third instalment, para. 172.

[27] UNCC F4 third instalment, paras. 176-8.

[28] UNCC F4 third instalment, paras. 184-186.

losses. Thus, Saudi Arabia also sought compensatory remediation, which included a project to create several shoreline reserves.[29] The UNCC agreed that the primary restoration for which compensation had been provided would not fully compensate the loss and that compensatory remediation was appropriate, stating:

> … two shoreline preserves with a total area of 46.3 square kilometres and operated for a 30-year period, would sufficiently compensate for Saudi Arabia's losses in ecological services in its intertidal shorelines. The Panel considers that such preserves, sited in habitats similar to those that have been damaged, would provide ecological services similar in kind to those that were lost. In the view of the Panel, such preserves are feasible, cost-effective and pose a low risk of adverse impacts. The Panel also notes that these preserves would provide benefits to wildlife as well as offer compensation for the damage to subtidal habitats[30]

The amount awarded was USD 46 million, a reduction from the USD 5.36 billion sought by Saudi Arabia, based on adjustments to certain costs, elimination of some costs due to lack of evidence, and "differences in the severity of oil contamination, losses in ecological services and expected recovery times in different areas," a variability that Saudi Arabia had not fully taken account of.[31]

Some of the requirements that claimants need to satisfy are seen in other claims that Saudi Arabia made for compensatory remediation that received no awards. One, based on the loss of wildlife, was rejected for insufficient evidence.[32] Another claim for ecological losses to shrimp and grouper fisheries from 1990 to 2001, based on lost catch figures and planned restocking projects, was rejected on the basis of insufficient evidence as well as inappropriate methodology.[33] Finally, a claim that proposed compensatory projects was rejected because it did not provide sufficient information to allow the UNCC to evaluate the technical merits of the programs, their relevance to specific losses, and their potential overlap with other projects proposed by Saudi Arabia.[34]

---

[29] UNCC F4 fifth instalment, paras. 611.

[30] UNCC F4 fifth instalment, paras. 630, 632.

[31] UNCC F4 fifth instalment, paras. 631, 633.

[32] UNCC F4 fifth instalment, paras. 650-663.

[33] UNCC F4 fifth instalment, paras. 664-675.

[34] UNCC F4 fifth instalment, paras. 676-682.

As the UNCC examples just provided illustrate, compensable environmental damage may include harm to natural resources with readily ascertainable market values, such as timber or fish, as well as to non-marketed environment goods and services, such as intertidal habitat or carbon sequestration. The International Law Commission describes compensation as a financial transfer that can "cover any financially assessable damage."[35] Some have argued that the loss of resources that are not traded in the market is not "financially assessable,"[36] and therefore there is no legal justification for compensating such losses. However, this ignores the International Law Commission's further explanation that "the qualification 'financially assessable' is intended to exclude compensation for the affront or injury caused by a violation of rights not associated with actual damage to property or persons."[37] That is, "financially assessable" is not intended to exclude losses to nonmarket resources, which are "actual damage." The UNCC stated that "there is no justification for the contention that general international law precludes compensation for pure environmental damage."[38]

## *B. Valuation of non-market environmental damage*

This section discusses methods for valuing non-market environmental damage, including those used by the UNCC.

The seeming novelty of claims for pure environmental damage stems from the extraordinary increase over the last 50 years in scientific understanding of how environmental systems—like the water cycle, biodiversity, soil formation, and the carbon cycle—function, and human society's fundamental reliance on their integrity.[39] Because of this, the UNCC, the EU ELD, and other legal regimes are called to assess compensation for pure environmental damage. In doing so, the UNCC applied the *Chorzów* standard—that compensation should "re-establish the situation which would, in all probability, have existed if that act had not been committed"—in light of "the location of the damaged environment or resource and its actual or potential uses; the nature and

---

[35] ILC art. 36; Factory at Chorzów, 29.

[36] UNCC F4 fifth instalment, para. 46.

[37] ILC, "Draft articles on Responsibility of States" 99.

[38] UNCC F4 fifth instalment, para. 58. See also, ELD, preamble (14), which excludes from its scope the following: personal injury, damage to private property and to economic loss. Its scope of coverage is similar to other natural resource damage regimes, including damage to protected species and natural habitats, damage to water and damage to soil.

[39] See, e.g., Millennium Ecosystem Assessment, Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC. Available at: http://www.millenniumassessment.org/documents/document.356.aspx.pdf.

extent of the damage; the possibility of future harm; the feasibility of the proposed remediation measures; and the need to avoid collateral damage during and after the implementation of the proposed measures."[40] In particular, the UNCC emphasized "restoring the environment to preinvasion conditions, in terms of its overall ecological functioning rather than on the removal of specific contaminants or restoration of the environment to a particular physical condition."[41] A consequence of this was that for both Kuwait and Saudi Arabia, the UNCC refused to fund the expensive and environmentally damaging removal of oily residues on desert and coastal surfaces, although it meant that those places would remain visually sullied by the conflict for a considerable amount of time to come.[42]

Another consideration particular to environmental claims is that they are usually handled as public claims where the government stands in the role of a trustee with fiduciary responsible for "a community interest in full remediation of the damage."[43] The UNCC environmental panel described the environment as a common concern that "entails obligations towards the international community and future generations."[44] The EU ELD states that interim losses do "not consist of financial compensation to members of the public,"

---

[40] UNCC F4 third instalment, para. 47.

[41] UNCC F4 third instalment, para. 48.

[42] UNCC F4 third instalment, paras. 126-129, 179-182.

[43] Sand, Environmental Principles Applied, in Payne & Sand 173-190; David D. Caron, The Place of the Environment in International Tribunals, in The Environmental Consequences of War: Legal, Economic and Scientific Perspectives 253, 256 (J. E. Austin & C. E. Bruch eds., Cambridge: Cambridge University Press 2000); David D. Caron, Finding Out What the Oceans Claim: The 1991 Gulf War, the Marine Environment, and the United Nations Compensation Commission, in Bringing New Law to Ocean Waters (David D. Caron and Harry N. Scheiber (eds), Nijhoff, Leiden 2004) 393, 394; UN Register of Damage, Rules and Regulations Governing the Registration of Claims, Article 11(1) (19 June 2009)(The UN Register of Damage, established in 2009, can receive claims in its public claims category for environmental damage resulting from the construction by Israel of its security wall); Agreement, Eri.-Eth., Dec. 12, 2000, 2138 U.N.T.S. 94, 40 I.L.M. 260 (Ethiopia claimed compensation for losses of gum Arabic and resin plants, and damage to terraces in the Tigray region for a value of approximately USD 1 billion and for loss of wildlife); UNCC Governing Council decision 7, S/AC.26/1991/7/Rev.1 (1992) (environmental damage claims to be reviewed as government claims); Cymie R. Payne, Developments in the Law of Environmental Reparations: A Case Study Of The UN Compensation Commission in Carsten Stahn, Jens Iverson, & Jennifer Easterday, eds. Environmental Protection and Transitions from Conflict to Peace: Clarifying Norms, Principles and Practices, (Oxford University Press forthcoming 2017.

[44] UNCC F4 third instalment, para. 42; Report and recommendations made by the Panel of Commissioners concerning the second instalment of "F4" claims, UN Doc. S/AC.26/2004/17 (2004) para. 38; and UNCC F4 fifth instalment, para. 40.

emphasizing the community nature of the loss.[45] Professor David Caron has characterized this relationship as a government acting "as an agent for the environment, for a community's interest in that environment."[46]

A consequence of this is that international (UNCC), regional (EU), and domestic (US) legal systems require the claimant government to use financial compensation to restore the environmental damage for which it was awarded. The UNCC established two programs—the Monitoring & Assessment tracking program and the substantive claim Follow-up Programme—to ensure that compensation would be used for the projects for which it was awarded.[47] This is especially important where the loss is to services, like carbon sequestration, in which the international community as a whole has an interest. In 2013, after eight years of overseeing the Follow-up Programme, the UNCC Governing Council declared that Iran had completed its environmental projects and that Jordan, Kuwait and Saudi Arabia had satisfactorily put in place the necessary systems and controls, the final funds would be released, and the mandate of the Programme had been fulfilled.[48] Under the EU ELD, "compensatory remedial measures should provide natural resources and services of the same type, quality and quantity to compensate for interim losses."[49]

## III. PRINCIPLES FOR ENVIRONMENTAL DAMAGE METHODOLOGY

Economists have long recognized that the natural environment can produce goods and services of value to humans,[50] and have developed a range of accepted approaches to measure these values.[51] Environmental

---

[45] EU ELD, Annex II (1)(d).

[46] David D. Caron, The Profound Significance of the UNCC for the Environment, in Payne & Sand, 268. Caron ties this shift in perspective to an equivalent change from a government owning the claims of its citizens (and residents) to the UNCC approach where the government acted as an agent for the individual claimants. Reflecting the earlier practice, a British court found that the British government properly declined to pay a citizen money that it had received from the Chinese government "on account of debts due to British subjects", stating that the relationship was not "the duty of an agent to a principal, or of a trustee to a cestui que trust." Rustomjee v The Queen, II Q. B. D. 74 quoted in Marjorie M. Whiteman, Damages in International Law, vol. III (1943) 2051-2052.

[47] UNCC Governing Council Decision 132, S/AC.26/Dec.132 (2001); UNCC Governing Council Decision 258, S/AC.26/Dec.258 (2005); Cymie R. Payne, Oversight of Environmental Awards and Regional Environmental Cooperation in Payne & Sand.

[48] UNCC Governing Council Decision 270, S/AC.26/Dec.270 (2013) and UNCC Governing Council Decision 271, S/AC.26/Dec.271 (2013).

[49] Manual on Procedures, Finland, 61.

[50] Freeman, A. Myrick. 2003. The Measurement of Environmental and Resource Values. Resources for the Future, Washington, DC.

[51] Freeman, A. Myrick, III, J. Herriges, and C. Kling. 2014. The Measurement of Environmental and Resource Values: Theory and Methods. 3rd Ed. Washington, DC: Resources for the Future. Champ, Patricia A., Kevin J. Boyle and

valuation may be performed to enhance the public's understanding of the role of environmental protection, for purposes of public policy setting (i.e., to balance the environmental costs of a policy or action against the expected benefits), or for environmental damages assessment (i.e., to assign values to be paid as damages for the environmental harm of an action or event).

The most common and well-accepted approach is to utilize market prices for environmental services that trade in reasonably competitive markets in the area being studied. For example, the expected price of a parcel of forestland can be used to estimate the potential economic value of forest products, over time, from the parcel (i.e., logs, fuel wood, etc.).[52] In many cases, however, there are no market values that can be observed to assess the value of environmental services. In these cases, economists have developed "non-market" methods to assign values to environmental services. The value of some non-market services can be estimated using "revealed preference" techniques, which involve observing individuals' behaviour when faced with choices. For example, while we cannot observe market prices for the aesthetic values provided by parkland to the general public, we can use information on how recreationalists choose between sites with differing aesthetic qualities to uncover the value of scenic beauty. In cases in which we cannot observe markets or behaviour, economists have used "stated preference" methods – surveys of the public – to elicit values for environmental goods and services. These surveys present respondents with hypothetical choices between states of the environment at varying cost. In addition, some environments provide us with services that would otherwise need to be provided by a built environment. The use of the implicit cost of providing environmental services is referred to in the literature as the "avoided cost" approach. For example, a coastal wetland may serve to process and absorb urban runoff. Absent this service, communities might need to construct costly water treatment facilities to address urban discharges.

In environmental damage contexts economists also use replacement costs, or restoration costs, to assign damages. For example, an oil spill may cause a wetland to die off, requiring efforts to replant the wetland to restore the services provided. While restoration costs are not values,[53] they can be used in some circumstances to understand the loss or gain experienced by the public given a change in the environment. Specifically, restoration costs are an acceptable measure of losses under certain conditions: the restoration

---

Thomas C. Brown (Eds.). 2003. A Primer on Nonmarket Valuation. Kluwer Academic Publishers; https://www.amazon.com/Nonmarket-Valuation-Economics-Non-Market-Resources/dp/9400771037/ref=sr_1_1?ie=UTF8&qid=1495630788&sr=8-1&keywords=A+Primer+of+Nonmarket+Valuation

[52] Land prices generally reflect highest and best uses, and thus are most relevant for valuing environmental service flows in cases in which the good in question (i.e., forest products) is the highest and best use in the market being referenced. Of course, many environmental services are not reflected in markets.

[53] Consider that the cost of restoring some environments may simply be far more expensive than any value that was lost due to an impact, or far less expensive than the values that environments produce.

action will provide services similar to what was lost (in both quality and quantity); the restoration action should be technically feasible; the restoration action should be the least cost approach available to achieve the restoration objective; and the cost of the restoration action is not grossly disproportionate to the value of the services provided. This last factor is typically demonstrated by showing that the action has been taken by the public in similar contexts, or is required by law or policy (e.g., policies that require developers to undertake wetlands mitigation).

Restoration cost-based approaches are the most commonly applied approaches to assess environmental damages. This is due to two factors. First, values and methods may not exist to allow for assignment of economic values to an environmental harm, and economic valuation can be expensive and time consuming. Restoration costs are often easier and less costly to estimate. Second, many environmental statutes call for the use of recovered funds to be used for restoration and replacement of the injured environment. As such, it is expedient to consider the cost of such restoration.

While economists can undertake primary research to understand the value the public holds for an environmental good or service, it is sometimes possible to use existing values from the literature for valuation purposes. The use of existing values in a new situation is referred to in economics as "benefit transfer." Benefit transfer has been used by environmental economists since the 1970s,[54] and standards for its application have been widely agreed upon.[55] These standards relate to assuring the quality of the underlying study, and the similarity of the good or service being valued. As stated in the US EPA's guidance, there should be similarity in terms of the "(1) definition of the environmental commodity being valued (include scale and presence of substitutes); (2) baseline and extent of environmental changes; and (3) characteristics of affected populations."[56]

There are several key principles that define sound environmental damage valuation, no matter the approach taken. First, analyses should be clearly presented such that all assumptions and calculations are transparent and reproducible. Second, care should be taken to avoid double counting of benefit categories (e.g., if a replacement cost is used, the assessment should not also value future lost services for the same replaced

---

[54] Sorg and Loomis (1984). http://recvaluation.forestry.oregonstate.edu/brief-history

[55] Johnston, R.J., J. Rolfe, R. Rosenberger, and R. Brouwer (Eds.). 2015. Benefit Transfer of Environmental and Resource Values: A Guide for Researchers and Practitioners. Springer; Office of Management and Budget (OMB). 2003. Circular A-4: To the Heads of Executive Agencies and Establishments. September 17; U.S. EPA. 2010. Guidelines for Preparing Economic Analyses. EPA 240-R-10-001. December.

[56] U.S. EPA. 2010. Guidelines for Preparing Economic Analyses. EPA 240-R-10-001. December. Pp.7-46.

resource). The baseline condition of the resource should also be considered (i.e., what services were provided by the resource in its baseline, or "but for" the event condition). Defining the baseline nature of a natural resource is particularly important in the application of benefit transfer, where similarity between the environments valued in the existing study and the case at hand is required for a sound transfer. Finally, in cases involving valuation of changes in environmental quality due to an event or action, the analysis should account for the likely recovery of the system over time.

While international law neither prescribes nor prohibits any particular valuation technique,[57] certain techniques may be considered best practice for valuing non-market natural resources. The UNCC most frequently used the estimated value of the cost of remediating and/or restoring the damaged resource. Saudi Arabia's claim for coastal remediation, described above, is typical. One of the commissioners for the environmental claims program emphasized that,

> First, claims for compensation must be well supported and may not be based solely on conjecture and speculation. To the extent scientific and technical experts are used to support the claims, the techniques and methodologies employed by the experts to support their conclusions must conform to generally accepted scientific principles. In addition, valuation methodologies used to quantify damages to natural resources must be reliable and must be based on the particular factual circumstances of the claim.[58]

In some cases, the scale of appropriate restoration can be established using habitat equivalency analysis (HEA) or resource equivalency analysis (REA), techniques which allow for formal consideration of damages resulting from past harms, as well as consideration of environmental recovery times and the path or recovery of a resource following harm. These techniques allow analysts to determine the appropriate scale of restoration given the scale of harm.[59] Once the scale of appropriate restoration is known, it is then possible to assign monetary damages based on the associated costs of the restoration actions.

---

[57] UNCC F4 fifth instalment, para. 80.

[58] José Allen, Points of Law, in Payne & Sand, 168.

[59] Robert E. Unsworth & Richard C. Bishop, Assessing Natural Resource Damages Using Environmental Annuities, 11 Ecological Economics (1994); Huguenin, Donlan, Van Geel, and Paterson, Assessment and Valuation of Damage to the Environment in Payne & Sand, 78-79. UNCC F4 fifth instalment, paras 611-636.

The UNCC used HEA to evaluate the scale of intertidal zone losses in Saudi Arabia.[60] Jordan used HEA to calculate that damage to rangeland and wildlife reserves from vehicular traffic, overgrazing by refugees' livestock, and refugees' use of plants for fuel would require compensation of USD 2.4 billion.[61] However, implementing the project as proposed would have required more land than was available in Jordan. The UNCC accepted the HEA approach in principle, and, in consideration of the limited land available, awarded USD 160.3 million. This amount reflected the costs of an alternative program in which rangeland users and managers would cooperatively manage the resource.[62] These and other examples of HEA demonstrate a monetization procedure for environmental damages that can be used to compensate for lost environmental resources that are not traded in the market.[63]

An alternative approach evaluates the loss of one or more specific ecosystem services. Iran used value transfer, one of the simplest forms of benefit transfer,[64] to quantify environmental loss, in one case multiplying an ecological service value for rangelands by the area of rangelands estimated to have been damaged by the presence of refugees, assuming the area lost all ecological services for one year.[65] No awards were made on the basis of that methodology, however. In the case of Iran's claim for rangeland service losses, as one of the commissioners recounted, "the Panel discarded Iran's theoretical computation of ecological

---

[60] See Section II.

[61] UNCC F4 fifth instalment, paras 353-366, Annex I.

[62] The amount awarded also reflected a reduction to account for "inadequacies in the information provided by Jordan and also the fact that Jordan failed to take steps to mitigate the damage, particularly by failing to reduce grazing pressure on the rangelands" UNCC F4 fifth instalment, paras. 362–363.

[63] See also, Kuwait's USD 194.1 million claim for the disruption of ecological services and human activities in desert areas. Kuwait sought compensatory remediation for desert areas damaged by tarcrete, windblown sand, dry oil lakes, wet oil lakes, oil-contaminated piles, oil-filled trenches, oil spills, military fortifications, and open detonation and open burning of ordnance. Ecological services that it claimed were harmed included soil stabilization, soil microcommunities, wildlife habitat, and vegetative diversity; human activities that were temporarily diminished included animal grazing and desert camping (a popular and culturally important form of recreation). Kuwait had received awards for the costs of assessing environmental damage from oil lakes that resulted from oil well fires and evaluating technology to remediate the damage. The UNCC also made award to Kuwait for cleaning and restoring terrestrial damage from oil wells, pipelines, trenches, mines, and other remnants of war. When it reached the compensatory remediation claims, the UNCC found Kuwait's use of HEA appropriate, but denied the claim because it found the losses were overstated and the remediation already provided for by other awards would be sufficient to address the losses. UNCC F4 fifth instalment, paras. 413-428.

[64] For "value transfers", a single value or average of values is drawn from one or more published studies. This is in contrast to benefit function transfer where a relationship is developed between the values in the literature and the attributes of the good being valued, and where that valuation function is then used to assign values to the case at hand.

[65] UNCC F4 fifth instalment, para. 175.

service losses for depleted rangelands as an overestimate, and instead applied alternative cost estimates based on commercial fodder prices."[66]

## IV. ECONOMIC PRINCIPLES FOR COMPENSATION FOR ENVIRONMENTAL HARM

### *A. The approach taken by Neotropica*

In attempting to place a monetary value on the environmental damages resulting from construction of two *caños* and clearing of trees and vegetation by Nicaragua in 2010 and 2013, Neotropica adopts an "ecosystem services" approach to classify the services provided by the study area, which involves listing all of the goods and services provided by the ecosystem prior to the 2010 and 2013 actions. In implementing this approach they use a "benefit transfer" framework, or the use of existing values from the literature and other cases, to assign damage estimates to a subset of services that they believe were diminished as a result of Nicaragua's actions.[67]

The Neotropica study categorizes ecosystem services according to a classification scheme first developed by the Millennium Ecosystem Assessment (MEA), dividing them into four groups: provisioning services; regulation services; supporting services; and cultural services. The MEA endeavoured to draw attention to the contributions of ecosystems to people's well-being and motivate measurement of these contributions. With respect to these objectives, the MEA taxonomic scheme is well-suited. However, the economics literature has highlighted that it is an impractical framework where the focus is on *valuation* of ecosystem services.[68] In particular, the MEA classification scheme does not distinguish between ecosystem processes and functions with ecosystem service values or benefits. In particular, "supporting services" (such as soil formation and habitat and nursery) and some "regulating services" (such as air quality regulation) are ecosystem functions that contribute to the delivery of an ecosystem service but may be more appropriately thought of as "intermediates" or factors in the production function of an ecosystem service.[69] Conflating ecosystem

---

[66] Peter H. Sand, Environmental Principles Applied, in Payne & Sand, 182-183; UNCC F4 fifth instalment, para. 178. Other factors in the UNCC valuation of the claim were the lack of evidence supporting the extent of the damage and the likelihood that factors unrelated to Iraq's invasion of Kuwait contributed to the damage. Id. 177.

[67] Neotropica states that their estimates are conservative (i.e., likely to understate actual losses) since not all of the services they considered were monetized. That said, they present no information that any of these services were in fact lost or are relevant for this case.

[68] Boyd and Banzhaf, 2007; La Notte et al., 2017.

[69] Boyd and Banzhaf, 2007.

functions and services is not just an issue of semantics, but leads to confusion regarding which endpoints should be valued to avoid double-counting.

Of the six ecosystem services monetized in the Neotropica report, four are categorized as regulating and supporting services. These services – gas regulation/air quality, natural hazards mitigation, soil formation/erosion control, and habitat and nursery – are all intermediates that contribute to, but are not themselves, the values that people derive from this site. Valuing these ecosystem functions separately and summing them with other categories (i.e., provision of timber and other raw materials) thus risks double counting of value.

Having identified relevant categories of ecosystem services, the Neotropica report then takes a simplified approach to estimate losses, valuing six categories of ecosystem services they believe were lost as a result of Nicaragua's actions. For each of these services they estimate a quantity of lost service, which is then multiplied by a monetary value to generate an annual loss, or "first year" damage estimate. This approach represents a highly-simplified application of benefit transfer. As noted above, while formal benefit transfer has been used by environmental economists since the 1970s and the requirements of sound transfers have been clearly defined in the published economics literature, the approach used by Neotropica is described as a "quick"[70] assessment approach requiring limited site specific data to place economic values to environment goods and services.

In defining approaches that are acceptable for assessing the monetary value of environmental harms, the EU developed a "toolkit" for member countries to use. This toolkit is intended to highlight best practices in environmental valuation, and notably does not include the "ecosystem services" approach used by Neotropica as an accepted methodology.[71] Importantly, Costanza et al. (2014), which provides an update to the 1997 paper upon which Neotropica relies, does not include damage valuation as one of the applications

---

[70] "A valuation technique that gained popularity in the 90s is benefits transfer. It is a quick technique that became popular thanks to the work of Costanza et al. (1997) which has been disseminated in our hemisphere by the Gund Institute of Economics of the University of Vermont, USA, and the U.S. NGO Earth Economics, among others." (page 24). As noted elsewhere in our report, benefit transfer is a method that pre-dated Costanza's work.

[71] Resource Equivalency Methods for Assessing Environmental Damage in the EU. July 2008. Deliverable 13: Toolkit for Performing Resource Equivalency Analysis to Assess and Scale Environmental Damage in the European Union. http://web.archive.org/web/20100602054339/http://www.envliability.eu:80/ docs/ D13MainToolkit_and_Annexes/REMEDE_D13_Toolkit_310708.pdf Further discussion of economic valuation techniques can be found in: Resource Equivalency Methods for Assessing Environmental Damage in the EU. July 2008. Deliverable 13: Annexes to the Toolkit. http://web.archive.org/web/20090617012240/http://www.envliability.eu:80/docs/D13MainToolkit_and_Annexes/D13_All%20Toolkit%20Annexes_July%202008.pdf

they claim this approach addresses. These authors instead highlight the role ecosystem service valuation can play in "heightening awareness and estimating the overall level of importance of ecosystem services."[72]

### *B. Transfer methods employed in the Neotropica study do not reflect sound economic principles*

For four of the six categories of ecosystem services, Neotropica estimates values applying benefit transfer methods. As noted above, benefit transfer is the process of adapting existing value estimates to new circumstances. Economists commonly employ benefit transfer methods for economic valuation studies where time and resource constraints prevent primary research. Benefit transfer may involve the application of a single, mean, or median value from relevant studies ("unit transfer"), calibration of a benefit function from a single study ("function transfer"), or estimation of a benefit function from multiple studies ("meta-analytic transfer"). The Neotropica study uses a mix of valuation approaches: the simplest form of benefit transfer for some ecosystem services, market prices for others, and replacement cost estimate for others.[73]

The accuracy and reliability of benefit transfer analyses depend critically on the similarity of the environmental and economic context between the original research and the transfer application, as well as the quality of the underlying study. Best practice guidelines for benefit transfer are discussed extensively in the resource economics literature and are prescribed, for example, in U.S. Office of Management and Budget and U.S. Environmental Protection Agency guidance documents for how to perform economic analysis.[74]

The Neotropica study references the work of Costanza et al.[75] and studies developed by the U.S. NGO Earth Economics as the model for the benefit transfer conducted to value the lost wetland ecosystem services in the *Humedal Caribe Noreste*. This framework, and the Costanza et al. study in particular, has been widely criticized

---

[72] Costanza et al. 2014. "Changes in the global value of ecosystem services". Global Environmental Change. 26 (152-158, 153). [72] Costanza, et al., for example, explain that "valuation is about assessing trade-offs" and do not include loss valuation as a use of ecosystem service valuation. A comment on the UN Environment Programme's TEEB also takes this position: "Because most valuation studies, including Costanza et al. (2014) do not assess the full range of ecosystem services, TEEB (2010) stressed that valuation is most useful for assessing the consequences of changes resulting from alternative management options, rather than estimating the system's total value." Katona, et al. Navigating the Seascape of Ocean Management, OpenChannels: Forum for Ocean Planning and Management (2017).

[73] As noted below, in some cases Neotropica confuses these approaches: the "value" used by Neotropica for natural hazard mitigation is actually a replacement cost (i.e., the cost to construct coastal defenses to replace a buffering ecosystem).

[74] U.S. Office of Management and Budget (OMB). Circular A-4: Regulatory Analysis. September 17, 2003.; U.S. Environmental Protection Agency, Guidelines for Preparing Economic Analyses, September 2000.

[75] Costanza, R., R. dArge, R. deGroot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. Oneill, J. Paruelo, R. G. Raskin, P. Sutton, and M. vandenBelt. 1997. "The value of the world's ecosystem services and natural capital." Nature 387:253-260.

and rejected by mainstream economics as inconsistent with sound economic principles and practices.[76] In general, these studies, sometimes referred to as "rapid assessments," categorize land cover types (e.g., wetland, forest, and prairie) and identify categories of ecosystem services relevant to those types. Based on the available literature, the researchers then estimate values for each category of ecosystem service for each land cover type and sum across relevant ecosystem service values to calculate a per acre (or hectare) value (or value range) for each land cover type. Where relevant, these studies then sum values across the land cover types to estimate a value for a study area, which may be a watershed, a country, or in the case of Costanza et al. the entire earth. The recent Federal Resource Management and Ecosystem Services Guidebook[77] summarize the theoretical and practical issues associated with this approach:

> "Many of the transfers applied in past ecosystem services literature (e.g., particularly in non-economics journals) and in ecosystem services valuation tools have applied methods that would be expected to generate large errors or invalid estimates, particularly due to incorrect aggregation of marginal values, failure to account for spatial connections between ecosystems and their human beneficiaries and their change over time, and other generalization errors."[78]

The Neotropica study refines this "rapid assessment" method somewhat by focusing on the ecosystem services of demonstrated relevance to the site injured habitats in question. However, the analysis falls prey to several common "rapid assessment" pitfalls. First, this approach ignores site-specific factors affecting the production of services by not accounting for variations in the ecological functioning, condition, or quality of the natural system being studied relative to the natural systems considered in the source studies. The Ramsar

---

[76] Bockstael, Nancy E., A. Freeman, III, R. J. Kopp, P.R. Portney, and V. Smith. 2000. "On Measuring Economic Values for Nature." Environmental Science & Technology 34:1384-1389. In Secretariat of the Convention on Biological Diversity, (2007), An Exploration of Tools and Methodologies for Valuation of Biodiversity Resources and Functions, Technical Series no. 28, Montreal, Canada, the authors state "…the methodologies underlying these efforts, and the figures they produced, remain controversial; moreover, as the Millennium Ecosystem Assessment notes, their usefulness for policy purposes is limited, as it is rare for all ecosystem services to be completely lost and even then, such a complete loss would usually happen only over time." (page 10).

Pearce, David. 1998. "Auditing the Earth." Environment 40:23-28. Toman, Michael, 1998. "Special section: forum on valuation of ecosystem services: Why not to calculate the value of the world's ecosystem services and natural capital." Ecological Economics. Elsevier, vol. 25(1), pages 57-60, April.

[77] National Ecosystem Services Partnership (NESP). 2016. Federal Resource Management and Ecosystem Services Guidebook. 2nd ed. Durham: National Ecosystem Services Partnership, Duke University, https://nespguidebook.com. NESP is an initiative of Duke University's Nicholas Institute for Environmental Policy Solutions and was developed with support from the U.S. Environmental Protection Agency.

[78] The Federal Resource Management and Ecosystem Services Guidebook is published by the National Ecosystem Services Partnership in the U.S. and included participation by more than 150 experts from U.S. federal agencies, universities, NGOs, and think tanks.

study referenced in the Neotropica report emphasizes the need to account for site-specific factors affecting ecological production functions when valuing wetland ecosystem services:

> "Not all wetlands, however, perform all of these hydrological functions to the same extent, if at all. Indeed, some wetlands perform hydrological functions which may be contrary to human needs, such as riparian wetlands which may act as runoff generating areas, thus increasing flood risk downstream. It is therefore crucial to quantify the functions of a wetland before valuing it."[79]

The extent to which a given hectare of ecosystem delivers specific services also depends on its situation in the broader landscape. For example, a wetland downslope of cropland may provide a valuable service by filtering nitrogen runoff and decreasing the total amount of the nutrient reaching a water supply whereas a wetland surrounded by forest is unlikely to intercept such runoff to begin with and therefore would not provide this service. The Neotropica study does not explicitly compare the ecological functions of the wetland ecosystems in the source studies with the damaged wetland area in the *Humedal Caribe Noreste*, skipping a key analytic step required to produce defensible results from any benefit transfer exercise.

In addition, by relying on site-specific studies valuing these types of services in other areas (including some studies focused on sites as far as Thailand), the Neotropica study fails to account for the potential differences in values associated with differences in socioeconomic context between sites. For example, the value of natural hazards mitigation of mangrove wetlands in the study relied upon by Neotropica reflects the added cost of actions to replace the hazard mitigation service with an engineered break wall.[80] This value would be highly dependent on the scale and type of defence built, the period over which the hazard mitigation effort is needed, and even whether it would be undertaken at all in the context of the harm described in this case. In transferring values of ecosystem services from other studies, the Neotropica study does not appear to account for the ecological and socioeconomic context affecting these values. The TEEB report referenced by Neotropica, however, explicitly directs ecosystem service valuations to address local context:

> "Many ecosystem service values, especially those relating to local benefits, are context specific. This reflects the natural environment's sheer diversity and the fact that economic values are

---

[79] Barbier, Edward B., Mike Acreman, and Duncan Knowler. 1997. Economic Valuation of Wetlands: A Guide for Policy Makers and Planners. Ramsar Convention Bureau, Gland, Switzerland.

[80] Barbier, E.B. 2007. Valuing Ecosystem Services as Productive Inputs. Economic Policy 22(1): 177-229; Barbier, E.B., I. Strand and S. Sathirathai. 2002. Do Open Access Conditions Affect the Valuation of an Externality? Estimating the Welfare Effects of Mangrove-Fishery Linkages in Thailand. Environmental and Resource Economics 21(4): 343-367.

> not a natural property of ecosystems but are integrally linked to the number of beneficiaries and the socio-economic context. The role of a coastal buffer zone to protect against extreme weather events can be vital or marginal, depending where you live. Water regulation is a lifeline in certain conditions, a useful back-up in others. Tourism is a major source of income in some areas, irrelevant in others, etc. This dependence on local conditions explains the variability of the values and implies that in general, the value of a service measured in one location can only be extrapolated to similar sites and contexts if suitable adjustments are made."[81]

Furthermore, by estimating an equal value over time for a given service to all habitat hectares, regardless of the level of quality or functioning, the analysis does not provide information to support an analysis of incremental changes in ecosystem services. This is particularly important for ecological systems that will recover over time from harm. Recovery of an injured habitat will mean a gradual increase in the provision of particular services (e.g., for fibre and raw materials and gas regulation).[82] It is unclear from the information presented in the Neotropica analysis whether this is taken into consideration, but the results presented reflects a binary presence or absence of the full per hectare value of these services at the site (i.e., no services for the next 50 years, and then the sudden return of services). As a result, the analysis does not reflect a valid accounting of ecosystem services at the site over time.

## V. EVEN IF THE FRAMEWORK WERE CORRECT AND APPLICABLE TO ASSESS ENVIRONMENTAL DAMAGES, THE ANALYSIS PRESENTED IS FLAWED

As noted above, the "quick" benefit transfer approach utilized by Neotropica is not a generally accepted approach for environmental damage assessment, but instead is advocated for use in raising awareness of the importance of healthy environments. Leaving aside our significant concerns with use of this approach for purposes of environmental damage assessment, the analysis Neotropica conducts is severely flawed. In this section, we consider what the results would be had Neotropica correctly performed the analysis they set out to perform, using their selected methodology. Significant errors that we have identified are described below. Sufficient detail is not presented in Neotropica's report to replicate some of the calculations done there, and there appear to be several errors in the numbers that are presented. As is shown, once corrections are made to the calculations and assumptions used by Neotropica, the resulting total damage value is only about three percent of that presented by Neotropica.

---

[81] TEEB. February 2011. The Economics of Ecosystems and Biodiversity for National and International Policy Makers. http://www.teebweb.org/publication/teeb-in-national-and-international-policy-making/.

[82] It is for this reason that Habitat and Resource Equivalency are used in many environmental damage claims, as discussed below.

Specifically, the Neotropica analysis is flawed in that:

- Services are valued which were not lost (e.g., soil formation and natural hazards mitigation).
- Capitalized value estimates are treated as annual values, and thus these values are counted multiple times over the analysis period (e.g., the value of the timber that was cut is included for each of the 50 years of the analysis).
- No recovery of services is assumed for 50 years.
- Values from the literature addressing very dissimilar circumstances are used to represent values in this case.
- Mistakes are made in how the stock values of environmental services are combined with flow values.

Given these flaws, the author's assertions that the resulting values are "conservative" (i.e., more likely to understate than overstate losses) are not supportable. Simply considering the scale of the damages calculated by Neotropica per hectare raises concerns. Specifically, a total area of approximately 6.2 hectares is claimed as disturbed to varying degrees by Nicaragua's actions. The total ecosystem service losses are estimated to be USD 2.8 million. This equates to losses of USD 455,340 per hectare, or USD 184,348 per acre. As discussed in this opinion below, the cost of purchasing ecosystem services credits in Costa Rica to offset any environmental harm caused by Nicaragua's actions would be more than an order-of-magnitude lower than these estimates.

Below we summarize the approach used by Neotropica for each category of service claimed as lost, and describe our specific concerns with the analysis performed and assumptions made. As noted, the approach they follow is largely a benefit transfer, with an assumed quantity of loss for each service category multiplied by a monetary value. The units used in the Neotropica report to describe the quantities of ecosystem services lost varies by service category (e.g., volume of standing timber, cubic meters of soil, hectares of habitat), and the monetary values used reflect various estimates drawn from the literature and past assessments. The six annual values for the six ecosystem services considered by Neotropica are summed to generate a total annual value. Finally, Neotropica assumes that these annual losses will occur each year for the next 50 years – effectively assuming no recovery of any of the monetized services for 50 years. Based on this time frame of assumed loss, they calculate a present value total loss estimate assuming a four percent discount rate.

Note that Neotropica provides several tables that present inputs to the analysis they perform, as well as summary tables of results. However, it is not possible to replicate the results they get given the information provided, and we found several instances in which there appear to be errors in the calculations.[83]

In the calculations we perform below these errors have been corrected. Details on our assumptions and calculations are contained in Appendix A.

## *A. Standing stock of timber*

As shown in Exhibit 1, Neotropica estimates the value of the standing stock of timber that was cut in C2010 and CE2013. This is done by multiplying the assumed stock of timber prior to actions taken at C2010 and CE2013 by a harvest factor, which reflects the author's assumption that 50 percent (half) of the standing stock of trees could have been harvested for sale absent Nicaragua's actions. Neotropica then multiplies this quantity of wood, expressed in cubic meters, by a price drawn from the Costa Rican market for the species found at the site.[84] They also assume that, in addition to harvesting 50 percent of the standing stock, it would have been possible to remove, sustainably, half of the annual growth of trees within the study area each year. This value is also multiplied by the same price. These two values are added together to yield a total annual value (or "first year damages"), adjusted to 2016 US dollars using a GDP deflator. Finally, a present value is calculated over the 50 year period of assumed harm. From these calculations Neotropica produces a damage value over the assumed 50 year period of USD 462,490.

In Exhibit 1 we provide the corrected calculations and damage estimate. Most importantly, the analysis mistakenly treats the monetary value of half the standing stock of trees that were removed in 2010 and 2013 as an annual value, when this value should be applied only once (at the time of the action), and summed with the present value of the annual growth rate.[85] That is, Neotropica estimates what the volume of standing timber (i.e., wood) was at the site prior to Nicaragua's actions. They then assume that half of that volume

---

[83] For example: with respect to gas regulation/air quality, it appears that Neotropica did not scale their estimated total loss to 2016 US dollars; with respect to natural hazards mitigation, it appears that Neotropica did not scale their estimated total loss to 2016 US dollars; and with respect to soil formation/erosion control, Neotropica's source document (Colegio Federado de Ingenieros y Arquitectos de Costa Rica, 2007) lists unit cost of soil as $5.78, whereas Neotropica used a value of $5.87.

[84] Natural resources often have both a "stock" and a "flow" component. The "stock" is the initial quality or level of a service (e.g., the volume of harvestable wood on a hectare of land, or the amount of carbon sequestered at a given moment in an ecosystem). The "flow" component is the addition expected each year to that stock. A mature ecosystem may still produce a flow of services, for example if managed to optimize timber production, or may be in steady-state.

[85] The analysis conducted by Neotropica is the equivalent of using a market value for a hectare of forest (purchased in fee interest) as the annual value of the timberland services provided by that forest, when it is in effect the present value of the flow of expected future services.

could have been harvested, and thus that it had a market value that was lost. Mistakenly, they then value that volume of standing stock as if it could have been harvested each year, when in fact it would only be available after the forest had regrown. In addition to considering the value of the standing stock, the Neotropica analysis assumes that these trees would continue to grow each year, and assign a market value to that additional volume of assumed growth. As shown in Exhibit 1, simply correcting for this factor reduces the present value 50-year loss estimate to USD 30,175, or about 6.5 percent of the Neotropica estimate.

Even this lower estimate may overstate damages. Specifically,

- It is not clear if the values used are stumpage values (reflecting the price paid for logs minus the harvest cost) or log prices. To the extent that these are harvested log prices, the values overstate the value of the standing timber.
- Even if the prices used are correct, no information is provided to support the notion that this area would have been sustainably harvested. Absent such evidence, including evidence of a market for the harvested product, the values presented will overstate the value of the standing timber. That is, these areas may not have a market value as commercial timberland.
- Since the site is recovering, and will presumably return to a forested state, it will in fact provide future timber services. Thus, the analysis developed by Neotropica may overstate the loss in annual growth (i.e., such growth might occur in the future despite the actions in 2010 and 2013). Removal of the loss of annual growth from the calculation above would reduce the damage estimate further.

Given these factors, the loss experienced by Costa Rica of standing timber services is no more than USD 30,175.

### *B. Other raw materials*

The Neotropica analysis of the value of "other raw materials" that might be used for fibre and energy suffers from many of the same problems as the estimate of standing timber value. Specifically, Neotropica estimates the value of other raw materials as the product of an assumed value per hectare times the number of disturbed hectares, which is then adjusted to 2016 US dollars using the GDP deflator. From this value they calculate a present value loss of USD 17,877. Note that we were unable to replicate the "first year" value they report on Table 14, but accept the value as reported for purposes of this discussion.

In Exhibit 1 we provide the corrected results. As with the standing stock of timber, Neotropica takes the estimate of the stock value of raw materials (per hectare) harmed at the site, and calculates a present value. However, this volume could not be removed each year for 50 years, and the initial harm caused by Neotrpica would be expected to recover over time. As such, the annual value of USD 1,200 should be used to represent

the present value of this service flow, or about seven percent of the value presented in Neotropica's Table 14 for this ecosystem service.

While this reflects the corrected present value loss, we have other concerns.

- Three studies are referenced from the literature as providing estimates of the per hectare value of "other raw materials," which are averaged together in the calculations. These values range from USD 2.02 to USD 467.94 per hectare, or over more than two orders-of-magnitude. As such, using the lowest value would result in a valuation only about one percent as large as the value presented. Using the higher value would result in a more than doubling of the result. In such instances – that is, when the literature values are not consistent – it is appropriate to select the value from the study of greatest relevance to the valuation problem and site being studied. That step was not taken by Neotropica.
- No support is presented in the Neotropica report that there would have been any local use of the cut vegetation for purposes of fibre or fuel. Absent such use, the correct valuation measure for this category of ecosystem service would be zero.
- No attempt is made by Neotropica to model the timing of the recovery of this service flow across the site. Instead, it is assumed that the services are lost for 50 years. It is likely this vegetation will recover well before 50 years. For this reason, and given that all of the vegetation at the site was valued in the first year, we believe there is no basis for assuming a future loss in services after the first year.

## *C. Gas regulation*

The Neotropica report considers the loss in "gas regulation" services from the site. This represents the loss in carbon sequestration services resulting from the cutting of vegetation at C2010 and CE2013. As discussed by the International Panel on Climate Change,[86]

> "Terrestrial ecosystems provide an active mechanism (photosynthesis) for biological removal of $CO_2$ from the atmosphere. They act as reservoirs of photosynthetically-fixed C by storing it in various forms in plant tissues, in dead organic material, and in soils. Terrestrial ecosystems also provide a flow of harvestable products that not only contain carbon but also compete in the market place with fossil fuels, and with other materials for construction (such as cement), and for other purposes (such as plastics) that also have implications for the global carbon

[86] Intergovernmental Panel on Climate Change. Third Assessment Report. 2001. 4.2 Land Use, Land-Use Change, and Carbon Cycling in Terrestrial Ecosystems. http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=158

> cycle. The global carbon cycle consists of the various stocks of carbon in the earth system and the flows of carbon between these stocks.

In assessing the role an ecosystem plays in the removal and storage of carbon, it is important to properly describe the role of the ecosystem in terms of storing a "stock" of carbon versus the role in further sequestration of carbon (the "flow"). The International Union for the Conservation of Nature provides useful definitions:[87]

> Stocks: The term terrestrial carbon stock is the sum of the carbon stocks, or pools, of all terrestrial ecosystems. The carbon pool of each ecosystem is determined by multiple elements – elements such as the carbon in vegetation, in soil, in leaf litter, and in woody debris.
>
> Flows: Carbon flows, or fluxes, refer to the annual exchanges of carbon between one system, such as the atmosphere, and another, such as the biosphere. Like stocks, flows will differ by the structure of each ecosystem. Typically, carbon exchange accounting includes photosynthesis, the accumulation of carbon in vegetation, soil and litter (assimilation), the decomposition of this matter, as well as the production of gaseous carbon such as CO2 (respiration), and emissions produced by disturbances, such as from deforestation and fire. These flows will change periodically depending on anthropogenic land uses and natural cycles.

To generate a present value estimate Neotropica multiplies the number of impacted hectares by a literature-based value for the carbon storage potential (expressed in dollars) for a hectare of habitat. No detail is provided to allow the reader to understand how similar the habitat was in this case (prior to disturbance) versus the habitat considered in the literature from which the value is drawn. The value used to establish a monetary damage estimate is USD 14,995 per hectare, to which Neotropica adds USD 26.83, which reflect the annual value of sequestered carbon per hectare. They then convert this value to 2016 US dollars using a GDP deflator, and calculate the present value over 50 years. This yields a present value loss estimate for this category of service of about USD 937,509.

The corrected damage estimate is presented in Exhibit 1. Most significantly, the value of the stock of carbon at the site prior to clearing at C2010 and CE2013 should not be applied each year for 50 years, nor should the annual increment be added to this value. The correct result, using the Neotropica value, is USD 47,778 (the value from the literature used by Neotropica, but correctly interpreted as a stock value), or about five percent of Neotropica's present value estimate.

---

[87] International Union for the Conservation of Nature. 2009. The Terrestrial Carbon Budget: Stocks and Flows. Draft report. https://www.iucn.org/sites/dev/files/import/downloads/terrestrial_carbon_stocks_and_flows.pdf

Estimates of the value of loss in sequestration services on a particular vegetated parcel of land can be complicated to develop and highly site specific. This is due to the complexities of measuring the stock of carbon sequestered at the site prior to the event in question, considerations of whether the injured site was continuing to sequester carbon (or was a mature area in steady state), the expected future land use of the site, and the growth rate of the site after the event, among other factors. For example, given that these harmed sites are experiencing re-growth, carbon sequestration services have returned at the site and may outpace the lost services moving forward.

There is no need to add to this stock value the value of annual future sequestration, as is done in the Neotropica analysis. First, there is no evidence that the harmed sites are not in fact sequestering carbon; that is, as the habitat recovers from the harm and the vegetation on the site grows, it will once again sequester carbon, possibly at a rate greater than prior to Nicaragua's actions. Second, the timber and raw materials damage calculations described above assume harvest of these products to get the economic benefit that is claimed as lost. If such a harvest took place, the carbon would no longer be sequestered. By including both of these services there is obvious double counting of damages – either the trees remain in place, providing a sequestration service, or are harvested, terminating that service. The analysis should not assume both services were possible off the same land area.[88]

The value of carbon sequestration used in this analysis is intended to reflect the marginal avoided cost of damage associated with climate change. That is, if we are able to sequester—or avoid the release of—$CO_2$, it is assumed that the effects of climate change will be mitigated. This value is referred to as the social cost of carbon, the value of which has been estimated by various governmental and non-governmental agencies. This value reflects the value of avoided impacts *to the world's population*, not simply the avoided costs to citizens of Costa Rica, and could be interpreted as overstating damages to Costa Rica.

[88] As noted earlier, one of the concerns with the ecosystem services approach is whether the assumed services can in fact be provided in combination, or if some services (e.g., coastal protection) are lost when other services (timber harvest) take place.

### *D. Soil formation/erosion control*

Neotropica presents a value for what they say are lost soil formation and erosion control services. They estimate this value by multiplying the volume of "removed" soil by a price to replace the soil, drawn from cost estimates for another site.[89] They then apply this value to estimate what they view as the cost over 50 years, adjusted using the GDP deflator.[90] Using these values, Neotropica creates what they refer to as an annual damage estimate of USD 54,926, for a present value over the 50 year period of approximately USD 1,180,000.

Neotropica implicitly assumes that soil displaced at the affected sites is "lost" from the site, when in fact the soil was simply redistributed.[91] Moreover, the caños have since re-filled with sediment. As such, no actions are needed to replace the soil formation / erosion control service. For this reason we believe the corrected value should be zero, and that this category of loss should not be included in the damage claim being made by Costa Rica.

Even the service had been lost, the corrected application of Neotropica's approach would be to recognize that the USD 54,926 value should not be used to create a present value; it is the cost of replacing all of the soil displaced at the site, which would only need to occur once, resulting in a corrected present value of about 5 percent of that reported by Neotropica).

### *E. Natural hazard mitigation*

Neotropica defines "natural hazard mitigation" to include the services provided by an ecosystem that mitigate risk and natural hazards, such as storms and other adverse weather conditions. That is, natural systems can either serve as a buffer between human communities and the effects of storm events (i.e., coastal flooding) or serve as a sink for excess surface water in the event of a storm.

---

[89] The case that they draw information from involved a mined area, which differs in both detail and scale from the case at hand.

[90] As noted, the authors report a value of $5.87/cubic meter which should be $5.78/cubic meter.

[91] Costa Rica's 2011 report to Ramsar (*i.e.*, Annex 155 to Costa Rica's Memorial on the Merits and source number 6 in Neotrópica's Table 2) states (referring to the 2010 Caño) "the materials extracted during the construction of the [2010] caño were dumped on both banks of the excavated waterway." (CRM Annex 155, pp. 32-33) In its March 2014 report to Ramsar (Source number 12 in Neotrópica's Table 2), Costa Rica reported that a December 2013 site visit to the eastern (2013) caño had revealed "[d]redge soil excavated from [the] channel and piled up along the bank." (Costa Rican March 2014 Report to Ramsar, CR-1 to May 2014 Compliance Report, p. 11 Figure 4).

There is no evidence presented that this service has been lost in this case, and thus we conclude that this category of loss should not be included in the damage claim being made by Costa Rica. That is, there is no information presented by Neotropica that the physical alterations made by Nicaragua, as subsequently remediated by Costa Rica, will lead to an increase in the risk of coastal flooding posed to nearby communities and infrastructure in the event of a storm event. In addition, the change in the physical landscape in this case – on the order of several hectares – is not comparable to the changes considered in the study on which Neotropica depends for monetary valuation (thousands of hectares of lost coastal mangrove).

Neotropica states that their analysis of the natural hazard mitigation services lost at this site relied on values from a study by Barbier et al (2002)[92] – however, that citation is unrelated to this issue. It is possible they are referring to Barbier (2007),[93] which is also cited. That study uses what is referred to as a "replacement cost" approach to ecosystem valuation (what we referred to above as "avoided cost"). That is, he considers the cost of constructing breakwaters and barriers along the coast to infer the value of mangrove as a natural shoreline buffer. As such, the Neotropica study mischaracterizes the values presented as "avoided cost in the destruction of infrastructure and properties," since the value is in fact the cost of shoreline protection. From this value they create a present value damage estimate of approximately USD 126,700, covering both the C2010 and CE2013 areas.

The purpose of the Barbier study was to provide information for decision makers considering actions to protect coastal mangrove in Thailand, by allowing them to describe the benefits of such systems. However, the values presented are replacement cost estimates specific to the coastline being studied, not economic values held by the public for such protection. The Thailand case study considers a situation in which there is regional and widespread loss of mangrove (described as 3.4 $km^2$ per year), that was expected to lead to increased vulnerability to storms. For the C2010 and CE2013 sites, there is no need described to create such coastal barriers, no evidence that such a cost would be justified by the hazard mitigation achieved, and no indication that such protection would be called for over the 50 years of the analysis. As such, we do not believe this ecosystem service should be included in the final damage estimate.[94]

---

[92] Barbier, E.B., I. Strand and S. Sathirathai. 2002. Do Open Access Conditions Affect the Valuation of an Externality? Estimating the Welfare Effects of Mangrove-Fishery Linkages in Thailand. Environmental and Resource Economics 21(4): 343-367.

[93] Barbier, E.B. 2007. Valuing Ecosystem Services as Productive Inputs. Economic Policy 22(1): 177-229.

[94] We were unable to identify the source of the hazard mitigation unit value used in the Neotropica report, and thus were unable to determine if the analysis correctly calculates the present value damage.

## *F. Habitat and nursery*

The Neotropica study describes the loss of "habitat and nursery services" and values those services using an average of values drawn from the published literature. Specifically, they average four habitat service estimates purportedly drawn from three published studies (see Appendix 3 of the Neotropica Report). The values cited by Neotropica as reported in the literature cover a very large range – USD 2.02 /hectare to USD 4,432/ hectare – all of which are presented as being annual values. The average of these values is then adjusted to 2016 US dollars using a GDP deflator, and a present value is calculated over the 50 years of assumed harm. The result is a damage estimate of USD 40,731 for this category of ecosystem services.

Since the average used by Neotropica is dominated by the high end estimates purported to be from Barbier et al. (2002),[95] we reviewed that source and the related Barbier (2002).[96] In Barbier (2002) the author estimates habitat and nursery services for mangrove in Thailand to be on the order of USD 55/hectare (page 205). In Barbier et al. 2002 the authors estimate these services for the same Thailand habitat to be approximately USD4 to USD 136/hectare (or an average of USD70 hectare), present value (page 358). We were unable to find the values used by Neotropica in either Barbier report. In any case, we believe these to be present values, but even treating them as annual estimates would reduce the Neotropica estimate from a present value of USD40,731 to a present value of approximately USD1,342 (page 358). That is, accepting the Neotropica approach, the correct value would be no more than 13 percent of the Neotropica estimate.

Finally, we have serious concerns with transferring a study performed for policy purposes in Thailand – with differing ecological, economic and cultural attributes – to this case. Most significantly, the Thai analysis considered the widespread and permanent loss of coastal mangrove habitat, not the interim loss of habitat pending recovery. As such, we believe that even the adjusted value presented in Exhibit 1 will overstate actual losses in habitat services in this case.

## *G. Valuation using Neotropica's methodology but correcting its errors*

In sum, correcting for Neotropica's errors, as described above, and omitting ecosystem services not relevant to this site and the harm at issue in this matter, we estimate a present value loss of no more than USD 84,296, which is approximately three percent of the Neotropica estimate. In our opinion, this value reflects the correct application of the approach Neotropica uses.

---

[95] Barbier, E.B., I. Strand and S. Sathirathai. 2002. Do Open Access Conditions Affect the Valuation of an Externality? Estimating the Welfare Effects of Mangrove-Fishery Linkages in Thailand. Environmental and Resource Economics 21(4): 343-367.

[96] Barbier, E.B. 2007. Valuing Ecosystem Services as Productive Inputs. Economic Policy 22(1): 177-229.

| **Exhibit 1: Original and Corrected Values Using Ecosystem Good or Service** | Year of Initial Harm | Neotropica: Present Value over 50 years (2016 USD) | Corrected Analysis: Estimate of Present Value Damages (2016 USD) | Correction Made |
|---|---|---|---|---|
| Standing Timber | 2010 | $420,162 | $27,248 | Corrected to One-Time Value |
| | 2013 | $42,327 | $2,927 | |
| | Total | $462,490 | $30,175 | |
| Raw materials (fibre and energy) | 2010 | $17,058 | $1,121 | Corrected to One-Time Value |
| | 2013 | $819 | $79 | |
| | Total | $17,877 | $1,200 | |
| Gas regulation/air quality | 2010 | $797,827 | $41,050 | Corrected to One-Time Value |
| | 2013 | $139,682 | $6,728 | |
| | Total | $937,509 | $47,778 | |
| Natural hazards mitigation | 2010 | $157,080 | $0 | Not relevant to injured area |
| | 2013 | $27,501 | $0 | |
| | Total | $184,581 | $0 | |
| Habitat and nursery (biodiversity) | 2010 | $34,662 | $4,384 | Adjusted Present Value |
| | 2013 | $6,069 | $760 | |
| | Total | $40,730 | $5,144 | |
| Soil formation/erosion control | 2010 | $722,031 | $0 | Not relevant to injured area |
| | 2013 | $457,893 | $0 | |
| | Total | $1,179,924 | $0 | |
| Total | 2010 | $2,148,821 | $73,803 | |
| | 2013 | $674,291 | $10,494 | |
| | Total | $2,823,112 | $84,296 | |

## VI. MONETIZING ENVIRONMENTAL DAMAGE USING STANDARD TECHNIQUES

As described above, the standard approach in natural resource damage assessment is to value damage claims using restoration or replacement costs. In our view, such an approach is appropriate for valuing Costa Rica's claims for environmental damage, and it would provide an accurate measure of loss that does not suffer from the weaknesses inherent in Neotropica's approach.

The largest environmental damage claims before the UNCC used this approach.[97] Damage to Saudi Arabia's coastal environment, discussed in Section II.A. above, was addressed by a combination of restoration costs and replacement costs. The restoration costs were valued by the cost of a remediation plan tailored to the injured sites in Saudi Arabia, using accepted restoration techniques that were expected to avoid unacceptable risks of adverse environmental impacts from the remediation itself.[98] The replacement costs were valued by the cost of shoreline reserves that would provide additional ecological services to replace those that were lost.[99]

It is common in the context of natural resource damage assessment for parties to use payments to land conservation banks, such as wetland banks, or to pay landowners to conserve or protect habitat as a means to offset environmental harms. This is a favoured approach because these actions assure that the same level of environmental services are available as would have been but for the harm in question. Relevant to this case, Costa Rica has an active market that pays landowners and communities for the management of habitat to provide ecosystem services.[100] The price paid for such agreements generally are set at a level that compensates landowners and communities for the lost economic value of the land when placed into conservation status while allowing some activities to continue in a sustainable manner. The International Institute for Environment and Development (UK) lists prices paid to private entities to conserve, manage, and enhance parcels of land to provide ecosystem services. As reported in that document, the highest price

---

[97] They included, in addition to the claim of Saudi Arabia discussed here (claim no. 5000451), Kuwait's claim for areas damaged by oil contamination in the form of oil lakes, oil-contaminated piles, oil trenches, oil spills from pipelines, physically disturbed by the construction and subsequent backfilling of oil trenches by Iraqi forces and by the construction of pipelines by Iraqi forces to transfer oil to fill those trenches UNCC F4 fourth instalment, part II, paras. 73-79, 89-102 (claim no. 5000454, award for this portion of the claim USD 1.97 billion; in para. 93, the Panel said that "remediation should be focused on the restoration of ecological functions, particularly in terms of regulating site stability, infiltration processes, and nutrient cycling.") and UNCC F4 fifth instalment, paras. 411-475 (claim no. 5000460 for loss of various natural resources).

[98] UNCC F4 third instalment, paras. 181-187.

[99] UNCC F4 fifth instalment, paras. 620-622, 630-636.

[100] Porras, I., Barton, D.N, Miranda, M. and Chacón-Cascante, A. (2013). Learning from 20 years of Payments for Ecosystem Services in Costa Rica. International Institute for Environment and Development, London.

paid for ecosystem services by Costa Rica in 2012 was USD 294/hectare/year (page 16). Placed in 2017 dollars (using the GDP price deflator) this price would be USD 309/hectare/year. Assuming a 20- to 30-year payment requirement for the 6.19 hectares that were injured (i.e., that recovery progresses at the harmed site, and thus the replacement is only needed until the site recovers),[101] this would imply an ecosystem service replacement cost of USD 1,913/year, or a present value for 20- to 30- years of USD 27,034 to USD 34,987 (which reflects the funds required to support a 20 to 30 year replacement program, assuming a four percent real discount rate on future costs).

It is important to note that the range of cost estimates presented above is several orders-of-magnitude lower than the damages claimed by Costa Rica, reflecting both the overstatement of damages in the Neotropica report, as well as the availability of efficient markets for ecosystem credits.

[101] As noted above, there is little evidence presented by Neotropica that the harm being addressed will persist for 50 years, or that the harm would not decline with time. As such, we pick a more reasonable time period for this replacement cost estimate.

## APPENDIX A

DETAILED CALCULATIONS

| Ecosystem good or service | Year of Initial Harm | Corrected Analysis: Estimate of Present Value Damages (2016 USD) | Formula | Explanatory Notes |
|---|---|---|---|---|
| Standing Timber | 2013 | $27,247.87 | (2.48 hectares*50% harvest rate*211 cubic m loss per hectare*$64.65 unit cost)+(21.482 PV adjustment factor*2.48 hectares*50% harvest rate*6 cubic m/year growth rate*$64.65 unit cost) | Present value loss: For the eliminated stock of standing timber, the number of hectares lost was multiplied by the cubic meters of loss per hectare, a one-time harvest rate, and unit cost per hectare. |

| Ecosystem good or service | Year of Initial Harm | Corrected Analysis: Estimate of Present Value Damages (2016 USD) | Formula | Explanatory Notes |
|---|---|---|---|---|
| | 2010 | $2,926.73 | (.43 hectares*50% harvest rate*211 cubic m loss per hectare*$40.05 unit cost)+(21.482 PV adjustment factor*.43 hectares*50% harvest rate*6 cubic m/year growth rate*$40.05 unit cost) | The value of eliminated stock was added to the present value of timber growing in subsequent years. The present value of growth was calculated as the product of the PV adjustment factor, hectares, harvest rate, growth rate, and unit cost. The unit cost was derived from Neotropica's calculations, which averaged the price of standing timber per cubic meter for several inventoried tree species. |
| Raw materials (fibre and energy) | 2013 | $1,120.50 | 5.76 hectares*$175.76 unit cost*1.1068 GDP scaling factor | One-time loss: The unit cost per hectare was multiplied by the number of |

| Ecosystem good or service | Year of Initial Harm | Corrected Analysis: Estimate of Present Value Damages (2016 USD) | Formula | Explanatory Notes |
|---|---|---|---|---|
| | 2010 | $79.07 | 0.43 hectares*$175.76 unit cost*1.0462 GDP scaling factor | hectares lost, then scaled damages by year of initial harm (2013 or 2010) to 2016 US dollars. The unit cost per hectare was derived from Neotropica's calculations, which averaged $2.02, $292.45, and the average of $109.66 and $4432.19, raw material values derived from literature. |
| Gas regulation/air quality | 2013 | $41,050.16 | 2.48 hectares*$14955 unit cost*1.1068 GDP scaling factor | One-time loss: The unit cost per hectare was multiplied by the number of hectares lost, then damages were scaled by the year of initial harm (2013 or 2010) to 2016 US dollars. The unit cost per hectare was derived from Neotropica's calculations, which took the sum of $14955.23 (stock value) and $26.83 (flow value, the average of $15.56 and $38.10). |
| | 2010 | $6,727.59 | 0.43 hectares*$14955 unit cost*1.0462 GDP scaling factor | |
| | 2013 | $0.00 | N/A | |

| Ecosystem good or service | Year of Initial Harm | Corrected Analysis: Estimate of Present Value Damages (2016 USD) | Formula | Explanatory Notes |
|---|---|---|---|---|
| Natural hazards mitigation | 2010 | $0.00 | N/A | Not relevant to injured area; natural hazards mitigation was therefore excluded from this analysis. |
| Habitat and nursery (biodiversity) | 2013 | $4,384.30 | 2.48 hectares*$62.50 unit cost*1.3167 GDP scaling factor*21.482 PV adjustment factor | Present value loss: The 21.482 PV adjustment factor was multiplied by the number of hectares lost, unit cost per hectare, and GDP scaling factor (to scale 2002 unit cost to 2016 US dollars). The unit cost per hectare was derived from Barbier 2002, as cited by Neotropica. |
| | 2010 | $760.18 | 0.43 hectares*$62.50 unit cost*1.3167 GDP scaling factor*21.482 PV adjustment factor | |
| Soil formation/erosion control | 2013 | $0.00 | N/A | Not relevant to injured area; soil formation/erosion control was therefore excluded from this analysis. |
| | 2010 | $0.00 | N/A | |
| Additional Inputs | | | | |
| Input | | Value | Formula | Explanatory Note |

| Ecosystem good or service | Year of Initial Harm | Corrected Analysis: Estimate of Present Value Damages (2016 USD) | Formula | Explanatory Notes |
|---|---|---|---|---|
| PV Adjustment Factor | | 21.48218462 | $(1-1.04^{-50})/0.04$ | Present value of an annuity: The current value of a set of cash flows in the future, given a 50-year time period and a 4% discount rate |

## APPENDIX B

CURRICULA VITAE

**ROBERT E. UNSWORTH** **PRINCIPAL AND DIRECTOR**

## Overview

Mr. Unsworth is a recognized expert in the field of natural resource economics and damage assessment. His consulting practice focuses on identifying appropriate methods for valuing environmental change in the context of complex environmental litigation, regulatory development, natural resource management, and public policy decision making. In his 32 years of experience he has addressed the full-range of issues encountered in natural resource damage assessment and subsequent environmental restoration.

## Education

Yale University. Master of Forest Science (focus on natural resource and environmental economics). 1986.

State University of New York, College of Environmental Science and Forestry. Bachelor of Science *magna cum laude* in Forestry (focus on forest economics). 1984.

## Summary of Experience

Mr. Unsworth is recognized as a leader in the field of **Natural Resource Damage Assessment (NRDA**). He has worked on over 100 assessments at sites throughout the US and the Caribbean, including playing a leading role in several of the most visible and complex assessments conducted to-date. His work has been for both plaintiffs and defendants involved in environmental damage claims. Examples of his work in this field include:

- **U.S. DEPARTMENT OF JUSTICE**. Serving as an expert witness in cases involving claims for environmental damage caused by wildland fire and legacy hazardous waste releases. Work includes affirmative presentation of damage claims, as well as review and critique of damage claims brought against the United States. Testimony has addressed forested ecosystems, wetlands, groundwater, and lost human use of natural resources.
- **UNITED NATIONS COMPENSATION COMMISSION.** Assisted in the identification and review of available methods for valuing environmental damages resulting from the 1990-1991 Gulf War. This effort included developing briefings for the Commission on available economic valuation and costing methods, and the strengths and weaknesses of these methods in the context of environmental claims.
- **CALIFORNIA ENERGY COMMISSION.** Developed guidance on the use of economics in assessing the ecological benefits of reductions in once-through cooling at power plans. Testified before the Commission on sound approaches to such assessments.
- **STATE AND FEDERAL TRUSTEES FOR NATURAL RESOURCES INJURED BY THE BP DEEPWATER OIL SPILL.** Participated as an expert economist in negotiations with BP over funding of early restoration projects to restore lost human use of the Gulf of Mexico environment.
- **U.S. FEDERAL TRUSTEES FOR RESOURCES INJURED BY THE EXXON VALDEZ OIL SPILL.** Managed the assessment of economic damages resulting from the *Exxon Valdez* oil spill. Assisted in the preparation and analysis of results from a nationwide contingent valuation survey designed to estimate changes in the passive-use value of Prince William Sound as a result of this oil spill.
- **VARIOUS U.S. CLIENTS**. Served as an expert on water valuation in the context of litigated cross-boundary water use conflicts and natural resource damage assessments. Analyses included integrating complex hydrological and biological models with economic valuation tools to yield defensible measures of resource value, and critiquing opposing experts models of water valuation.

- **EUROPEAN COMMISSION.** Served as an expert reviewer of proposals and work product related to the development of methods for determining compensation for environmental harm under the European Union's Environmental Liability Directive.
- **U.S. STATE AND FEDERAL CLIENTS.** Authored guidance documents on best practices for natural resource and environmental valuation, including approaches for assessing damages to wetlands and other aquatic systems, indigenous community impacts, cultural resources, and groundwater. Authored the first published paper on habitat equivalency analysis, which has become the most widely used techniques for environmental damage assessment. Mr. Unsworth is often called upon to speak on the topic of environmental damage assessment, to both technical audiences and legal professionals.
- **VARIOUS U.S. TRIBAL GOVERNMENTS.** Provide expert guidance on methods for assessing the economic and cultural impacts of environmental change in over two dozen tribal (indigenous) communities. Related to this work, for the U.S. Department of the Interior, developed guidance on the use of economics in indigenous community damage claims.

Other relevant work includes:

- **ELECTRIC POWER RESEARCH INSTITUTE.** Led a series of studies of the effect of climate change on the U.S. economy, including the agricultural, forest products, water resources, recreational, and commercial fishing sectors.
- **VARIOUS U.S. FEDERAL AGENCIES.** Developed guidance documents on the use of economics to value environmental changes resulting from oil pipeline releases, injures to National Park resources, and environmental changes associated with air pollution.
- **WORLD COMMISSION ON DAMS (SOUTH AFRICA).** Developed a report describing the potential uses of welfare economics in the assessment of the environmental and social impacts of hydropower dam projects.
- **UGANDA'S MINISTRY OF WATER AND ENVIRONMENT**. Participated in an assessment of the contribution of water resources development and environmental management to Uganda's economy. Specific role was the identification of methods for placing values on forested ecosystems and wetland ecosystems potentially impacted by changes in land use and water management.
- **UNITED NATIONS (NEW YORK)** Presented at seminar on the Protection of the Environment in Relation to Armed Conflict, sponsored by the Permanent Missions to the United Nations of Sweden, Denmark, Finland, Iceland and Norway, in support of ongoing work of the United Nations International Law Commission.

## Leadership

In addition to his consulting practice, he currently serves as a Principal and Director of Industrial Economics, Incorporated (IEc). From 2005 to 2011 he served as IEc's President, responsible for strategic planning as well as day-to-day operations. In addition to his professional responsibilities, he serves as Vice-Chair of the Board of Directors of the Student Conservation Association, a 60-year old organization dedicated to the development of environmental conservation skills in young people of all backgrounds. He is also member of the Board of Directors of the Yale Alumni Service Corps, and has worked with this organization to serve communities in Ghana and India.

## Selected Publications and Presentations

Bishop, Richard and Robert Unsworth, 1994, "Assessing Natural Resource Damages Using Environmental Annuities," *Ecological Economics* 11:35-41.

Mendelsohn, Robert, Daniel Hellerstein, Michael Huguenin, Richard Brazee, and R. Unsworth, 1992, "Measuring Hazardous Waste Damages with Panel Models," *Journal of Environmental Economics and Management* 22:259-271.

Environmental Performance of Tanker Designs in Collision and Grounding: Method for Comparison. Committee for Evaluation Double-Hull Tanker Design Alternatives, Marine Board, Transportation Research Board, National Academies. Washington, DC. 2001.

Equivalency Methods in Natural Resource Damage Assessment. Law Seminars International, Natural Resource Damages. Newark, NJ, November 12-13, 2009

Factors Trustees Consider in Selecting Damage Assessment Approaches. Fourth Annual Advanced Conference on Natural Resource Damages, Law Seminars International. Santa Fe, NM, July 15-16, 2010.

Identifying and Accounting for Cultural Use of Natural Resources in the NRDAR Process, Economic and Other Methodologies. State and Tribal Government Working Group, 2011 Natural Resource Damage Assessment and Restoration Workgroup. Albuquerque, NM, February 15-16, 2011.

Assessment of Lost Cultural Use in the NRDAR Process. U.S. Department of the Interior, Annual NRDA Restoration Workshop, Tribal Session. Phoenix, AZ, March 28, 2011.

An Introduction to Tribal Natural Resource Damage Claims. Wth Dr. Gerald (Taiaiake) Alfred, for the Law Seminars International Conference on Natural Resource Damages. Santa Fe, NM, July 14-15, 2011.

Thoughts on Early Restoration and the Measurement of the Benefits of Enhanced Remediation in the Context of Natural Resource Damage Assessment. Ad-Hoc Industry Natural Resource Damage Group 8th Annual Natural Resource Damage Symposium. Washington, DC, October 25-26, 2011.

Natural Resource Damage Claims Using Habitat and Resource Equivalency: The Case of Wildland Fire. Law Seminars International, Natural Resource Damages: *Evolving strategic, tactical and substantive issues*. Washington, DC, February 14-15, 2013.

Climate Change and Wildland Fire Damages (with Christine Lee). Wildland Fire Litigation Conference, Monterey, California April 26, 2014.

Baseline: What Does It Really Mean and How Do You Prove It? Law Seminars International Conference on Natural Resource Damages. Washington, DC. April 2014.

Trustee Considerations in Applying Non-use Valuation Methods for Purposes of NRDA. Law Seminars International: The Eighth Annual Advanced Conference on Litigating Natural Resource Damages. Santa Fe, NM. July 24-25, 2014.

The Role of an Expert in Environmental Damages Litigation. Boston College School of Law, Boston, Massachusetts. March 2016.

Economics of Natural Resource Damage Assessment. University of Houston Law Center, Houston, Texas. September 2016.

A Practitioner's View: An Update on Tribal Damage Assessment. Law Seminars International, Tribal Natural Resource Damage Assessment. Seattle, WA. 16 December 2016.

Environmental and Natural Resource Economics in Practice: Water Wars in the American South. Yale University, New Haven, Connecticut. March 2017.

**Cymie R. Payne**
+1 510 735 1520
cp@cymiepayne.org
www.cymiepayne.org
@CymiePayne

---

**PROFESSIONAL EXPERIENCE**

**Rutgers University** 2011-present
**Associate Professor** 2016-present
**Assistant Professor**, School of Environmental and Biological Sciences, Department of Human Ecology; School of Law; Bloustein School of Public Policy and Planning
Courses Taught: Environmental Law and Policy; International Environmental Law; Climate Governance

**Lewis and Clark Law School** 2010-2011
**Distinguished Environmental Law Scholar**
Course Taught: Deepwater Horizon Blowout Seminar

**International Union for Conservation of Nature and Natural Resources (IUCN)**, Gland, Switzerland, 2010 to present
**Counsel *pro bono publico*, member World Commission on Environmental Law** –

Oral and written submissions to Seabed Disputes Chamber of International Tribunal for the Law of the Sea in Case No. 17, Responsibilities and obligations of States sponsoring persons and entities with respect to activities in the International Seabed Area.

Oral and written submissions to International Tribunal for the Law of the Sea in Case No. 21, Request for an advisory opinion submitted by the Sub-Regional Fisheries Commission. Transcripts, webcasts and documents for both available at www.itlos.org.

Legal advisor to IUCN delegation to Preparatory Committee established by General Assembly resolution 69/292: Development of an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction

**University of California, School of Law, Berkeley** 2006-2010
**Lecturer**
Courses Taught: Climate Change Law & Policy; International Environmental Law; International Courts and Tribunals.

**Director, Global Commons Project and Associate Director, Center for Law, Energy and the Environment**[102]

**United Nations Security Council (UN Compensation Commission)**, Geneva, Switzerland, 1999-2005
**Senior Legal Officer (Team Leader), Legal Officer** - Legal team reviewing environmental reparations from 1990-1991 Gulf War.

**Goodwin, Procter, LLP**, Boston, Massachusetts, 1998-1999
**Associate Attorney** - Legal services specializing in real estate, land use, wetlands, coastal zone, water, historic preservation and toxics.

---

[102] *Formerly the California Center for Environmental Law and Policy (CCELP)*

**United States Department of the Interior, Office of the Solicitor**, Washington, D.C., 1997-1998 **Attorney-Advisor**, Solicitor's Honors Program

**United States Department of the Interior, Office of the Secretary**, Washington, D.C., 1996, **Law Clerk/Assistant** to Joseph Sax, Deputy Assistant Secretary for Policy

**California Coastal Commission**, San Francisco, California, 1995, **Law Clerk/Analyst**

**Nuclear Claims Tribunal of the Marshall Islands**, 1995-1996, **Consultant**

**EDUCATION**

University of California, Berkeley, School of Law (Berkeley Law), Juris Doctor, May 1997

The Fletcher School of Law and Diplomacy, Master of Arts, May 1993

**PUBLICATIONS**

**Book:**

GULF WAR REPARATIONS AND THE UN COMPENSATION COMMISSION: ENVIRONMENTAL LIABILITY (C.R. Payne & P.H. Sand, eds, Oxford University Press, 2011)(Author: chapter 1, *The UNCC Program: Environmental Claims in Context*; chapter 5, *Tracking and Follow-Up Programmes for Environmental Awards*; *Guidance for Researchers*).

**Chapters:**

*Protection of the Natural Environment*, *in* OXFORD GUIDE TO INTERNATIONAL HUMANITARIAN LAW (Ben Saul, Dapo Akande, eds., Oxford University Press, forthcoming)

*Defining the 'Environment' and the Principle of Environmental Integrity*, *in* ENVIRONMENTAL PROTECTION AND TRANSITIONS FROM CONFLICT TO PEACE: CLARIFYING NORMS, PRINCIPLES AND PRACTICES (C. Stahn, J. Iverson, & J. Easterday, eds., Oxford University Press forthcoming).

*Developments in the Law of Environmental Reparations: A Case Study of the UN Compensation Commission*, *in* ENVIRONMENTAL PROTECTION AND TRANSITIONS FROM CONFLICT TO PEACE: CLARIFYING NORMS, PRINCIPLES AND PRACTICES (C. Stahn, J. Iverson, & J. Easterday, eds., Oxford University Press forthcoming).

*Legal Liability for Environmental Damage: The United Nations Compensation Commission and the 1990-1991 Gulf War*, *in* STRENGTHENING POST-CONFLICT PEACEBUILDING THROUGH NATURAL RESOURCE MANAGEMENT, VOLUME 6: GOVERNANCE, NATURAL RESOURCES, AND POST-CONFLICT PEACEBUILDING (C. Bruch, C. Muffett, and S. Nichols, eds., 2016).

*Collective Responsibility for Sound Resource Management:* Erga Omnes *Obligations and Deep Seabed Mining* in Environmental Rule of Law: Trends from the Americas (OAS 2015). [Also published in Spanish as *La responsabilidad colectiva para la gestión adecuada de los recursos marinos* in Estado de derecho en materia ambiental: Tendencias en las Américas (OAS 2015).]

*The Norm of Environmental Integrity in Post-Conflict Legal Regimes, in* JUS POST BELLUM (C. Stahn, J. Easterday, and J. Iverson, eds, Oxford University Press, 2014).

*Environmental Liability*, *in* ESSENTIAL CONCEPTS OF GLOBAL ENVIRONMENTAL GOVERNANCE (J.-F. Morin & A. Orisini, eds., Routledge, 2014).

*Guide to Sources* in THE IRAN-UNITED STATES CLAIMS TRIBUNAL AND THE PROCESS OF INTERNATIONAL CLAIMS RESOLUTION with D.D. Caron, J. Crook and L. Caplan (D.D. Caron and J.R. Crook eds., Transnational Publishers 2000).

**Articles:**

*The Limits of Judicial Mechanisms for Developing and Enforcing International Environmental Norms,* PROCEEDINGS OF THE ANNUAL MEETING (AMERICAN SOCIETY OF INTERNATIONAL LAW), Vol. 109 (forthcoming).

*Public Participation and Norm Formation for Risky Technology: Adaptive Risk Governance of Solar Radiation Management,* 5:2-4 CLIMATE LAW 210-251 (with Rachael Shwom & Samantha Heaton, 2015).

*ICJ Halts Antarctic Whaling – Japan Starts Again*, 4:1 TRANSNATIONAL ENVIRONMENTAL LAW 181-194 (2015).

*Australia v. Japan: ICJ Halts Antarctic Whaling*, 18:9 AM. SOC. INT'L L. INSIGHTS (2014).

*Argentina's ICSID Arbitrations and the UNCC Experience: Consistency and Capability in Mass Claims,* 6 WORLD ARBITRATION AND MEDIATION REVIEW 427-61 (2012).

*International Environmental Law-Making and the International Court of Justice,* PROCEEDINGS OF THE ANNUAL MEETING (AMERICAN SOCIETY OF INTERNATIONAL LAW), Vol. 105 (March 23-26, 2012), pp. 66-66c.

*Mastering the Evidence: Improving Fact Finding by International Courts*, 41 ENVIRONMENTAL LAW 1191-1220 (2011).

*State Responsibility and Liability for Deep Seabed Mining in International Waters*, ENVIRONMENTAL POLICY AND LAW (co-authored with Donald Anton and Robert Makgill, 2011).

*Pulp Mills on the River Uruguay (Arg. v. Uru.)*, 105 AM. J. INT'L L. 94 (January 2011).

*Environmental Impact Assessment as a Duty under International Law: The International Court of Justice Judgment on Pulp Mills on the River Uruguay*, 3 EUR. J. OF RISK REGULATION 317 (2010).

*Pulp Mills on the River Uruguay: The International Court of Justice Recognizes Environmental Impact Assessment as a Duty under International Law*, 14:9 AM. SOC. INT'L L. INSIGHTS (2010).

*Balancing the Risks: Choosing Climate Alternatives*, EARTH ENVTL. SCI. 8 (2009).

*State of Play: Changing the Climate in Copenhagen*, 13 AM. SOC. INT'L L. INSIGHTS (2009).

*Local Meets Global: The Low Carbon Fuel Standard and the WTO*, 34 NORTH CAROLINA JOURNAL OF INTERNATIONAL LAW & COMMERCIAL REGULATION 891 (2009).

*Introductory Note to Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Compliance Procedures*, 46 INTERNATIONAL LEGAL MATERIALS 1174 (2007).

*U.S. Supreme Court, Greenhouse Gas Regulation and Foreign Policy Considerations*, 11 AM. SOC. INT'L L. INSIGHTS (3 May 2007).

*Environmental Damage at the United Nations Compensation Commission*, 2 INTERNATIONAL ENVIRONMENTAL NEWS (Summer/Fall 2006).

*UN Commission Awards Compensation for Environmental and Public Health Damage from 1990-91 Gulf War*, AM. SOC. INT'L L. INSIGHTS (10 August 2005).

*Local Regulation of Natural Resources: Efficiency, Effectiveness, and Fairness of Wetlands Permitting in Massachusetts*, 28 ENVIRONMENTAL LAW 519 (1998).

*Foreword to Symposium: The Ecosystem Approach: New Departures for Land and Water*, 24 ECOLOGY LAW QUARTERLY 619 (1997).

**Reports, Reviews, Briefs:**

*Sustainable Management of High Seas Marine Resources: Scoping Note on Rules and Practices of International Law,* Role of International Law in Sustainable Natural Resource Management for Development Committee, International Law Association (2016).

International Tribunal for the Law of the Sea, Case No. 21, Request for an advisory opinion submitted by the Sub-Regional Fisheries Commission (SRFC) (Request for Advisory Opinion submitted to the Tribunal)(Brief for the International Union for Conservation of Nature, with D.K. Anton, R. Churchill, D. Freestone, N. Oral, A. Telesetsky and M. Tsamenyi, 2013).

Seabed Disputes Chamber of International Tribunal for the Law of the Sea, Case No. 17, Responsibilities and obligations of States sponsoring persons and entities with respect to activities in the International Seabed Area (Request for Advisory Opinion submitted to the Seabed Disputes Chamber)(Brief for the International Union for Conservation of Nature, with D.K. Anton & R. Makgill, 2010).

*Abram Chayes & Antonia Handler Chayes' The New Sovereignty: Compliance with International Regulatory Agreements* 24 ECOLOGY LAW QUARTERLY 173 (1997) (book review).

*Gerard Piel, Only One World* 17 FLETCHER FORUM 224 (1993) (book review).

**PRESENTATIONS (selected)**

*Future of Environmental Claims in International Arbitration*, panel discussion, New York Bar Association, May 2017.

*Adjudicating International Environmental Disputes: Lessons from Recent Jurisprudence*, Annual Meeting, American Society of International Law, Washington, DC, April 2017.

*Legal dimensions of the concept of climate justice – Work of the International Law Commission on "Protection of the Atmosphere,"* 27th Legal Advisers Meeting at the United Nations, October 2016.

*Whale Wars: What Happens Now? The Bigger Picture: Biodiversity Beyond National Jurisdiction*, American Bar Association – Section of International Law, Tokyo, Japan, October 2016.

*Jus Post Bellum and Reparation*, *Jus Post Bellum* Final Conference: Taking Stock of Macro Principles, Grotius Centre for International Legal Studies – University of Leiden, The Hague, October 2016.

*Guest Lectures – International Environmental Law*, Yale College, Fall 2016.

*Sustainable Use and Conservation of High Seas Natural Resources*, International Law Association –Johannesburg, South Africa, August 2016.

*UNCC Environmental Program: Lessons for Collective Arbitration*, Exploring Critical Issues in Arbitration, American Arbitration Association and NYU Law School, New York City, May 6, 2016.

*Environmental Effects of Armed Conflic*t, and *Progressive Development through UN Bodies of Environmental Law and Compensation Programs* (two sessions), International Legal Dialogue—Middle East North Africa, American Society of International Law and Columbia Law School, Amman, Jordan, December 14-15, 2015.

*Towards a New Implementing Agreement under UNCLOS on Marine Biodiversity in Areas Beyond National Jurisdiction*, International Law Weekend, American Branch of the International Law Association, New York, November 2015.

*Protecting the Environment: Post-Conflict, Seminar on Protection of the Environment During Armed Conflict*, United Nations Headquarters, New York, November 2015. (also co-organizer with Ambassador Marie

Jacobsson, International Law Commission Special Rapporteur; Carl Bruch, Environmental Law Institute).

*Guest Lectures*, Yale School of Forestry and Environmental Studies, September 2015.

*The Limits of Judicial Mechanisms for Developing and Enforcing International Environmental Norms Roundtable*, American Society of International Law Annual Meeting, April 2015.

*Collective Responsibility for Sound Marine Resource Management*, Inter-American Congress on the Environmental Rule of Law, Organization of American States-UNEP-IUCN-Caribbean Court of Justice, Kingston, Jamaica, March 2015.

*Everything Is Different Now: Armed Conflict and Protection of the Environment*, Law and Environment Workshop, Tel Aviv University Faculty of Law, Tel Aviv, Israel, December 2014.

*Illegal, Unreported and Unregulated Fishing: Law of the Sea Tribunal Advisory Opinion*, Pew Fellows Program in Marine Conservation Annual Meeting, Sausalito, CA, November 2014.

*Protecting the Environment in the 21st Century*, Seminar on Protection of the Environment During Armed Conflict, United Nations Headquarters, New York, October 2014. (also co-organizer with Ambassador Marie Jacobsson, International Law Commission Special Rapporteur; Carl Bruch, Environmental Law Institute).

**BAR MEMBERSHIP & PROFESSIONAL ACTIVITIES**

Member, Massachusetts State Bar (active), California State Bar (inactive), US Supreme Court Bar

Program Committee, American Society of International Law (2016-present)

Executive Committee, Executive Council, American Society of International Law (2013-2016)

Board of Editors, American Society of International Law, *Insights* (2008-2016)

Co-Chair, Program Committee, American Society of International Law Annual Meeting 2012

Expert Reviewer, IPCC, Fifth Assessment Report, Working Group 3

IUCN Commission on Environmental Law, Specialist Groups: Oceans and Armed Conflict (2002 to present)

Advisory Board, International Environmental Law IG, ASIL (2014 -2017), (chair 2008-2011)

Rutgers Climate Institute (2013-present), Rutgers Initiative on Climate and Society (2011-2013)

International Law Association (2011 to present) Member, Sustainable Development Study Group (2014); Member, Role of International Law in Sustainable Natural Resource Management for Development Committee (2015-present)

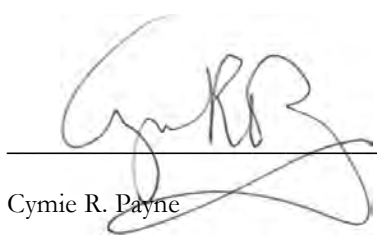
European Society for International Law (2011 to present)

Manuscript referee, Cambridge University Press, Journal of Applied Ecology, Edward Elgar, Journal of International Dispute Settlement, Transnational Environmental Law, Science, Griffith Law Review

Civil Society Observer, United Nations Climate Change Conference of the Parties (2007-2009)

NSF Peer Review – Science, Technology and Society 2012

**LANGUAGES** - French (United Nations *Certificat d'aptitudes linguistiques*); Spanish



Cymie R. Payne

Robert E. Unsworth

Date: 26 May 2017

# Annex 2

G. Mathias Kondolf, PhD, Review of Costa Rica's Claims for Compensation in the Río San Juan Delta

May 2017

**Review of Costa Rica's Claims for Compensation in the Río San Juan Delta**
G. Mathias Kondolf, PhD
May 2017

## Introduction and Scope

I am a fluvial geomorphologist, specializing in environmental management and restoration of rivers. I have been on the faculty of the University of California Berkeley for 29 years, where I teach hydrology, river restoration, environmental planning, and environmental science.

I have studied the geomorphology of the Río San Juan area, and the disputed area in particular, since 2012. Among other things, I have conducted studies of erosion and sediment delivery along the river, channel changes in the lower Río San Juan, and related analyses. In connection with this work, I have overflown the river mouth five times from October 2012 to October 2016 and conducted three site visits over the same period, the most recent in October of 2016. I testified before the Court in the hearings of April 2015.

In connection with its claim for compensation, Costa Rica has submitted a report prepared by Fundación Neotrópica ("Neotrópica"), dated 3 June 2016, which values the environmental impact of Nicaragua's work in the disputed area.[1] I have reviewed that report, as well as the additional "Explanatory Addenda" dated 8 December 2016.[2] I have also reviewed the Memorial on Compensation to which those documents are annexed.

The present report addresses three aspects of the Neotrópica valuation: (1) its valuation of "soil formation/erosion control" services; (2) its valuation of "natural hazard mitigation" services; and (3) its application of a 50-year recovery period for impacts caused by Nicaragua's works.

In respect of these matters, it is my opinion that: (1) Nicaragua's works did not impact soil formation or erosion control services; (2) Nicaragua's works also had no impact on the ability of the disputed area to mitigate "natural hazards"; and (3) the recovery that has already occurred at the site to date indicates that realistic recovery periods range from 1-2 years for refilling the caños, 1-5 years for the regrowth of grass and underbrush, and 4-5 years for the re-establishment of trees sufficient to perform most functions expected from a woodland.[3]

---

[1] Fundación Neotrópica, "Monetary Valuation of the environmental damages arising from the construction of caños and clearing of trees and vegetation performed by the Government of Nicaragua in the Costa Rican territory of Isla Portillos, as required by the Judgment of the International Court of Justice of 16 December 2015" (3 June 2016), Annex 1 to the Memorial of Costa Rica on Compensation.

[2] Fundación Neotrópica, "Explanatory addenda…" to the 3 June 2016 report (8 December 2016), Annex 2 to the Memorial of Costa Rica on Compensation.

[3] Neotrópica lists 14 sources as providing the inputs for its valuation (Table 2). I have previously reviewed many of those reports, and I refer the Court to the critique provided in my first report,

### (1) Soil Formation/Erosion Control

Neotrópica assumes that Nicaragua's works impaired "soil formation/erosion control" services in the disputed area. However, those services are not provided by the impacted area and thus were not diminished as a result of Nicaragua's works.

Concerns regarding soil formation and erosion control services are generally understood to apply principally in upland sites, where deforestation and other disturbances risk causing increased erosion and delivery of fine sediment downslope. In such an environment, removing stabilizing vegetation or scraping off the soil surface could cause such impacts.

These concerns are not applicable to the disputed territory, which is an active river delta that is a zone of deposition of sediments eroded in the upper parts of the river basin **[Figure 1]**. The land is flat and the water surface barely slopes seaward. There are very high sediment loads reaching this naturally depositional zone. Such high rates of deposition led to rapid sedimentation and infilling of the Bay of San Juan in the 19th century. Since the mid-20th century, sediment loads have increased at least 10-fold. (Andrews, 2015; Kleinn, et al., 2002.)

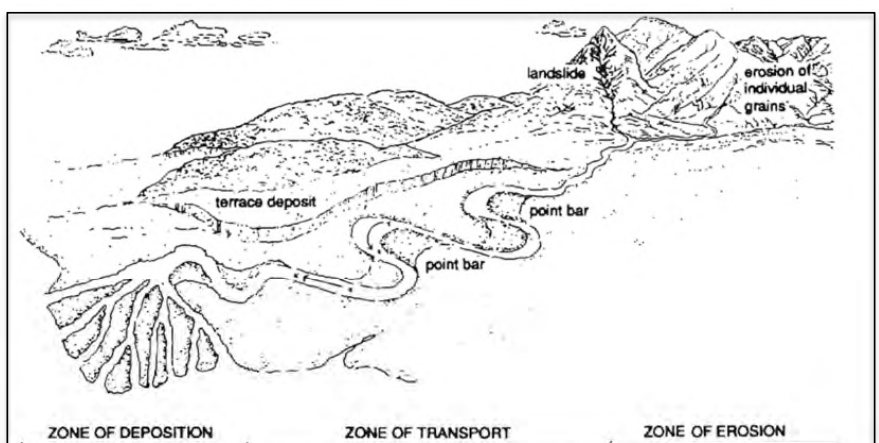



**Figure 1.** Idealized river basin showing zones or erosion, transport, and deposition (adapted from Schumm, 1977). The mouth of the Río San Juan lies the zone of deposition, so it naturally receives high sediment loads and experiences dynamic channel change.

For these reasons, erosion is not an issue in the disputed area. Rather, it is an area where the deposition of sediment happens constantly and rapidly, and where small irregularities in the land surface (such as excavations) are quickly smoothed out by deposition of sediment. Indeed, the entire area owes its

"Distributary Channels of the Río San Juan, Nicaragua and Costa Rica: Review of Reports by Thorne, UNITAR, Ramsar, MEET, and Araya-Montero (July 2012), Appendix 1 to the Counter-Memorial of Nicaragua in the underlying case.

existence to the deposition of sediments that have been transported from upstream sites. As is typical of deltas, this dynamic area is characterized by a complex of multiple, shifting distributary channels (caños) that open and close in response to high flows and deposition of sediments. At a broad scale, the delta landform can be seen as existing in the balance between the supply of sediment from upstream and its deposition within the delta, which tend to build the delta, and natural subsidence (from compaction of sediments) and coastal wave erosion, which tend to reduce the delta.

Due to the depositional nature of the delta region, the caños that were excavated in 2010 and 2013, small features to begin with, rapidly filled with sediment and revegetated. This is documented in aerial imagery and field evidence.[4] The 2010 caño filled in within less than a year, and the 2013 eastern caño had largely filled in by the time Costa Rica built a dyke across it in March 2015. By that date, the caño's dimensions were smaller than expected by Costa Rica, as Annex 4 to the Memorial on Compensation explains (pp.14-15), due to rapid natural deposition and revegetation. After the dyke was installed, there was further sedimentation of the caño.

From field evidence presented in various reports, it is clear that the sites have already recovered to a significant degree: the caños have filled in with sediment and revegetated. For example, the Ramsar Advisory Mission found, in its 2014 report (on Mission 77), that there is a "high capability for natural regeneration of vegetation in this area" (p.14). That assessment accords with the views expressed by Professor Thorne.[5]

Sequential satellite imagery from 2010-2017 (see Appendix A[6]) shows clearly the extent of disturbance associated with digging the 2010 caño (image of 2010-11-19), and the rapidity of the caño filling in, which had largely occurred by the following year (image of 2011-12-26). Rapid sedimentation of the caño is expected in this environment, as depressions tend to have greater deposition rates, such that the topography of floodplains and delta plains tends to even out over time.

The sequential images also show the rapidity of tree re-establishment, which had largely occurred four years later (image of 2014-09-26), with individual trees clearly visible on the imagery. It is not possible to measure tree heights from the imagery, but the plan-form tree outlines visible on the imagery have similar form

[4] I also note that rather than being "removed" from the wetland, the soil that was excavated from the caños was redistributed along the margins of the caños. CRM Annex 155, pp.32-33; Thorne, 2013, p.3 (reporting that the "freshly dredged sediment" extracted during Nicaragua's works in 2013 was visible in "patches…on the floodplain adjacent to the new caño to the east," having been deposited there by the "spoil pipes" attached to the dredger).

[5] Testimony of Prof. C. Thorne on the afternoon of 14 April 2015 (CR 2015/3, p.42): "Vegetation does recovery very quickly in these areas."

[6] In addition to the satellite imagery of the 2010 caño discussed in this report, Appendix A also includes satellite imagery of the areas felled in 2010, as well as satellite imagery of the site of the 2013 caño from 2013-2017.

and dimensions to those of the surrounding woodland by 2014. Also visible on the imagery is the extensive blowdown from the hurricane of November 2016, which can be clearly identified in the image of 2016-12-02.

The rapidity of the re-sedimentation of both caños illustrates the irrelevance of the "erosion control" service in these locations. Even if the site of the caños provided the claimed erosion control "service," there would be no ongoing harm, because the caños have filled and revegetated, as can be seen in the sequential satellite imagery.

**(2) "Natural Hazards" Mitigation**

Neotrópica claims losses due to "natural hazards mitigation" services, evidently referring to "flood and storm protection…the ability of ecosystems to reduce natural hazards and disasters" (p.18). There is no geomorphological basis for this claim.

In that regard, the Neotrópica report does not describe how the soils or vegetation in the caño sites regulate floods. In fact, these are flooded forests, which are often naturally inundated. Excavating a small caño or clearing patches of vegetation within this environment would not impair natural regulation of flooding.

Neotrópica assumes that there was a "hydrological impact on the area."[7] However, from a scientific perspective, there was no material hydrological impact from the caños, even when they remained open. None of the sources cited by Neotrópica suggests that such an impact occurred.[8] Rather, they posited the existence of certain risks, such as breaching of the Harbor Head Lagoon barrier spit, capture of the river, saltwater intrusion into the small lagoon at the end of the 2013 caño, rupture of the nearby beach barrier, "complex process-response mechanisms," and "serious and irreversible morphological and environmental degradation." None of these risks materialized.

Viewing the site in its larger context, even if there were some flood "mitigation" function (i.e., flood reduction) that could have been provided by the sites of the 2010 and 2013 caños, there are no settlements that would be affected either upstream or downstream. Thus, Neotrópica's claim that it "determined that the natural hazard mitigation service is important to the area, the infrastructure, and nearby towns, especially because these areas are highly vulnerable to the effects of climate change" (p.45) is contradicted by conditions on the ground. The only nearby settlement is San Juan del Norte, Nicaragua, which is located

[7] See Table 12, listing a description of this "impact" as "required data" for this aspect of the valuation.

[8] Neotrópica indicates that all 14 of the reports it cites provide data relevant for valuing the impact to "natural hazards mitigation" allegedly caused by Nicaragua's works (Table 12). With the exception of report #11 (which is not in the record and does not appear to be publicly available), I have reviewed all of these documents, some of which I critiqued in my July 2012 report.

approximately 4 km west of the 2013 caños and approximately 6 km west of the 2010 caño, on a different waterbody, the Río Indio. Any changes induced by the caños, even while they were open, could not have affected flooding or the impacts of other natural hazards at San Juan del Norte.[9]

It is notable that Hurricane Otto made landfall in the disputed area in November 2016. There is no evidence that the caños or related clearing of trees and underbrush had any appreciable impact on the way the storm impacted the disputed area or the surrounding communities and infrastructure.

**(3) Recovery Time**

Neotrópica assumes that it will take 50 years for the disputed area to recover from the impacts of Nicaragua's works. The basis for this recovery time is not clearly articulated, but it appears to be built on two flawed assumptions.

First, Neotrópica states (p.31): "Since the action may affect one or more resources, the time for restoration must correspond to the resource with the longest recovery time." However, there is no scientifically valid reason to apply the recovery time for the longest recovering resource, which Neotrópica assumes is trees, to all elements of the site, including soil, grass and shrubby vegetation, which recovered much more rapidly.

Second, Neotrópica indicates that the 50-year recovery period for trees is based on the assumption that the felled trees had an average age of 115 years, with 46% being over 100 years old (Explanatory Addenda, p.9). These figures rely on data from the 2010 caño as reported in CRM Annexes 145 and 154. However, as indicated in the critique contained in my July 2012 report, they were calculated using growth rates that are probably less than half the correct growth rate (thus yielding tree ages that are too old), and by including only trees with diameters larger than 10cm, which distorted the data set and artificially increased the percentage of the area reported to have been occupied by larger trees.[10] This means that the average tree age and distribution values for the area of the 2010 caño used by Neotrópica are incorrect.

[9] The San Juan delta area is materially different from the coastal mangroves, wetlands, and reefs described in the four studies from which Neotrópica derives its estimated ecosystem values for hazard mitigation services (p.158). In those cases—from Thailand, Mexico, and Belize, respectively—the mangroves, wetlands, and reefs at issue were situated in large, linear features along the coast, acting as a significant barrier to wave energy and thus protections for human settlements along the coast. (Barbier et al., 2002; Barbier, 2007; Camacho-Valdez, et al., 2014; Cooper, et al., 2009.) In contrast, the small areas of flooded forest affected by the caños cleared by Nicaragua are not large enough or located in such a way (i.e., as a protective line between the ocean and human settlements or infrastructure) that they could protect nearby settlements.

[10] Indeed, the Costa Rican reports on which Neotrópica relies reported tree ages that are contradicted by Professor Thorne's estimate of the age of the land on which they grew. In his 2015 report (p.16), Professor Thorne indicated his opinion that the oldest tree felled in the location of the 2010 caño was 248 years old. The Costa Rican reports on which Neotrópica relies estimated tree ages for this location of up to 296-353 years. See CRM Annexes 145 and 154.

In addition, Neotrópica applies these erroneous values to the site of the 2013 caño. There is no basis for doing so because, as Professor Thorne has explained, the 2013 caño was constructed in a location where the vegetation was different and younger.[11] Accordingly, it is incorrect for Neotrópica to conclude that it would take trees 50 years, on average, to recover.

In light of the evidence available, realistic recovery times would be 1-2 years for refilling the caños, based principally on empirical observations on aerial imagery, and 4-5 years for re-establishment of trees (reflecting the rapid growth rates in this environment). The trees present in 4-5 years would not be equivalent to the largest specimens reported as having been cut during the clearance of the 2010 caño, but they would perform most functions expected from a woodland, including providing habitat and food resources.

Based on these principles and the changes observed on the satellite imagery, I estimate recovery time for other functions and their potential benefits as follows:

- For grass and underbrush, 1-5 years, based on recovery patterns observed in aerial imagery.
- For uptake of carbon by trees, 1-5 years, based on recovery observed on aerial imagery and accounting for the more rapid uptake of carbon by growing trees than by mature, old-growth trees (a point relevant to mitigation of greenhouse gas emissions by sequestration of carbon in vegetation).
- For habitat and biodiversity, 10-20 years, reflecting the fact that while basic ecosystem functions would be restored within 1-2 years, larger trees offer greater complexity in habitats. Thus, to increase habitat complexity, recovery should allow for growth of larger trees, which is rapid in this environment (as visible on aerial imagery), but which slows after approximately 10 years.

[11] Testimony of Prof. C. Thorne on the afternoon of 14 April 2015 (CR 2015/3, p.42): "The nature of the ground and the vegetation through which the first caño was cut, in my opinion, differed from that of the second and third caños, which are much further north and on land which is much younger, because it was only created by the progradation of the delta many years after the land at the root of the delta. Consequently, because it was not as old and as well established, it did not have the mature trees of great antiquity that were destroyed when the first caño was cut. Therefore, I would say, in my opinion, the environmental impact of the second and third caños was not as great as that of the first caño."

**References**

Aguilar-Gonzalez, B., Carranza-Vargas, M., Hidalgo-Chaverri, M. and Fernandez-Sanchez, A. of Fundación Neotrópica. 2016. Monetary Valuation of the environmental damage arising from the construction of artificial caños and clearing of trees and vegetation performed by the Government of Nicaragua in Costa Rican territory on Isla Portillos, as required by the Judgment of the International Court of Justice of 16 December 2015. Annex 1 to the Memorial of Costa Rica on Compensation.

Aguilar-Gonzalez, B. et al. of Fundación Neotrópica. 2016. Explanatory addenda to the Report "Monetary valuation of the environmental damages arising from the construction of artificial *caños* and clearing of trees and vegetation in Isla Portillos, Humedal Caribe Noreste, Costa Rica, in conformity with the Judgment of the International Court of Justice, The Hague" in view of the request for clarification by Nicaragua in the note addressed to Ambassador Sergio Ugalde (HOL-EMB-280) dated 18 November 2016. Annex 2 to the Memorial of Costa Rica on Compensation.

Andrews, E. 2014. 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. Annex 3 to the Reply of Nicaragua in the *Construction of a Road* case.

Araya-Montero, M. 2010. Appraisal of maximum average age of the trees felled in primary forest areas in the Punta Castilla, Colorado, Pococi and Limon sectors of Costa Rica, as a result of the Nicaraguan Army's occupation for apparent restoration of an existing canal. Annex 145 to the Memorial of Costa Rica in the underlying case.

Araya-Montero, M. 2011. Age approximation of trees cut in the Area under Costa Rica's Environmental Management located on the causeway of the artificial channel built on a portion of territory of Calero Island to connect the San Juan River with los Portillos Lagoon. Annex 154 to the Memorial of Costa Rica in the underlying case.

Barbier, E., Strand, I. and Sathirathai, S. 2002. Do Open Access Conditions Affect the Valuation of an Externality? Estimating the Welfare Effects of Mangrove-Fishery Linkages in Thailand. Environmental and Resource Economics, 21(4): 343-367.

Barbier, E. 2007. Valuing ecosystem services as productive inputs. Economic Policy, 22(1): 177-229.

Camacho-Valdez, V., Ruiz-Luna, A., Ghermandi, A. and Nunes, P. 2014. Valuation of Ecosystem Services Provided by Coastal Wetlands in Northwest Mexico. Ocean & Coastal Management, 78:1-11.

Cooper, E., Burke, L. and Bood, N. 2009. Coastal Capital: Belize – The Economic Contribution of Belize's Coral Reefs and Mangroves. WRI Working Paper. World Resources Institute, Washington, D.C., 53 pp.

Kleinn, C., Corrales, L. and Morales, D. 2002. Forest area in Costa Rica: A comparative study of tropical forest cover estimates over time. Environmental Monitoring and Assessment, 73:17-40.

Kondolf, G. 2012. Distributary Channels of the Río San Juan, Nicaragua and Costa Rica: Review of Reports by Thorne, UNITAR, Ramsar, MEET, and Araya-Montero. Appendix 1 to the Counter-Memorial of Nicaragua in the underlying case.

Ministry of Environment, Energy and Telecommunications of Costa Rica. 2011. Evaluation and assessment of the environmental situation in the Northeastern Caribbean Wetland (*Humedal Caribe Noreste*) pursuant to the Order of the International Court of Justice. Annex 155 of the Memorial of Costa Rica in the underlying case.

Ministry of Environment and Energy (MINAE) of Costa Rica. 2015. Report of works carried out from 26 March to 10 April 2015. Annex 4 to the Memorial of Costa Rica on Compensation.

Report by the Secretariat of the Ramsar Convention, Ramsar Advisory Mission No. 77. 2014. Included as part of Annex 22 to the Memorial of Costa Rica on Compensation.

Schumm, S. 1977. The fluvial system. John Wiley & Sons, New York.

Thorne, C. 2013. Report on the Impact of the Construction of two New Caños on Isla Portillos. Appendix PM-33 to Costa Rica's Request for the Indication of New Provisional Measures.

Thorne, C. 2015. Written Statement prepared for the underlying *Certain Activities* case.

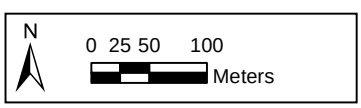
Thorne, C. 2015. Oral Testimony in the underlying *Certain Activities* case, on the afternoon of 14 April 2015 (CR 2015/3, p.42).

# APPENDIX A

## 2010 CAÑO
## SATELLITE IMAGERY
## 2009-2017


N
0 25 50 100
Meters
2010-09-09


N
0 25 50 100
Meters
2010-11-19




2011-12-26


N
0 25 50 100
Meters
2013-09-13


N
0 25 50 100
Meters
2013-11-14


N
0 25 50 100
Meters
2014-09-26

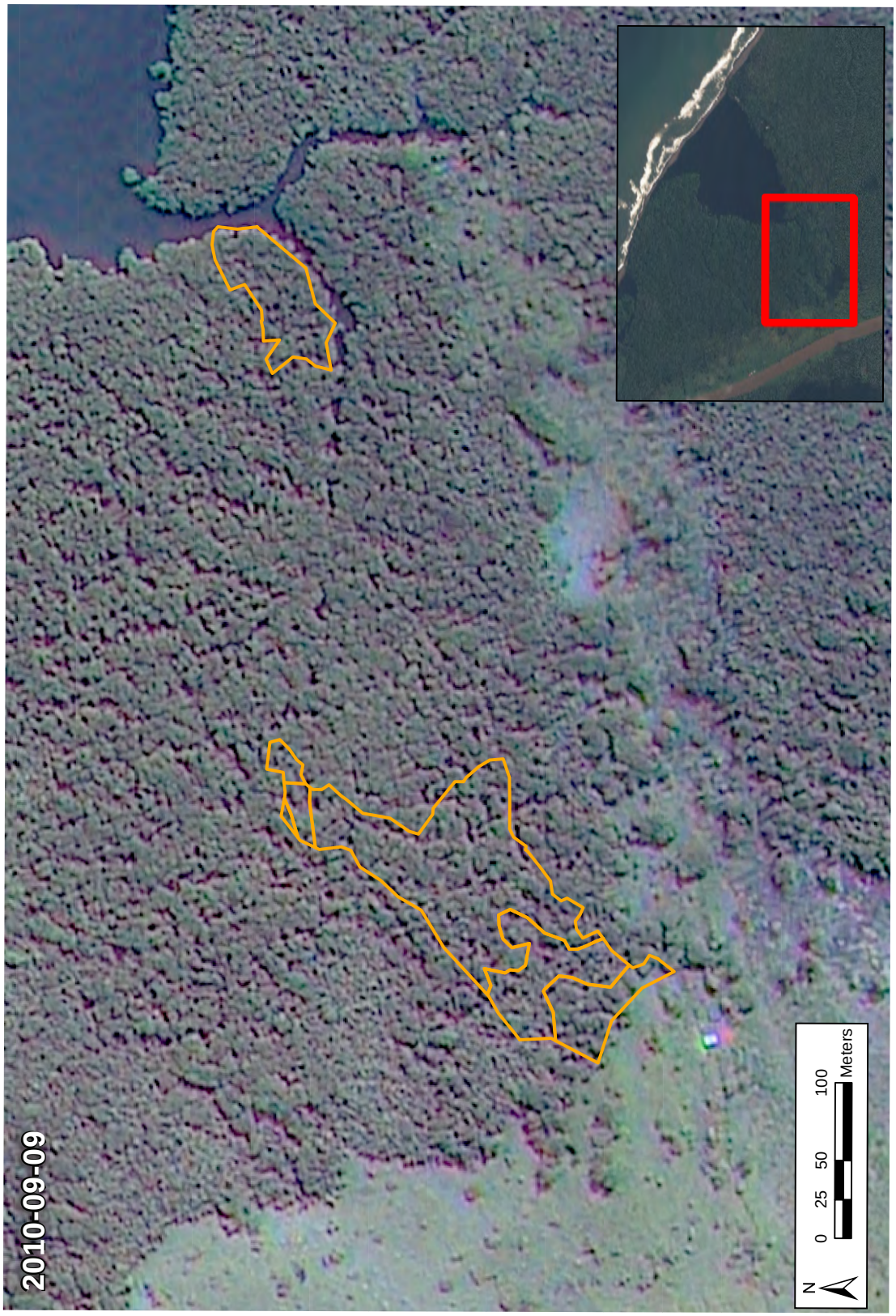

N
0 25 50 100
Meters
2015-02-26

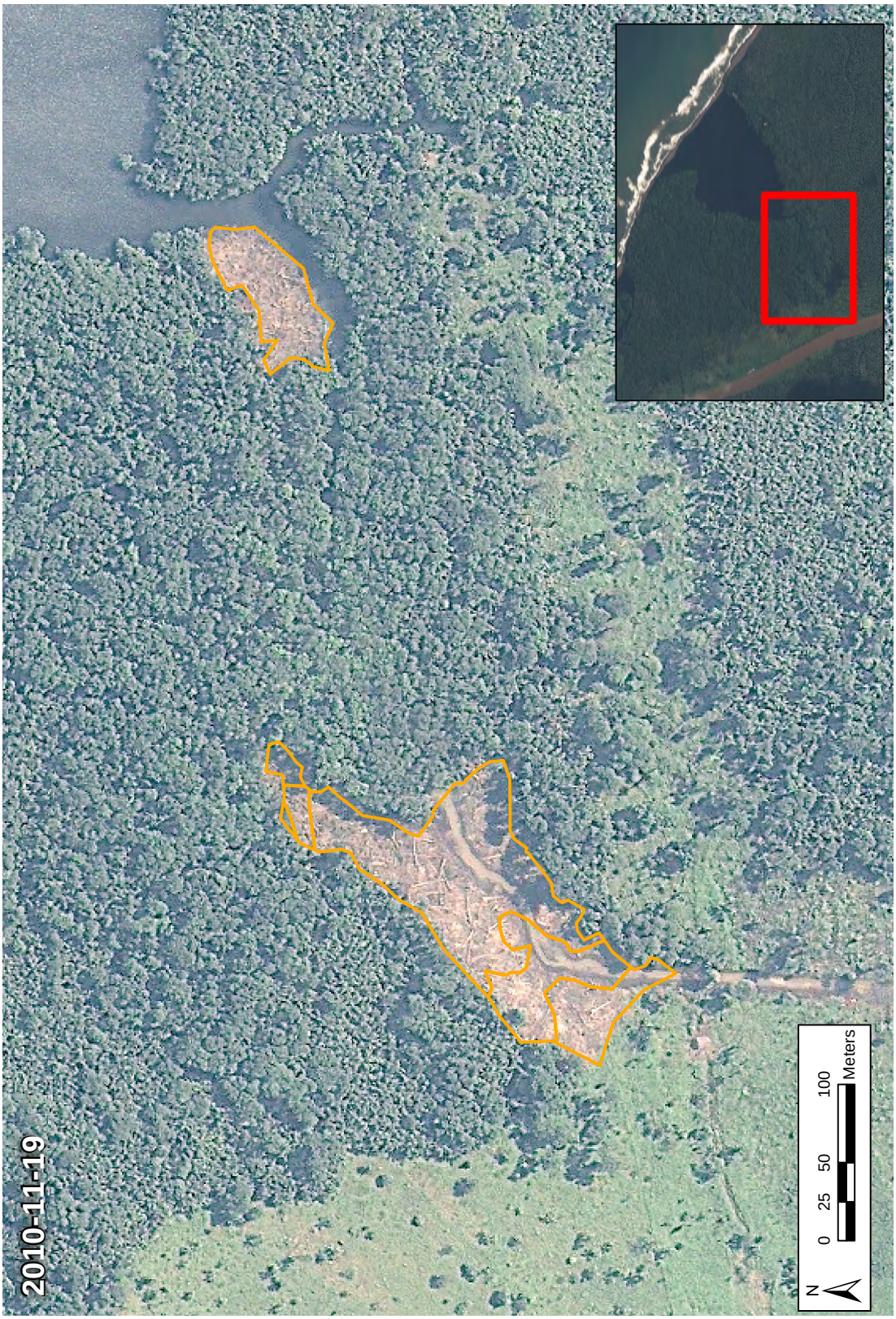

N
0 25 50 100
Meters
2016-12-02

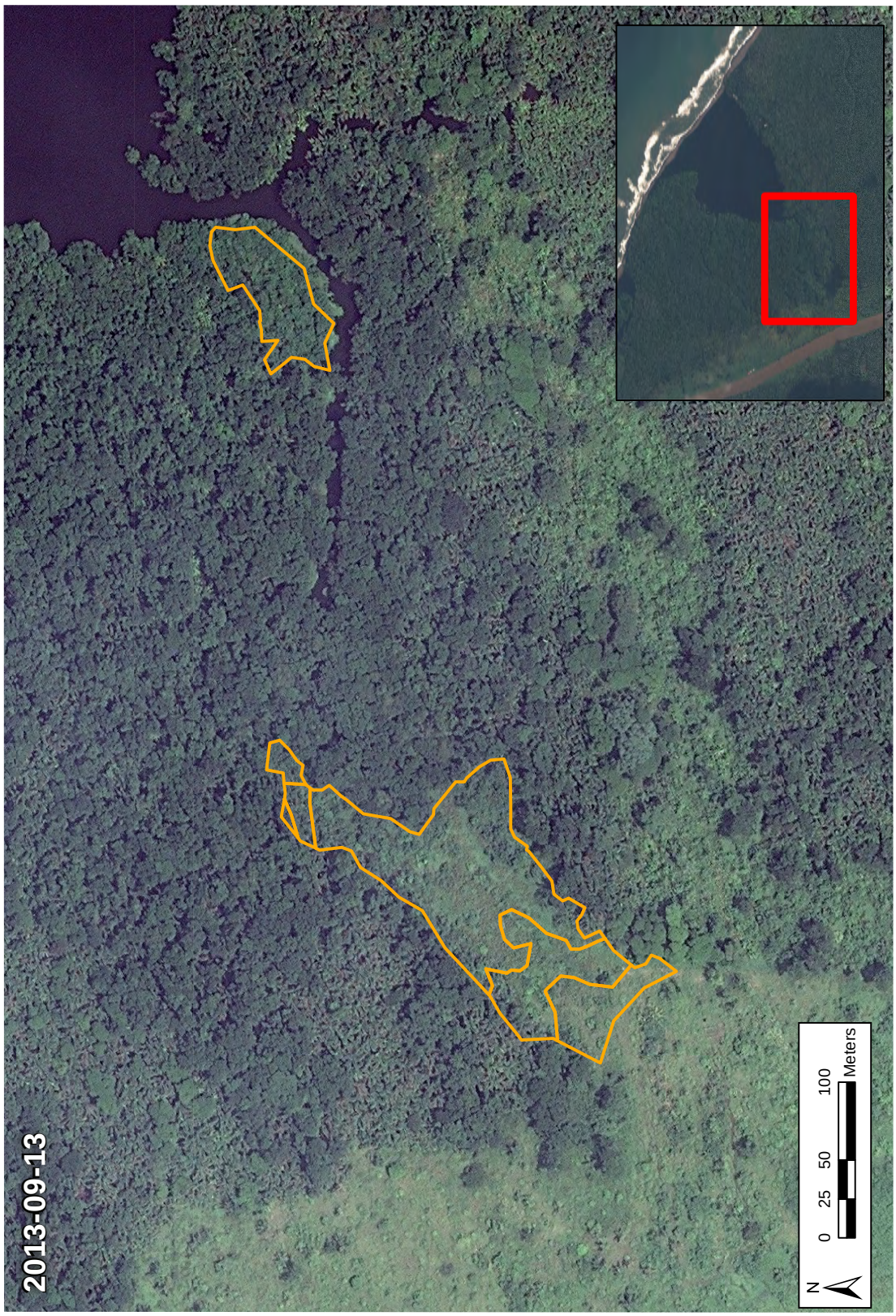

N
0 25 50 100
Meters
2017-01-17

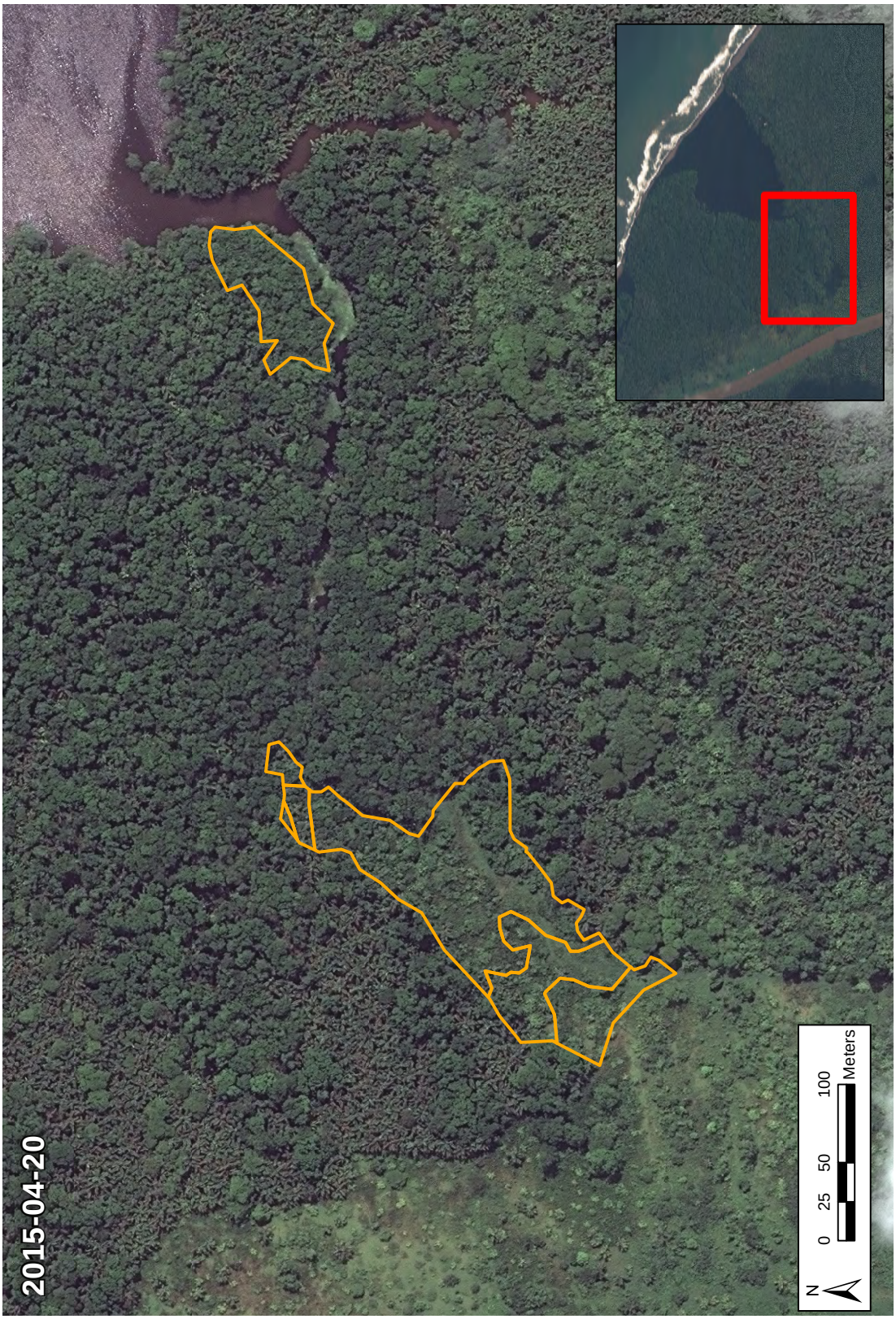
# 2010 CAÑO

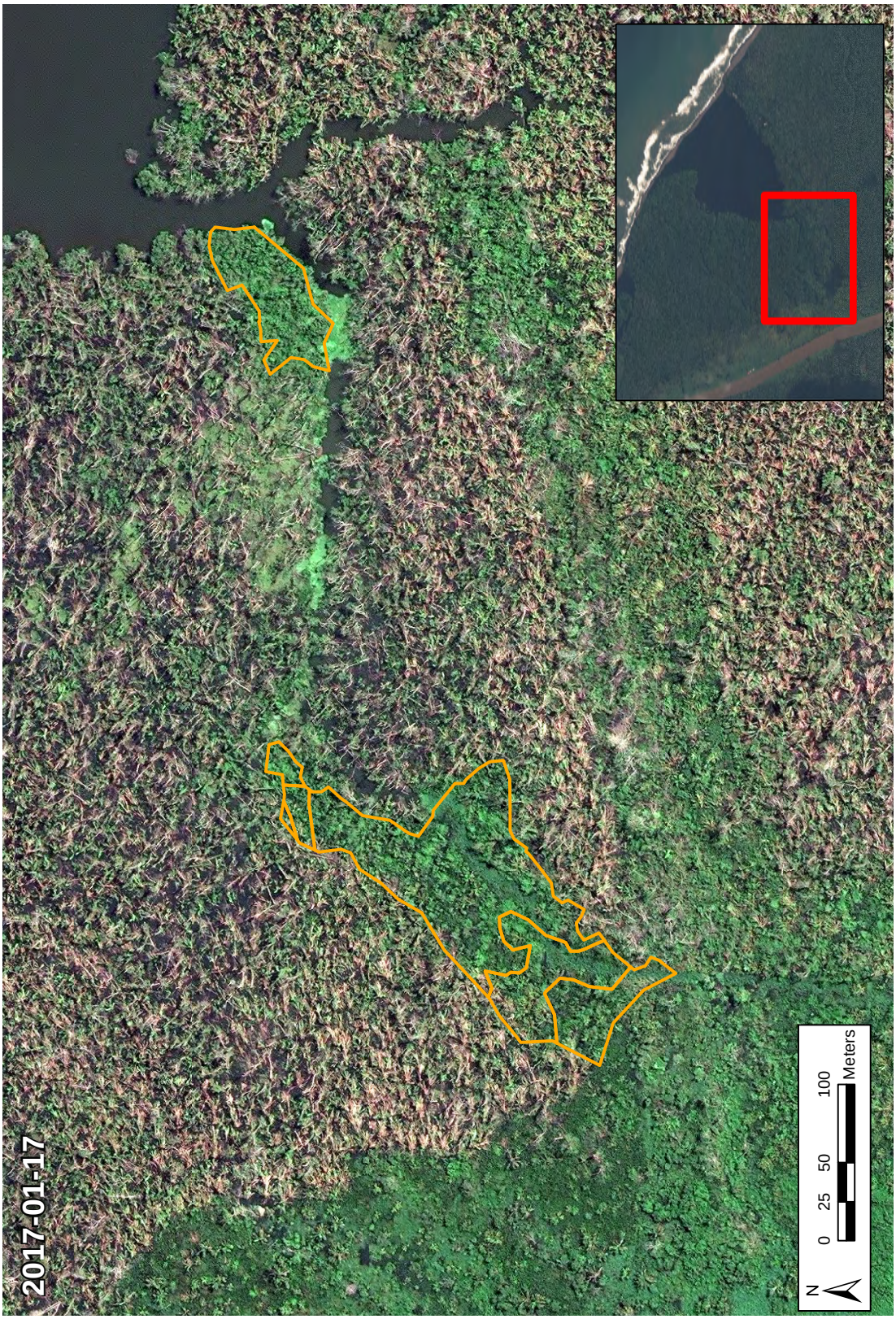
# FELLED AREAS


2010-09-09
N
0
25
50
100
Meters


2010-11-19
N
0
25
50
100
Meters


2013-09-13
N
0
25
50
100
Meters


2015-04-20
N
0
25
50
100
Meters


2017-01-17
N
0 25 50 100
Meters

# 2013 CAÑO

# SATELLITE IMAGERY
# 2013-2017


2013-01-02
N
0
25
50
100
Meters


2013-09-13
N
0
25
50
100
Meters


2013-11-16
N
0
25
50
100
Meters


2015-04-20
N
0
25
50
100
Meters


2015-12-15
N
0
25
50
100
Meters


2016-01-22
N
0
25
50
100
Meters


2017-01-17
N
0
25
50
100
Meters


2017-03-10
N
0
25
50
100
Meters

# Annex 3

Summary Chart of the Information Provided by the Institutions Responsible for Addressing the Damages Caused by Nicaragua in the Isla Portillos Area

Transmitted 7 June 2016

Excerpt

(English Translation)

## SUMMARY CHART OF THE INFORMATION PROVIDED BY THE INSTITUTIONS RESPONSIBLE FOR ADDRESSING THE DAMAGES CAUSED BY NICARAGUA IN THE ISLA PORTILLOS AREA

| No. | Institution | Item | Description | Relationship with the provisions of the Judgment of the ICJ | Amount USD |
|---|---|---|---|---|---|
| 1 | Tortuguero Conservation Area (ACTo)[1] | Wages | Includes the costs incurred in the payment of personnel wages per day of work, which corresponds to attention to environmental protective activities on Isla Portillos. | The staff of the Tortuguero Conservation Area is the staff directly responsible for the protection of the environment in the disputed area. In this sense, they are responsible for all of the actions necessary to monitor, assess, and mitigate damages caused by the excavation of the three "pipes" and the surrounding areas that were drilled by Nicaragua. Due to the actions of Nicaragua, this personnel had to devote a significant amount of time to internal and institutional coordination meetings, patrolling, joint missions with the personnel of the Secretariat for the Ramsar Convention, measurement and data analysis, and mitigation that otherwise would have been unnecessary. | 29,412.88 |
| 2 | Conservation Area | FOOD | Calculations have been done based done the official rate | Since ACTo personnel had to travel and remain on the | 8,886.53 |

[1] Corresponds to 162 visits (from October 10, 2010 until November 16, 2015) to the area in dispute by personnel from the Tortuguero Conservation Area on surveillance and environmental conservation missions, equipment maintenance, and coordination of joint meetings of the Ramsar Secretariat, including those held on October 22 and 25, 2010, January 7, April 5–6, 2011, January 30, August 3, 2012, March 7, September 18, December 10, December 11, 2013, March 11, July 25, November 12, December 5, December 17, 2014, March 26 to April 10, June 9, July 8, and October 3, 2015.

| | | | | | |
|---|---|---|---|---|---|
| | | | | Temporary measures from March 8, 2011. | |
| 8 | Ministry of Security | Wages of Law Enforcement and Border Police forces. | Includes the salaries of the 48 Law Enforcement officers that were assigned to the area adjacent to the Los Portillos Lagoon and Agua Dulce Lagoon from March 2011 to September 2013, and to 46 officers from the Border Police that were assigned to those same outposts from October 2013 to December 2015. The total number of officers is divided into two groups that alternate 10-day continuous work shifts in the region and 10 days of break outside the region. During their stay in the area, they worked in two 12-hour shifts. | Nicaragua's actions in Costa Rican territory, according to the Court's ruling, required the Costa Rican authorities to assign police resources from other regions of the country, to create new police outposts and a new division of the Border Police, first, to avoid Nicaragua claiming sovereignty over additional territories in the region, and second, to provide security for the territory in dispute from the adjacent area, in accordance with the Order of Temporary Measures dated March 8, 2011. These police forces were to surveil the actions of the Nicaraguan army and provide security from undisputed Costa Rican sovereign territory. The police outpost adjacent to the Los Portillos Lagoon, right next to the disputed area, had to be assisted from the Agua Dulce Lagoon outpost. None of these police outposts existed prior to the onset of the conflict. The border police were created as a response to Nicaragua's military presence in Costa Rican territory, and once this police division was sufficiently organized, it took | 3,092,834.17 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | control of the outposts in the Agua Dulce Lagoon and in the adjacent area of the Los Portillos Lagoon in October 2013. | |
| 9 | Ministry of Security | Operating costs of police outposts. | Includes the costs of construction and equipment for the police outposts in the area adjacent to the Los Portillos Lagoon and Agua Dulce Lagoon. | Nicaragua's actions in Costa Rican territory, according to the Court's ruling, required the Costa Rican authorities to assign police resources from other regions of the country, to create new police outposts and a new division of the Border Police, first, to avoid Nicaragua claiming sovereignty over additional territories in the region, and second, to provide security for the territory in dispute from the adjacent area, in accordance with the Order of Temporary Measures dated March 8, 2011. In order to comply with these objectives, it was necessary to construct two police outposts: one in the area immediately adjacent to the area in dispute, along the edge of the Los Portillos Lagoon, and another nearby in a location accessible by boats of the Coast Guard Service, in Agua Dulce Lagoon. | 82,062.17 |
| 10 | National Emergency Commission | Transportation costs of the Ramsar Mission and Ministry of Environment and Energy of Costa Rica (MINAE) personnel. | Includes the costs of flight hours required to transport the Ramsar mission and MINAE personnel to the territory in dispute on July 25, 2014. | In order to determine the level and type of environmental risks generated by the construction of the East pipeline, it was necessary to coordinate a joint mission with MINAE environmental protection personnel and personnel from the Secretariat. | 11,282.00 |

## CUADRO RESUMEN DE LA INFORMACIÓN PROPORCIONADA POR LA INSTITUCIONES ENCARGADAS DE ATENDER LOS DAÑOS OCASIONADOS POR NICARAGUA EN LA ZONA DE ISLA PORTILLOS

| N ° | Institución | Ítem | Descripción | Relación con las disposiciones de la Sentencia de la CIJ | Valor en US $ |
|---|---|---|---|---|---|
| 1 | Área de Conservación Tortuguero (ACTo) [1] | Salarios | Comprende los costos incurridos en el pago de salarios de cada miembro del personal por día de trabajo, que corresponde a la atención a las acciones de protección del medio ambiente en Isla Portillos. | El personal del área de Conservación Tortuguero es el personal directamente responsable de la protección del medio ambiente en la zona en litigio. En ese sentido son responsables de todas las acciones necesarias para supervisar, evaluar y mitigar los daños provocados por la excavación de los tres "caños" y las zonas circundantes que fueron taladas por Nicaragua. Debido a las acciones de Nicaragua, este personal debió dedicar una cantidad importante de tiempo para reuniones internas e interinstitucionales de coordinación, patrullaje, misiones conjuntas con el personal de la Secretaría de la Convención Ramsar, medición y análisis de los datos y medidas de mitigación que de otro modo no hubiera sido necesario. | 29,412.88 |
| 2 | Área de Conservación | ALIMENTACIÓN | El cálculo se ha realizado en función de la tarifa oficial | Debido a que el personal de ACTo tenía que viajar y permanecer en la | 8,886.53 |

[1] Corresponde a 162 visitas ( desde el 10 de octubre de 2010 hasta 16 el noviembre, 2015 ) a la zona en disputa por el personal del Área de Conservación Tortuguero en misiones de vigilancia y conservación del medio ambiente, mantenimiento de equipos y coordinación de reuniones y misiones conjuntas de la Secretaría de Ramsar, incluyendo las que tuvieron lugar el 22 de octubre , 25 de Octubre de 2010 , el 7 de enero , 5-6 de abril de 2011, 30 de enero, 3 agosto de 2012, 7 de marzo, 18 de septiembre, 10 de diciembre, 11 de diciembre de 2013, 11 de marzo, 25 de julio, 12 de noviembre, 5 de diciembre, 17 de diciembre de 2014, 26 de marzo al 10 de abril, 9 de junio, 8 de julio y 3 de octubre del año 2015.

| | | | | | |
|---|---|---|---|---|---|
| | | | | Medidas provisionales del 8 de marzo de 2011. | |
| 8 | Ministerio de Seguridad | Salarios de los efectivos de la Fuerza Pública y de la Policía de Fronteras | Comprende los sueldos de los 48 policías de la Fuerza Pública que se asignaron a los puestos policiales en la zona adyacente a la Laguna Los Portillos y Laguna de Agua Dulce desde marzo de 2011 a septiembre de 2013 y a 46 oficiales de la Policía de Fronteras que se asignaron a esos mismos puestos de octubre de 2013, a diciembre de 2015. El número total de policías se divide en dos grupos que se alternan en turnos de 10 días de trabajo continuo en la zona y 10 días de descanso fuera del área. Durante su estancia en la zona trabajaban en 2 turnos de 12 horas. | Las acciones de Nicaragua en territorio costarricense, según lo determinó la Corte, obligó a las autoridades costarricenses a asignar recursos policiales de otras regiones del país, crear nuevos puestos policiales y una nueva división de Policía de Fronteras, primero, para evitar, que Nicaragua reclamara soberanía sobre territorios adicionales en la región, y segundo, para brindar seguridad al territorio en disputa desde la zona adyacente, de conformidad con la Providencia de Medidas Provisionales del 8 de marzo de 2011. Estos efectivos de policía debían vigilar las acciones del ejército nicaragüense y proporcionar seguridad desde territorio de indisputable soberanía costarricense. El puesto policial adyacente a la Laguna Los Portillos, justo al lado de la zona en litigio debía ser atendido desde el puesto de Laguna de Agua Dulce. Ninguno de esos dos puestos policiales existía antes del inicio del conflicto. La policía fronteriza fue creada como una respuesta a la presencia militar de Nicaragua en territorio costarricense y una vez que esta división policial estuvo suficientemente organizada tomó | 3,092, 834.17 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | control de los puestos en Laguna de Agua Dulce y en la zona adyacente a la Laguna Los Portillos, en octubre de 2013. | |
| 9 | Ministerio de Seguridad | Costos operativos de puestos policiales. | Comprende los costos de construcción y equipamiento para los puestos de policía en la zona adyacente a la Laguna Los Portillos y Laguna de Agua Dulce. | Las acciones de Nicaragua en territorio costarricense, según lo determinó la Corte, obligó a las autoridades costarricenses a asignar recursos policiales de otras regiones del país, crear nuevos puestos policiales y una nueva división de Policía de Fronteras, primero, para evitar que Nicaragua reclamara soberanía sobre territorios adicionales en la región, y segundo, para brindar seguridad al territorio en disputa desde la zona adyacente, de conformidad con la Providencia de Medidas Provisionales del 8 de marzo de 2011. Con el fin de cumplir estos objetivos fue necesario construir dos puestos policiales, uno en el área inmediatamente adyacente a la zona en disputa, en la margen de la Laguna Los Portillos y otra cerca en un punto accesible por barcos del Servicio de Guardacostas, en Laguna de Agua Dulce. | 82, 062,17 |
| 10 | Comisión Nacional de Emergencias | Costos de transporte de Misión Ramsar y personal del MINAE. | Comprende los costos de las horas de vuelo requeridas para el transporte de la misión de Ramsar y el personal del MINAE al territorio en disputa el 25 de julio de 2014. | Para determinar el nivel y tipo de riesgos ambientales generados por la construcción del caño Este, fue necesario coordinar una misión conjunta con personal de protección del medio ambiente del MINAE y personal de la Secretaría | 11,282.00 |

# Annex 4

José María Tijerino Pacheco, Outgoing Report, Period 8 May 2010 to 30 April 2011, Ministries of State and Police and Public Security

April 2011

Excerpt

(English Translation)

**OUTGOING REPORT**
**Period May 8, 2010 to April 30, 2011**

# MINISTRIES OF STATE AND POLICE AND PUBLIC SAFETY

***José María Tijerino Pacheco***

**April 2011**

## LEGAL REFERENCES

In accordance with Guideline R-CO-61 dated June 24, 2005, published in The Gazette (La Gaceta) No. 131 dated July 7, 2005 and Article 12 of the General Domestic Control Act, which establishes that chiefs and subordinate office-holders must submit an Outgoing Report and formally turn over the respective entity or agency to their successor, the undersigned hereby submits the following Outgoing Report for the period in which he acted as Minister of State and Police and Public Safety, pursuant to Presidential Agreement No. 001-P dated May 8, 2010. Certificate of Delivery of Property dated August 25, 2010.

police response in new fields of action, have spurred the establishment of new work strategies.

An investment project is made up of a series of actions that in their pre-investment, investment, and execution phases enable the administration to provide a comprehensive solution with adequate planning for the legal system and institutional control of available economic resources, which is a necessary issue for transparent management of the apportioned budget.

Within this context, Law Enforcement developed a series of projects which, due to their great importance, deserve special mention.

**Reactivation of the Border Police**

As a result of events on the northern border in recent months, the urgent goal was established of reactivating the Border Police in order to ensure the safety of citizens and respect for national sovereignty, planning, organizing, directing, and executing the actions necessary for such purpose.

The area of operation is the entire land border line, which extends for 300 kilometers in the northern zone and 363 kilometers in the southern zone.

During this period, steps were taken to form the Border Police. The first 150 officers assigned to the border regions were trained, for whom 400 complete uniforms and 400 weapons were purchased. We recommend recruiting 1,850 additional officers in the midterm.

In parallel, the creation of two regional offices under the organizational structure of the Ministry of Public Safety is currently in the approval process by the Ministry of National Planning and Economic Policy: the Chorotega Northern Region with the counties [*cantones*] of La Cruz, Los Chiles, and Upala, and the Caribbean Border Region with the counties of Sarapiquí, Talamanca, and Pococí.

In addressing the area, we had the collaboration of the Ministry of Public Works and Transportation, which authorized a route from La Aldea to Fátima de Sarapiquí and from there to Delta Costa Rica in the Northern Area. The opening of another transportation route is expected from Boca San Carlos to Puerto Lindo; in addition,

a bridge is in planning at the source of the river Río Colorado to enable transportation to Isla Calero.
With regard to the infrastructure needed for the operation, we are working on the remodeling and construction of the first 30 out of a total of 45 police outposts, with a capacity of 40 officers each.

**Implementation of motorized groups**
These groups were implemented to provide immediate response in vulnerable communities in inner cities, where heavy traffic or poor road planning hinder immediate police response. Using motorcycle patrols, which facilitates and improves movement, we intend to improve response times, strengthen police-community relations, and reduce operating costs.

To achieve this, the need to acquire motorcycles with the technical specifications and performance needed to meet the outlined goals was forecast through a prefeasibility study. We planned to acquire forty-three 400 cc dual sport dirt bike type motorcycles, which is a suitable resource to implement this project.

**United, Safe, and Healthy Communities Program**
The United, Safe, and Health Communities Program carried out comprehensive interventions in marginalized urban communities to simultaneously combat health, housing, safety, education, dependent care, and transportation problems and preparation for the working world.

The communities chosen in the first year were the four central districts of San José (Merced, Hospital, Catedral and Carmen), San Pedro de Montes de Oca, San Juan de Dios de Desamparados, León XIII in Tibás, San Francisco (Guararí) in Heredia, Quepos in the Cantón de Aguirre and Barrio Cristóbal Colón (Cieneguita) in Limón.

**INFORME DE FIN DE GESTIÓN**
**Período 08 de mayo del 2010 al 30 de abril del 2011**

# MINISTERIOS DE GOBERNACIÓN Y POLICÍA

# Y

# DE SEGURIDAD PÚBLICA

***José María Tijerino Pacheco***

**Abril, 2011**

## REFERENCIA LEGAL

De acuerdo con la Directriz R-CO-61 del 24 de junio del 2005, publicada en La Gaceta N° 131 del 07 de julio del 2005 y el artículo 12 de la Ley General de Control Interno, el cual establece que los jerarcas y los titulares subordinados deben presentar un Informe de Fin de Gestión y realizar la entrega formal del ente u órgano respectivo a su sucesor, el suscrito hace entrega del siguiente Informe de Fin de Gestión por el periodo en que se desempeñó como Ministro de Gobernación y Policía y de Seguridad Pública, según Acuerdo Presidencial N° 001-P del 08 de mayo del 2010. Acta de Entrega de Bienes de fecha 25 de agosto del 2010.

respuesta policial en nuevos campos de acción, han motivado que se establezcan nuevas estrategias de trabajo.
Se comprende como proyecto de inversión una serie de acciones que en sus etapas de pre-inversión, inversión y ejecución, permiten a la administración dar solución integral con una planificación adecuada al ordenamiento jurídico y al control institucional de los recursos económicos disponibles, tema necesario para gestionar con transparencia el presupuesto asignado.
Dentro de este marco, la Fuerza Pública elaboró una serie de proyectos que por su gran importancia merecen una mención especial.

**Reactivación de la Policía de Fronteras**
Producto de los hechos acaecidos en meses recientes en la frontera norte, se estableció como objetivo prioritario la reactivación de la Policía de Fronteras con el fin de velar por la seguridad ciudadana y el respeto de la soberanía nacional, planificando, organizando, dirigiendo y ejecutando las acciones necesarias para tal fin.
El área de operación es todo el cordón fronterizo terrestre, el cual tiene una extensión de 300 kilómetros en la zona norte y de 363 kilómetros en la zona sur.
En este periodo se implementaron acciones para la conformación de la Policía de Fronteras. Se capacitó a los primeros 150 oficiales destinados a las áreas fronterizas, para los que se adquirieron 400 uniformes completos y 400 armas. Se recomienda reclutar 1.850 oficiales más a mediano plazo.

En otro orden de ideas, actualmente se encuentra en proceso de aprobación por parte del Ministerio de Planificación Nacional y Política Económica, la creación de dos direcciones regionales dentro de la estructura orgánica del Ministerio de Seguridad Pública: la Región Chorotega Norte con los cantones de La Cruz, Los Chiles y Upala, y la Región Frontera Caribe con los cantones Sarapiquí, Talamanca y Pococí.
Para atender la zona se contó con la colaboración del Ministerio de Obras Públicas y Transportes, que habilitó un camino desde La Aldea a Fátima de Sarapiquí y de ahí hasta Delta Costa Rica en la Zona Norte. Se espera la apertura de otra vía de comunicación de Boca San Carlos hasta Puerto Lindo; asimismo se tiene proyectado

un puente en el nacimiento del Río Colorado que permita la comunicación con la Isla Calero.
Respecto a la infraestructura necesaria para la operación, se trabaja en la remodelación y levantamiento de los primeros 30 puestos policiales de un total de 45, con capacidad para 40 funcionarios cada uno.

**Implementación de grupos de motorizados**
Estos grupos fueron implementados para brindar respuesta inmediata prioritariamente en las comunidades vulnerables y en los centros de ciudad, donde el alto tránsito o la mala planificación vial inciden en la inmediatez de la respuesta policial. Mediante el patrullaje en motocicleta, medio que facilita y agiliza el desplazamiento, se pretende mejorar los tiempos de respuesta, fortalecer la relación Policía - Comunidad y reducir los costos operativos.

Para lograr lo anterior se proyectó mediante estudio de prefactibilidad la necesidad de adquirir motocicletas con las especificaciones técnicas y de desempeño necesarias para cumplir los objetivos trazados. Se proyectó adquirir 43 motocicletas tipo montañera, doble propósito, 400 centímetros cúbicos, lo cual es un recurso idóneo para desarrollar dicho proyecto.

**Programa Comunidades Solidarias, Seguras y Saludables**
El Programa Comunidades Solidarias, Seguras y Saludables realizó intervenciones integrales en comunidades urbano marginales para combatir simultáneamente los problemas de salud, vivienda, seguridad, educación, cuido de dependientes, transporte y preparación para el mundo del trabajo.

Las comunidades seleccionadas en el primer año fueron los cuatro distritos centrales de San José (Merced, Hospital, Catedral y Carmen), San Pedro de Montes de Oca, San Juan de Dios de Desamparados, León XIII en Tibás, San Francisco (Guararí) de Heredia, Quepos del Cantón de Aguirre y el Barrio Cristóbal Colón (Cieneguita) de Limón.