

**CERTAIN ACTIVITIES CARRIED OUT BY NICARAGUA  
IN THE BORDER AREA**

**(COSTA RICA V. NICARAGUA)**

**REJOINDER OF THE REPUBLIC OF NICARAGUA  
ON COMPENSATION**

**Annexes**



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**Annex 1**

**Cymie R. Payne, J.D. & Robert E. Unsworth, Report on  
Methodology for Valuing Environmental Damage Compensation  
(Second Report)**

**25 August 2017**



International Court of Justice

Case Concerning Certain Activities Carried Out by Nicaragua in the Border Area  
Compensation  
Costa Rica v. Nicaragua

Report on Methodology for Valuing Environmental Damage Compensation  
(Second Report)

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25 August 2017

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PAYNE & UNSWORTH – 25 August 2017

## I. SUMMARY

In its Order of 18 July 2017, the Court has requested further information “on the sole question of the methodology adopted in the expert reports presented by the Parties ... on the question of compensation due in the present case.” In our expert report of 26 May 2017, we described the legal and technical aspects of assessing and valuing compensation for environmental damage that are used in domestic and international practice where a party is legally liable for compensation as a result of causing harm. The methodology we described, referred to as the “replacement cost” approach, is used in international and domestic courts to address a wide range of environmental injuries under a wide range of environmental conditions. Use of replacement costs to establish damages may, as the most commonly used approach, be considered best practices. This method is appropriate to assess and value compensation in this matter, that is, 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.

Primary restoration of the harmed site, to the extent that Costa Rica proposes to undertake it, has already been done, no further restoration work is contemplated, and Costa Rica has sought compensation for its restoration costs.<sup>1</sup> We infer that the site will be left to recover naturally and therefore that replacement services will be required while recovery is taking place, over a period of 20 to 30 years. International and state practice recognize that reparations for environmental injury include lost ecosystem services for this period. This element of a remedy is called compensatory restoration or interim damages. In our view a replacement cost approach meets this standard for reparations for interim losses pending recovery of the harmed ecosystem.

The interim damages valuation approach we propose is to estimate the cost of replacement habitat for the injured area for 20 to 30 years, or the time for the site to recover from the harm. Our cost estimate is based on reported payments to private parties to protect habitats on their lands, drawn from information on a well-established habitat conservation program in Costa Rica.<sup>2</sup> Our approach does not attempt to find a theoretical value for the ecological change that occurred at this site, but instead, more directly, proposes that Costa Rica be compensated with replacement services while the harmed area recovers.

The approach used by Fundación Neotrópica (Neotrópica) to estimate compensation for interim damages due in this case is described by Costa Rica as the “ecosystem service valuation” approach. This approach is described as being made up of two primary steps: (1) identification of ecosystem services that have been lost, and (2) subsequent assignment of monetary values to those lost services.

In implementing the monetization step, Costa Rica uses one of several available ecosystem service valuation methodologies, benefits transfer. Benefits transfer involves estimation of damages associated with harmed services using monetary values transferred from past studies at other sites.<sup>3</sup>

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<sup>1</sup> Costa Rica’s Memorial on Compensation (CRMC), pp. 60-71.

<sup>2</sup> Cymie R. Payne & Robert E. Unsworth, Report on Environmental Damage Valuation, 26 May 2017 (Payne & Unsworth May 2017), p. 33.

<sup>3</sup> Primary valuation methods would generate estimates of damages specific to conditions at the site in question in this matter. International tribunals such as the UN Compensation Commission, arbitral tribunals, and the IOPC Funds use the cost of primary restoration as the first choice in cases of environmental damage. *Burlington Resources Inc. v. Republic of Ecuador*, ICSID Case No. ARB/08/5, Decision on Counterclaims (7 Feb. 2017) (award for environmental damage related to mining, based on cost of soil and groundwater remediation, remediation of mud disposal pits and taking into

These values are then summed to derive a total measure of damages. When the technique is used, it is far more commonly applied to value direct human use losses, such as lost recreational fishing, tourism, or beach visit opportunities. This is due to the fact that these services are far more homogeneous in their nature across sites and cases, and because the literature available to draw upon is generally more well-developed, allowing for use of benefits transfer functions to make the transfer more accurate than the simple application of unit values. Benefits transfer is not commonly used to value interim losses of the full-range of ecological services—such as hazard mitigation or biodiversity—in a legal remedies setting, as discussed below.<sup>4</sup> For these and other reasons, in the case of ecological service losses, the best practice is the use of replacement costs based on habitat equivalency.

In our report of 26 May 2017 we concluded that the ecosystem service valuation approach, including the specific assumptions and analytical decisions made by Neotrópica to select services for valuation and the assumptions used to estimate monetary compensation in this matter, “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.”<sup>5</sup> We found—among other problems—that the approach used by Neotrópica included compensation for environmental services that did not appear to be lost;<sup>6</sup> incorrectly applied capitalized values annually over the 50-year analysis period (resulting in inappropriate counting of these values multiple times);<sup>7</sup> and failed to meet the standards of sound economics in applying values from very dissimilar circumstances to assess damages in this matter.<sup>8</sup> In their report of 3 August 2017, Neotrópica does not correct their analysis for any of these concerns, instead asserting that their original damages estimate is in fact correct and defensible, if not conservative.<sup>9</sup>

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account land uses ranging in sensitivity from UNESCO Man and Biosphere Program land, the Amazon region, and indigenous lands to agricultural and industrial uses); 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.

<sup>4</sup> M.T. Huguenin, M.C. Donlan, A.E. van Geel and R.W. Paterson, “Assessment and Valuation of Damages to the Environment” *in* Cymie R. Payne and Peter H. Sand, *Gulf War Reparations and the UN Compensation Commission: Environmental Liability* (Oxford University Press 2011) 78-80.

<sup>5</sup> Payne & Unsworth May 2017, Executive Summary. In their report of 3 August 2017, Neotrópica implies that we are biased in our assessment, with the goal of minimizing damages. They state: “Nicaragua says that given the range of different values, it is appropriate to select the value from the study of greatest relevance to the valuation problem and site being studied (Payne & Unsworth 2017). They do not indicate which one they think this is. If we applied the criteria of proximity, methodology and socio-cultural similarities, such a proposition would hurt their interest, as the newest study, with a better methodology (remote sensing), made in close socio-cultural and ecological context would be the Camacho-Valdez, V. et al. (2014) which in fact would mean a value per hectare about 3 times larger.” Fundación Neotrópica August 2017 Report, CRRC, Annex 1, p. 35. As made clear in stating our qualifications in our original submission, both Unsworth and Payne have established decades-long careers objectively assessing both the correct approaches to, and values for, environmental damages. Our interest is solely to provide the Court with an objective assessment of damages consistent with best practices.

<sup>6</sup> Payne & Unsworth May 2017, pp 29-30, Sections V.D. & V.E.

<sup>7</sup> Payne & Unsworth May 2017, pp 23-26 Section IV. See below for further discussion.

<sup>8</sup> Payne & Unsworth May 2017, p. 19, Section IV.B.

<sup>9</sup> Fundación Neotrópica August 2017 Report, CRRC p. 29. Throughout their report and the supporting letters provided as appendices, Neotrópica refers to their estimates as “conservative” – that is, likely to understate losses. Given the assumptions made and calculations performed by Neotrópica, there is no reason to believe that the damages estimate

In response to the Court’s request for information regarding the appropriate methodology to apply in establishing damages, Neotrópica asserts, among other arguments, that the approaches utilized by the United Nations Compensation Commission (UNCC) in 2005 “...are old and predate the mainstreaming of the ecological services approach... .”<sup>10</sup> In fact, the general approach relied upon by Neotrópica to calculate damages—identification and valuation of ecosystem services and valuation of those services—existed long before the UNCC proceedings began in 1999.

In addition, the specific valuation approach used by Neotrópica here—benefits transfer—was considered and rejected by the UNCC in its deliberations. Neotrópica also asserts that the approaches utilized by the UNCC were different and inapplicable to this matter because the ecological context is different. As we discuss in this report, the standard techniques used to assess damages for harm to environmental resources are common to all ecosystems, and contrary to statements in Neotrópica’s report, they were applied to a broad range of ecosystems in the context of claims brought before the UNCC. These assertions do not lend support to Neotrópica’s approach or conclusions.

The concerns we raise in our 26 May 2017 report stand: we do not find Neotrópica’s response consistent with sound economics in the field of environmental damages assessment where the goal is to make the injured party whole for the harm suffered. The new material and new arguments presented by Neotrópica in their 3 August 2017 report and the comments of their reviewers who were asked to provide supporting statements only serve to reinforce our concerns.

The Court has determined that compensation should be paid by Nicaragua in this matter. Healthy natural systems provide essential environmental services. The importance of natural systems, such as the wetland harmed by Nicaragua’s actions, is not at question. Nor is the need for compensation when illegal harms take place. What is at question before the Court is the appropriate measure of damages that will serve to make Costa Rica whole, consistent with established international environmental damages practice and sound economics. To meet this standard, in our 26 May 2017 report, we separately assessed damages using a more appropriate and widely-accepted technique based on the cost to purchase conservation actions that will serve to replace what has been lost as a result of Nicaragua’s actions. Our opinion is that the Court need not rely on a highly uncertain and unreliable valuation technique, but instead can provide compensation sufficient to allow Costa Rica to take actions that will offset the harm caused by Nicaragua. This approach, used by the UNCC and other authorities, reflects best practices in environmental damages assessment. The damages estimate we develop, USD 27,034 to USD 34,987, reflects the cost to undertake a 20- to 30-year conservation program intended to offset the environmental harm to Costa Rica’s natural resources. Costa Rica takes issue with the appropriateness of applying these estimates to this context, but notably does not provide an alternative replacement cost estimate. Again, we believe that a replacement cost approach to compensation is an appropriate remedy in this matter, and avoids the shortcomings of the approach used by Neotrópica.

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they develop is conservative, and in any case, these comments only reinforce the conclusion that the ecosystem services model used in this matter provides highly uncertain results.

<sup>10</sup> Fundación Neotrópica August 2017 Report, CRRC, p. 43.

## II. 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. She has acted as 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.

### III. APPLICATION OF THE REPLACEMENT COST METHODOLOGY TO THE INFORMATION PROVIDED BY COSTA RICA

Applying best practices and the information supplied by Costa Rica, we recommended using a **replacement cost** methodology to value the compensation due to Costa Rica.<sup>11</sup> Replacement cost is the monetary measure of the cost to provide a substitute ecosystem or ecosystem service (e.g., the purchase of conservation credits to offset a harm). Replacement costs are typically used as a measure of secondary restoration (also referred to as compensatory restoration or interim damages) where primary restoration is not feasible, or where natural recovery will take time. For example, U.S. law defines replacement as “the substitution for an injured resource with a resource that provides the same or substantially similar services, when such substitutions are in addition to any substitutions made or anticipated as part of [removal or remedial actions] and when such substitutions exceed the level of response actions determined appropriate to the site [by regulation].”<sup>12</sup>

Costa Rica performed a limited assessment of the extent and nature of the injury. They claim that:

- 6.19 hectares of habitat were affected;<sup>13</sup>
- 9502.72 cubic meters of soil were removed;<sup>14</sup>
- 211 cubic meters per hectare of standing timber were removed;<sup>15</sup> and
- channels were cut in three locations at two points in time.<sup>16</sup>

In developing our estimate of the reasonable cost of replacement, we accept Neotrópica’s position that 6.12 hectares of habitat experienced a loss in services, and further assume that all ecosystem services are lost from these hectares for 20 to 30 years even though recovery is already progressing.<sup>17</sup>

Compensation in cases such as this should be based on the cost of primary and, as needed, secondary restoration of these injured resources.<sup>18</sup> It is agreed that the channels filled in through

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<sup>11</sup> Given that the terminology of ecosystem services valuation and environmental damages assessment is somewhat esoteric, we provide a glossary at the end of this report, with definitions from both the economics literature and regulatory sources and we highlight in bold the first time we define a term in the text.

<sup>12</sup> US Code of Federal Regulations, 43 CFR 11.14; see also 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, Art 2.11, Annex II 1.2.3 (EU ELD).

<sup>13</sup> 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 on Isla Portillos, as required by the Judgment of the International Court of Justice of 16 December 2015 (Fundación Neotrópica June 2016 Report), p. 56, CRMC, Vol. I, Annex 1.

<sup>14</sup> Fundación Neotrópica June 2016 Report, p. 53.

<sup>15</sup> *Ibid.*, p. 53.

<sup>16</sup> *Ibid.*, p. 10.

<sup>17</sup> CRMC, p. 33; Kondolf, Mathias. May 2017. Review of Costa Rica’s Claims for Compensation in the Río San Juan Delta, in Fundación Neotrópica (2016). Explanatory addenda to the report “Monetary value 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)”, p. 3.

natural processes and that Costa Rica built a dyke at the eastern 2013 site, performing what we would call primary restoration. Costa Rica is separately seeking compensation for the cost of this activity.<sup>19</sup>

Costa Rica has not indicated that it will attempt further primary restoration, such as replacing trees or displaced soil. Costa Rica says that natural recovery (i.e., unassisted by human intervention) will take 50 years.<sup>20</sup> In his review of Costa Rica's claims for compensation, G. Mathias Kondolf indicated that recovery periods are in the range of 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.<sup>21</sup> Given differences of opinion in the expected period of recovery, and understanding that some services may recover more slowly than others, we accepted Costa Rica's recovery period for our analysis.<sup>22</sup> In our damages estimate we assume full-replacement for 20 to 30 years, which is equivalent in present value terms to Neotrópica's assumed 50 year period with recovery.<sup>23</sup>

Best practices for interim damages are to provide replacement services of the same type and quality, and of comparable value as those injured.<sup>24</sup> Specifically, this means calculating compensation for interim losses based on the cost of projects that can provide equivalent ecosystem services to those lost, rather than performing economic studies of the monetary value of the lost services.<sup>25</sup> Comparability is typically achieved at the time the replacement is selected. A common approach to make this kind of calculation in a way that links compensation to actual replacement of the lost services is to use payments to landowners to preserve otherwise unprotected land with comparable ecosystem service values. Given Costa Rica's experience with payment for ecosystem services programs, and the existence of unprotected wetlands in Costa Rica, including in the general region of Isla Portillos,<sup>26</sup> this is a feasible approach.<sup>27</sup> We note that Costa Rica has not suggested that

<sup>18</sup> Primary restoration involves actions to restore pre-event conditions at the harmed site (e.g., filling of the dredged caños). Compensatory restoration provides replacement services until such time that such actions, or natural recovery of pre-event conditions, are achieved.

<sup>19</sup> CRRC, p. 5.

<sup>20</sup> CRMC, p. 33.

<sup>21</sup> G. Mathias Kondolf, Review of Costa Rica's Claims for Compensation in the Río San Juan Delta, May 2017, p. 6 (NCMC, Annex 2, p. 160).

<sup>22</sup> Report by Fundación Neotrópica on the Question of the Methodology for the Assessment of Environmental Damage, 3 Aug. 2017 (Fundación Neotrópica August 2017 Report), CRRC, Annex 1, p. 51; G. Mathias Kondolf, Review of Costa Rica's Claims for Compensation in the Río San Juan Delta (May 2017) (Kondolf May 2017 Report) p. 6.

<sup>23</sup> That is, the present value of harm over 50 years, where the harm recovers with time, is about 14 times the first year's loss; the present value harm assuming 20 to 30 years of total loss is similarly equivalent to 13.6 to 17 times the first year's loss.

<sup>24</sup> 15 CFR 990.53(c)(2) (US Oil Pollution Act regulations).

<sup>25</sup> This is generally the methodology used by the UNCC, discussed in greater detail below and in Payne & Unsworth May 2017, p. 33. See also US Department of the Interior, Natural Resource Damage Assessment and Restoration Federal Advisory Committee Final Report (2007) p.15, available at <http://www.nrdapracticexchange.com/documents/Final%20FACA%20Report%20May%202007.pdf>.

<sup>26</sup> Ramsar Sites Information Service: Annotated List of Wetlands of International Importance, Costa Rica ("The area is used largely for agriculture, and cattle ranching, tourism and fishing are also important activities."). Accessed 8/22/2017. Available at: [https://rsis.ramsar.org/sites/default/files/rsiswp\\_search/exports/Ramsar-Sites-annotated-summary-Costa-Rica.pdf#1503421030](https://rsis.ramsar.org/sites/default/files/rsiswp_search/exports/Ramsar-Sites-annotated-summary-Costa-Rica.pdf#1503421030)



protecting such an area would not be feasible. In estimating damages using this approach we selected the highest unit price paid for ecosystem services in Costa Rica as listed by the International Institute for Environment and Development.<sup>28</sup> We then calculated the cost of paying for ecosystem services at that highest per hectare price for 20 years and for 30 years. Again, while Neotrópica takes issue with this approach, they do not present alternative cost measures, but instead argue that only a welfare valuation approach is acceptable for damages estimation.

#### IV. COSTA RICA'S CRITICISMS OF THE METHODOLOGY USED BY THE UNCC ARE UNFOUNDED

##### *A. Ecological Differences Are Irrelevant to Choice of Method*

Costa Rica implies that it is improper to consider the UNCC claims process as a relevant reference in this case because “the wetland environment that is the subject of the current claims is radically different from the environment at issue before the UNCC environmental claims panel.”<sup>29</sup> Neotrópica states, “The Methodology proposed by Nicaragua grossly undervalues environmental damage, including the misplaced comparison of environmental damage in the early 1990’s in desert like conditions.”<sup>30</sup>

This is misleading both because the claimant countries of the Gulf region represent wide ecological variety, and because the choice between the valuation methodologies assessed by the UNCC and those proposed by Costa Rica does not hinge on the ecosystem in question.

The UNCC claims addressed a variety of ecosystems, including the Ramsar-listed sites in Iran (Shadegan wetland) and Jordan (Al-Azraq wetland).<sup>31</sup> The UNCC reviewed claims for damage to ecosystems in the desert, coastal zones, and ocean floor;<sup>32</sup> cropland and rangeland soils compacted by refugees and their livestock;<sup>33</sup> and desert soil ecosystems damaged by tracked military vehicles.<sup>34</sup> The wide diversity of ecosystem types that were presented in the UNCC claims is also evidenced by

<sup>27</sup> Payne & Unsworth May 2017, p. 33-34.

<sup>28</sup> Payne & Unsworth May 2017, p. 34; 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.

<sup>29</sup> CRRC 2.6, p. 6.

<sup>30</sup> Fundación Neotrópica August 2017 Report, CRRC Annex 1, p. 34.

<sup>31</sup> 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. 140, hereinafter, UNCC F4 first instalment; 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) para. 140, hereinafter, UNCC F4 fourth instalment, part 1; Payne & Unsworth May 2017, p. 16; Convention on Wetlands of International Importance especially as Waterfowl Habitat, United Nations Treaty Series, vol. 996, No. 14583, p. 245; Ramsar List per Article 2.1.

<sup>32</sup> UNCC F4 first instalment, para. 13 (claims included “damage to coastlines; damage to fisheries; damage to wetlands [mangrove, coastal desert and freshwater] and rangelands; damage to forestry, agriculture and livestock”); UNCC, Report and recommendations made by the Panel of Commissioners concerning the fifth instalment of “F4” claims, S/AC.26/2005/10 (2005), hereinafter UNCC F4 fifth instalment. (claims addressed damage to wetlands, marine environments including coral reefs, fisheries, subtidal and intertidal zones, deserts, endangered wildlife, forests).

<sup>33</sup> UNCC F4 fifth instalment, paras. 175-181 (Iran), paras. 353-366 (Jordan).

<sup>34</sup> 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. 62, hereinafter, UNCC F4 third instalment.



the range of experts that were engaged to advise the F4 Panel in fields including: desert ecology and botany, agriculture, forestry, terrestrial and marine remediation techniques, marine biology, coastal ecology and geomorphology, geology, hydrogeology, and water quality.<sup>35</sup>

Choice of valuation methodologies is based on many factors, but the literature does not suggest that geographical considerations count amongst them. Practice suggests that they do not. The European Union’s Environmental Liability Directive (EU ELD)<sup>36</sup> recommendations for methodologies apply equally to states as ecologically different as Italy and Sweden.<sup>37</sup> The US natural resource damage regulations apply the same valuation methodologies to incidents in diverse locations from Alaska to Hawaii.<sup>38</sup> While the services provided may vary, the tools available to establish damages are the same, as described in our initial report.

### *B. The UNCC Methodology is Appropriate and Consistent with Current Best Practice*

Costa Rica argues that the ecosystem services approach was developed after the UNCC program was completed in 2005, and therefore that the UNCC methodology is no longer relevant and is now out of date.<sup>39</sup> It states that reliance on the UNCC approach “is problematic because the UNCC concluded its claims processing in 2005, i.e. the very year that the main instrument mainstreaming the ‘ecosystem services’ approach and terminology—the Millennium Ecosystem Assessment (MEA)—was published.”<sup>40</sup> Costa Rica also claims that its approach is supported by studies and decisions of the UN Environment Programme and the parties to the Convention on Biological Diversity.<sup>41</sup>

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<sup>35</sup> UNCC F4 Fourth Instalment, part 1, para. 54.

<sup>36</sup> EU ELD.

<sup>37</sup> Stevens & Bolton LLP, *The Study on Analysis of Integrating the ELD into 11 National Legal Frameworks*, Final Report Prepared for the European Commission – DG Environment (2013).

<sup>38</sup> For example, U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), *Damage Assessment and Restoration Plan and Environmental Assessment (DARP/EA) for the January 11, 2010 Adak Petroleum Diesel Spill* (2013) 16 (Alaska), available at <https://casedocuments.darp.noaa.gov/northwest/adak/admin.html>; US Department of the Interior, *Final Restoration Plan and Environmental Assessment for the May 14, 1996 Chevron Pipeline Oil Spill into Waiuu Stream and Pearl Harbor, Oahu, Hawaii* (1999), available at <http://www.gc.noaa.gov/gc-rp/ph-fea2.pdf>.

<sup>39</sup> CRRC 2.6, p. 6 (“in more recent years, new methodologies have been developed – including within the framework of the United Nations and the Conference of the Parties of the Biodiversity Convention – that recognize the full and potentially long lasting extent of harm to the environment.”), *Fundación Neotrópica August 2017 Report*, CRRC Annex 1, p. 45.

<sup>40</sup> CRRC para. 2.8, p. 7; *Fundación Neotrópica August 2017 Report*, CRRC Annex 1, p. 43. The MEA’s purpose was “to assess the consequences of ecosystem change for human well-being and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being.” *Millennium Ecosystem Assessment, Ecosystems and Human Well-being: Synthesis* (Island Press, Washington, DC 2005) v.

<sup>41</sup> UNEP, *Guidelines for the Development of Domestic Legislation of Liability, Response Action and Compensation for Damage Cause by Activities Dangerous to the Environment*, adopted by the Governing Council of the United Nations Environment Programme in decision SS XI/5, part B of 26 February 2010 (no mention of specific valuation techniques, damage defined in part in terms of services); *Conclusions of the Group of Legal and Technical Experts on Liability and Redress in the context of paragraph 2 of Article 14 of the Convention on Biological Diversity*, UNEP/CBD/COP/8/27/Add.3 (18 Oct 2005) (restoration costs only valuation methodology mentioned, UNCC referenced as a source); *CBD Synthesis Report* (n 84) (recommends UNCC approach, expresses caution regarding

i. Ecosystem Services Have Been Used since the 1970s to Analyze, Manage, and Value the Environment

As we noted in our Summary, Costa Rica’s terminology needs to be clarified. When Costa Rica refers to its “ecosystem services approach,” it means the identification of ecosystem services that have been lost, and use of benefits transfer, one of several available ecosystem service valuation methodologies, to assign monetary values to the lost services. In this section we discuss the history of these methods.

The **ecosystem approach** is an analytical approach that takes the ecosystem as the unit to be studied, “based on the application of appropriate scientific methods focused on levels of biological organization, which encompass the essential structure, processes, functions, and interactions among organisms and their environment.”<sup>42</sup> It can be used for regulation and management.<sup>43</sup> **Ecosystem services** or **environmental services** are “functions performed by a natural resource for the benefit of another natural resource or the public.”<sup>44</sup> The concept can be used to qualify and scale harm to an environment that has suffered negative impacts. We use the concept of ecosystem services as an intermediate step in valuing injured environment. **Ecosystem functions** 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 (e.g., gas regulation is a function provided by ecosystems, not a service).<sup>45</sup>

In placing values on changes in ecosystems associated with some action, economists have long found it useful to consider the services provided by those ecosystems.<sup>46</sup> In fact, as early as the

benefits transfer); CBD decision XI/16 (no mention of specific valuation techniques or compensation approaches); UNEP/CBD/COP/11/INF/17 (paper on links between biodiversity and carbon stocks, not economic valuation) and UNEP/CBD/COP/11/INF/18 (bibliography of environmental restoration).

<sup>42</sup> Millennium Ecosystem Assessment Glossary, 894.

<sup>43</sup> Douglas P. Wheeler, Keynote Address, 24 Ecology L.Q. 623, 630 (1997) (describing ecosystem approach to environmental management in California).

<sup>44</sup> EU ELD, Article 2.13.; see also Rashid Hassan, Robert Scholes, Neville Ash, eds., *Ecosystems and human well-being : current state and trends : findings of the Condition and Trends Working Group* (Island Press 2005) Appendix D, Glossary, 895, available at <https://www.millenniumassessment.org/en/Condition.html#download> (Millennium Ecosystem Assessment Glossary); U.S. CERCLA regulations, “services means the physical and biological functions performed by the resource including the human uses of those functions. These services are the result of the physical, chemical, or biological quality of the resource.” US 43 CFR 11.14. Also “For the purposes of this part, services include provision of habitat, food and other needs of biological resources, recreation, other products or services used by humans, flood control, ground water recharge, waste assimilation, and other such functions that may be provided by natural resources.” US 43 CFR 11.71(e).

<sup>45</sup> For example, “Ecosystem processes and functions are the biological, chemical, and physical interactions between ecosystem components. Functions and processes are not end-products; they are intermediate to the production of final ecosystem services.” Boyd, James and Spencer Banzhaf, “What are Ecosystem Services? The Need for Standardized Environmental Accounting Units,” *Ecological Economics* 63, p. 620 (2007).

<sup>46</sup> For example, Elliff and Kikuchi highlight that, “The explicit recognition of the term “ecosystem services” is fairly recent, but the general notion that natural ecosystems support human society is ancient.” Elliff, Carla I. and Ruy K.P. Kikuchi, “The ecosystem service approach and its application as a tool for integrated coastal management,” *Natureza and Conservacao* 13:105-111, 106 (2015). Multiple early texts in the field of environmental economics are focused on describing methods to value the contributions of natural resources to peoples’ well-being, including the seminal text by Freeman first published in 1979. Freeman, A.M., III, *The Benefits of Environmental Improvement: Theory and Practice* (Johns Hopkins University Press for Resources for the Future: Baltimore, 1979).

1980s, the U.S. Department of the Interior explicitly required the consideration of changes in services when assessing damages for harm to natural resources.<sup>47</sup> The Millennium Ecosystem Assessment report highlighted the importance of understanding the full range of services provided by ecosystems, including how such services may be impacted by human activity<sup>48</sup> and described existing, well-accepted economic valuation methods that may be used to value these services.<sup>49</sup> Neither the publication of the Millennium Ecosystem Assessment report nor the publication in 1997 of a paper by Costanza et al. estimating “a first approximation of the relative magnitude of global ecosystem services”<sup>50</sup> represented a change in the state-of-the-science of ecosystem damages assessment, although both drew the attention of non-specialists to this important topic.

It is helpful to note the distinction between values and valuation. **Valuation** is the “process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on).”<sup>51</sup> In economic terms, it expresses the economic willingness-to-pay of humans for an ecosystem service, assuming perfect markets that reflect the interdependencies of humans and natural systems. **Social welfare values**, or “surplus” values, are the **values** held by the public for an ecosystem service above the cost of providing that service,<sup>52</sup> that is, the “contribution of an action or object to user-specified goals, objectives, or conditions.”<sup>53</sup>

Many different economic methodologies have been developed for valuing ecosystem services, all of which could be applied within the ecosystem services approach. The benefits transfer technique used by Costa Rica is just one of these. Benefits transfer has been applied for valuation since the 1970s.<sup>54</sup> Experts who write approvingly of using an ecosystem services approach may also caution about misuse of benefits transfer, as discussed below.

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<sup>47</sup> 51 Federal Register 27750 (1986).

<sup>48</sup> “The Millennium Assessment focuses on how humans have altered ecosystems, and how changes in ecosystem services have affected human well-being...” Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-Being: A Framework for Assessment, available at: <http://millenniumassessment.org/en/Framework.html>.

<sup>49</sup> Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-Being: A Framework for Assessment. Chapter 6: Concepts of Ecosystem Value and Valuation Approaches.

<sup>50</sup> Robert Costanza et al., “The value of the world’s ecosystem services and natural capital”, *Nature*, Volume 387, No. 6630 (1997), p. 253.

<sup>51</sup> Millennium Ecosystem Assessment Glossary, 902.

<sup>52</sup> See, for example: Freeman, A.M., III, Joseph A. Herriges, and Catherine L. Kling. 2014 *The Measurement of Environmental and Resource Values: Theory and Methods*. Third Edition. Resources for the Future Press: New York, NY. pp. 12-13, 46-47.

<sup>53</sup> Millennium Ecosystem Assessment Glossary, 902.

<sup>54</sup> Johnston, Robert J., John Rolfe, Randall S. Rosenberger, and Roy Brouwer, Introduction to Benefit Transfer Methods, in *Benefit Transfer of Environmental and Resource Values, A Guide for Researchers and Practitioners*, (Editors: Johnston, R.J., Rolfe, J., Rosenberger, R., Brouwer, R. (eds.) Springer 2015) p. 20.

ii. The UNCC Assessed Claims Valued Using Ecosystem Service-Based Methodologies

The UNCC did, in fact, consider ecosystem services in its assessment of environmental damage, as we explained in our May 2017 report.<sup>55</sup> There is no logical connection between the soundness and relevance of the UNCC methodology and the publication date of the Millennium Ecosystem Assessment because the use of ecosystem services to analyze environmental harms in a remedy context was established long before 2005<sup>56</sup> and the UNCC assessed several claims that used it, making awards for some.

While UNCC environmental claimants most frequently sought compensation for the cost of response, monitoring, assessment, remediation, and restoration activities, where remediation or restoration were not possible—for example, an oiled shoreline ecosystem that was too fragile for active remediation—claimants used alternative approaches to render the value of lost ecosystem services in terms of financial compensation. About this, one of the UNCC F4 Commissioners wrote,

In its valuation of such environmental damage, the Panel took into account a number of novel methodologies developed for this purpose in contemporary systems of environmental law and economics, on the basis of informal testimony by leading experts in the field. [footnote: Including professors Robert Costanza (Vermont) and the late David W. Pearce (London)] While it considered retrospective contingent valuation and ‘travel cost’ surveys inadequate for quantifying Kuwait’s and Saudi Arabia’s alleged loss of recreational shoreline uses, it accepted ‘habitat equivalency analysis’ (HEA) as an appropriate method for determining the nature and extent of compensatory remediation in order to make up for the loss of ecological services; e.g., of rangeland wildlife habitats in Jordan, and natural shoreline habitats in Kuwait and Saudi Arabia. ... in the event of ecological services that were irreversibly lost in the wake of the 1991 Gulf War (i.e., the *Humpty-Dumpty* type of casualties), the only practicable remediation was to provide victim countries with new ecological services that would be roughly equivalent in value. The outcome, therefore, were three compensatory projects as outlined and modified in the technical annexes to the Panel’s final report. [footnotes omitted]<sup>57</sup>

In one of these claims, Jordan proposed a monitoring and assessment study using **Habitat Equivalency Analysis (HEA)** to scale restoration alternatives in order “to reflect the magnitude and temporal extent of resource injuries, to quantify, in monetary terms, the loss of ecosystem services” in marine areas.<sup>58</sup> HEA is the assessment of the required scale of compensatory restoration needed to offset a particular harm, establishing equivalency between the scale of the harm and the benefits of a compensatory action by using a service measure.<sup>59</sup> The UNCC made an award for

<sup>55</sup> Payne & Unsworth May 2017 pp. 16-17.

<sup>56</sup> See, e.g., Gretchen Daily, *Nature's Services* (1997); Nick Hanley and Clive L. Spash, *Cost-benefit analysis and the environment* (1993); David W. Pearce and R. Kerry Turner, *Economics of natural resources and the environment* (1990). Carol Adaire Jones, *Economic Valuation of Resource Injuries in Natural Resource Liability Suits*, 126 *J. Water Resources Plan. & Mgmt.* 358-65 (2000).

<sup>57</sup> Peter Sand, *Compensation for Environmental Damage from the 1991 Gulf War*, 35:6 *Environmental Policy and Law* 244-249 (December 2005). For a discussion of the implementation of these approaches into national legal systems, see European Union, *Study on Analysis of integrating the ELD into 11 national legal frameworks: Final Report* (16 December 2013).

<sup>58</sup> UNCC F4 First Instalment, paras. 338, 339, 342.

<sup>59</sup> Zafonte, Matthew and Steve Hampton. 2007. “Exploring Welfare Implications of Resource Equivalency Analysis in Natural Resource Damage Assessments. *Ecological Economics*. 61 (134-145).

Jordan's proposed study, saying that "it is appropriate for Jordan to attempt to assess these environmental impacts and examine restoration options, and the methods proposed are internationally recognized."<sup>60</sup> The UNCC made two other awards to Jordan, for studies that involved HEA and assessment of lost ecosystems services in desert environments<sup>61</sup> and in wetlands.<sup>62</sup>

Jordan, Kuwait and Saudi Arabia also used HEA to scale the interim damages for certain injured sites, where natural recovery over decades was the only appropriate remediation.<sup>63</sup> They defended their use of HEA, as explained in the UNCC report, on the grounds that

HEA is a methodology that is widely accepted and is often used to quantify the ecological loss of services caused by oil spills and other released contaminants. According to the Claimants, HEA provides an appropriate mechanism to assign the costs of compensatory restoration to alternatives that can provide resources and gains equivalent in type and quality to the losses sustained. In their view, the methodologies utilized by them in the fifth "F4" instalment claims are internationally accepted methods for measuring the extent of loss of natural resources so that proper compensation can be made for such losses.<sup>64</sup>

The published reports of the UNCC panel thus demonstrate that several UNCC claimants presented their environmental injuries in terms of ecosystem services, and that the UNCC gave due attention to the validity and general acceptance of the approach for an international legal proceeding.

### iii. Environmental Liability Regimes Established Prior to 2005 Recognized Ecosystem Services

Ecosystem services were recognized in valuing damages for the compensation of environmental harm in the United States and the European Union before 2005 when the UNCC completed its claims review process. The methodology that we recommend for use in this case is based on the concept of ecosystem services.

Services are a component of analysis under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), where the public authorities must identify alternatives for "(i) the restoration or rehabilitation of the injured natural resources to a condition where they can provide the level of services available at baseline, or (ii) the replacement and/or acquisition of equivalent natural resources capable of providing such services."<sup>65</sup> CERCLA regulations define services as "the physical and biological functions performed by the resource including the human uses of those functions. These services are the result of the physical, chemical,

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<sup>60</sup> *Ibid.*, para. 339.

<sup>61</sup> UNCC F4 First Instalment, paras. 344, 348.

<sup>62</sup> UNCC F4 First Instalment, paras. 352, 354.

<sup>63</sup> UNCC F4 Fifth Instalment, paras. 73, 356-366 (Jordan's claim for damage to rangelands and endangered oryx and sand gazelles), 420-428 (Kuwait's claim for damage to rangeland and other terrestrial sites), 606-610 (Saudi Arabia's claim for damage to desert rangelands), 676-682 (Saudi Arabia's claim for damage to shoreline ecosystems). Kuwait also claimed interim damages for lost shoreline resources, which it calculated using a different methodology, "discounted service hectare years". This claim received an award. *Ibid.*, paras. 442-457.

<sup>64</sup> *Ibid.*, para. 79.

<sup>65</sup> 43 CFR 11.82.

or biological quality of the resource.”<sup>66</sup> They include “provision of habitat, food and other needs of biological resources, recreation, other products or services used by humans, flood control, ground water recharge, waste assimilation, and other such functions that may be provided by natural resources.”<sup>67</sup> The quantification phase of a natural resource damage assessment under CERCLA requires “determining the extent to which natural resource services have been reduced as a result of the injuries determined in the Injury Determination phase of the assessment.”<sup>68</sup>

The parallel U.S. statute for oil spills, the Oil Pollution Act of 1990 (OPA), also includes services as key concept, with the goal “to make the environment and public whole for injuries to natural resources and services.”<sup>69</sup> It requires both primary restoration, “any action, including natural recovery, that returns injured natural resources and services to baseline,” and compensatory restoration, “any action taken to compensate for interim losses of natural resources and services that occur from the date of the incident until recovery.”<sup>70</sup> We discuss how compensatory restoration can be calculated in section VI of this report.

Similarly, the 2004 EU ELD defines “damage” in terms of impairment of natural resource services.<sup>71</sup>

#### iv. The UNCC Reviewed Claims that Sought to Use Benefits Transfer

As we described in our May 2017 report, in its fifth instalment of claims, the UNCC reviewed and rejected the use of the benefits transfer methodology proposed by Iran.<sup>72</sup> It was noted in the UNCC panel report that: “The ecological service value which Iran uses to calculate this amount is that estimated in R. Costanza et al., “The value of the world’s ecosystem services and natural capital”, *Nature*, Volume 387, No. 6630 (1997), p. 253.”<sup>73</sup> This is the approach Neotrópica uses to develop its damages estimate.

Costa Rica uses the benefits transfer methodology to value a set of ecosystem services lost for a period of time. Benefits transfer relies on adopting monetary values derived from primary valuation efforts to value lost services at a different site.<sup>74</sup> **Benefits transfer** is an “[e]conomic valuation

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<sup>66</sup> 43 CFR 11.14 – Definitions. The US approach to environmental compensation requires the public authority to prepare a natural resource damage assessment (NRDA). NRDA is defined as “the process of collecting, compiling, and analyzing information, statistics, or data through prescribed methodologies to determine damages for injuries to natural resources”.

<sup>67</sup> 43 CFR 11.71(e).

<sup>68</sup> 43 CFR 11.71(a). This section of the regulations, subsection 11.71(d) directs specifically how services and methodologies should be selected.

<sup>69</sup> 15 CFR 990.10.

<sup>70</sup> 15 CFR 990.30.

<sup>71</sup> EU ELD, Article 2.2.

<sup>72</sup> UNCC F4 fifth instalment, para. 175. 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.

<sup>73</sup> UNCC F4 fifth instalment, endnote 35.

<sup>74</sup> Payne & Unsworth May 2017p.14.

approach in which estimates obtained (by whatever method) in one context are used to estimate values in a different context.”<sup>75</sup> US regulations refer to Neotrópica’s application as the unit value methodology, but focus on human use losses of natural resources in their definition of this approach. US CERCLA regulations explain, “unit values are preassigned dollar values for various types of nonmarketed recreational or other experiences by the public. Where feasible, unit values in the region of the affected resources and unit values that closely resemble the recreational or other experience lost with the affected resources may be used.”<sup>76</sup>

While the benefits transfer valuation method used by Neotrópica was developed in the 1970s, its use in the damages context has been limited. US environmental liability regulations—written well before the 1997 Costanza paper on which Neotrópica relies—allowed use of benefits transfer to value “recreational or other experience lost” (such as fishing or beachgoing) where “unit values that closely resemble” those lost can be found.<sup>77</sup> The reliability of the results obtained from its application varies depending on the strength of the transfer and associated assumptions (discussed further in Section V of this report).

Regulations and standards developed in the US and EU post-UNCC did not adopt benefits transfer as a “quick” ecosystem services approach to value changes in ecosystems due to environmental harms. As noted in the May 2017 Counter-Memorial of the Republic of Nicaragua on Compensation, several authorities, such as the National Ecosystem Services Partnership (NESP) have explicitly rejected the ecosystem services approach based on “quick” benefits transfer – the very approach Neotrópica uses. The NESP states,

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. For example, benefit transfer studies that purport to value ecosystem services on a biome or worldwide scale are widely considered to be invalid by economists and of little practical value for decision making. Similarly, ecosystem services valuation tools that simply multiply a unit value by the area of an ecosystem do not reflect changes in ecosystem services value that will occur with changes in the number of users or beneficiaries, nor do they reflect how values change as resources become scarcer.<sup>78</sup>

In addition, the European Union developed a “toolkit” for use in assessing monetary value of environmental harms notably does not include the approach used by Neotrópica as an accepted methodology.<sup>79</sup>

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<sup>75</sup> Millennium Ecosystem Assessment Glossary 895.

<sup>76</sup> 43 CFR 11.83 (c)(2)(vi).

<sup>77</sup> 51 Federal Register 27750 (1986).

<sup>78</sup> National Ecosystem Services Partnership (NESP), *Federal Resource Management and Ecosystem Services Guidebook*. (2nd ed. Durham: National Ecosystem Services Partnership, Duke University 2016) available at: <https://nespguidebook.com>.

<sup>79</sup> REMEDE, Resource Equivalency Methods for Assessing Environmental Damage in the EU, Deliverable 13: Toolkit for Performing Resource Equivalency Analysis to Assess and Scale Environmental Damage in the European Union (July 2008).



In short, Neotrópica asserts that the approach they follow – ecosystem service identification followed by valuation using benefits transfer – was not available to the claimants who came before the UNCC seeking compensation for harms caused by Iraq’s illegal occupation of Kuwait. As discussed above, this is simply not the case. They also rely on the date of the publication of the Millennium Ecosystems report as demonstrative of a change in the state of the science of ecosystem valuation. While the Millennium Ecosystems Assessment report is an important document that reflected the culmination of several decades over which the importance of ecosystems to human well-being was increasingly acknowledged, this report was not the first to highlight the value of ecosystem services.<sup>80</sup> There was no change in the state-of-the-science in 2006.

v. The Authorities Cited by Costa Rica Support the UNCC Methodology but Caution Regarding Use of the Benefits Transfer Methodology

Costa Rica refers a number of times to the Synthesis Report on valuation prepared for the Conference of the Parties to the Convention on Biological Diversity (CBD),<sup>81</sup> claiming that this report supports its methodology and implying that it is evidence that the UNCC approach is outdated.<sup>82</sup> On the contrary, the Synthesis Report refers favorably to the UNCC and raises several caveats regarding benefits transfer. Regarding the UNCC’s approach as an international methodology for valuation of complementary and compensatory remediation, the CBD Synthesis Report further says that,

In the context of temporary damage to natural resources without commercial value, some conclusions of the United Nations Compensation Committee with regard to its work on Iraq’s liability for environmental damage from the invasion and occupation of Kuwait are pertinent.<sup>83</sup>

The CBD Synthesis Report then reviews the UNCC F4 panel’s use and assessment of issues regarding various valuation methodologies, and concludes,

However, the Panel did not consider that these potential difficulties are a sufficient reason for a wholesale rejection of these methodologies, or for concluding that their use is contrary to international law principles. The Panel reiterated its previous statements that remediation measures for damaged resources should focus on primary restoration, in terms of the restoration of ecological functioning. Consequently, compensatory restoration measures should be considered only where there is sufficient evidence that primary restoration will not fully

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<sup>80</sup> Elliff, Carla I. and Ruy K.P. Kikuchi, The ecosystem service approach and its application as a tool for integrated coastal management, *Natureza and Conservacao* 13: 105-111 (2015).

<sup>81</sup> Conference of the Parties to the Convention on Biological Diversity, Liability and Redress in the Context of Paragraph 2 of Article 14 of the Convention on Biological Diversity: Synthesis report on technical information relating to damage to biological diversity and approaches to valuation and restoration of damage to biological diversity, as well as information on national/domestic measures and experiences, UNEP/CBD/COP/9/20/Add.1 (20 March 2008) (CBD Synthesis Report); Conference of the Parties to the Convention on Biological Diversity, Liability and redress in the context of paragraph 2 of Article 14 of the Convention, UNEP/CBD/COP/DEC/XII/14 (2014) (taking note of various studies, including the CBD Synthesis Report). See also, Conference of the Parties to the Convention on Biological Diversity, Incentive measures: application of tools for valuation of biodiversity and biodiversity resources and functions, UNEP/CBD/COP/DEC/VIII/25 (2006), Annex (“benefits transfer is still a developing subject. More work needs to be undertaken to assess its validity”).

<sup>82</sup> CRRC 2.8-2.12, pp 7-10.

<sup>83</sup> CBD Synthesis Report, para. 128.



compensate for any identified losses. It is only in such cases that HEA would be considered as a helpful tool in determining how much compensatory restoration is necessary and feasible in the circumstances.<sup>84</sup>

The CBD Synthesis Report describes benefits transfer as a “comparatively inexpensive and fast method”, but one that “has been the subject of considerable controversy in the economics literature, as it has often been used inappropriately.”<sup>85</sup> It says,

one may in some decision-making contexts be willing to trade quick and cheap numbers against a certain loss in accuracy, provided that minimum quality standards are met. For instance, if valuation data is available on the biodiversity damage and its restoration in a very comparable other case, benefits transfer may provide at least an indication on whether the costs of proposed restoration measures are excessive when compared with the expected benefits of these measures.<sup>86</sup>

This indicates the need for great care and limited application of the method as it is applied by Costa Rica, which we analyze in section V of this report.

#### V. REGARDLESS OF WHETHER THE ECOSYSTEM SERVICES APPROACH IS APPROPRIATE IN THIS CASE, THE ANALYSIS CONDUCTED BY NEOTRÓPICA DOES NOT MEET BEST PRACTICES

Central to the question of which damages approach should be used to assign damages in this matter is the question of whether Neotrópica’s analysis meets the standard of best practices for the methods they have chosen. Despite our highlighting significant shortcomings in our earlier report to the Court, Neotrópica did not modify their approach, assumptions, or calculations, but instead responded with a series of new arguments in an attempt to support their analysis and results. In this section we summarize our four primary concerns with the Neotrópica application of the ecological economics approach: (1) whether the benefits transfer they construct is consistent with well-established best practices; (2) the potential for double counting across service categories (in particular, using market values of timber as proxy measures for ecosystem values of living trees in addition to non-market values for the same services); (3) improper summing of values for ecosystem services over time; and (4) confusions over the purpose of the social discount rate used by Neotrópica. We also present a description of how the analysis could have been done well, following best practices.

Two key concepts are present value and social discount rate. **Present value** is the equivalent value of a projected stream of future benefits (or costs), accounting for a time-dependent weight (discount rate), expressed as a single sum today.<sup>87</sup> Calculation of a present value of ecosystem services typically involves the use of a positive social discount rate. **A social discount rate** is the risk-free rate at which society trades off current consumption of goods and services for future goods and

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<sup>84</sup> *Ibid.*, para. 130.

<sup>85</sup> *Ibid.*, para. 136.

<sup>86</sup> *Ibid.*

<sup>87</sup> U.S. Environmental Protection Agency, National Center for Environmental Economics. May 2014. Guidelines for Preparing Economic Analyses, p. 6-2.

services.<sup>88</sup> This is the rate that is used to convert a stream of damages in the future into a single present value.

#### *A. Poorly Constructed Benefits Transfer*

Neotrópica states explicitly that they did not conduct any primary valuation for this matter. Instead, they apply existing values from the literature and other sources to generate a damages estimate. As noted above, while benefits transfer is used to assess losses in human services (e.g., lost beach visits following an oil spill), in our experience it is not applied in the context of environmental liability assessment to ecological service losses, such as soil formation, biodiversity or natural hazard mitigation. This is particularly true in terms of the simple transfer of values from the literature as opposed to a benefits function transfer.<sup>89</sup> In such instances replacement cost based estimates of loss, using habitat equivalency, are far more commonly applied. This is largely related to the challenge of conducting a sound transfer, including the lack of studies in the literature that directly address the type of ecosystem change at hand, the wide-variation in the nature of the services being valued, as well as other factors. All of these factors lead to a high level of uncertainty in the resulting values.<sup>90</sup>

Regarding the development of a primary damages estimate, Neotrópica states:

The time investment and cost of applying these methodologies can be significant, as they depend on a systematic collection of primary or secondary information that, using the environmental services framework described above, must be careful. Thus, they can be called slow methodologies. A valuation technique that gained popularity in the 1990s 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.<sup>91</sup>

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<sup>88</sup> *Ibid.*, p. 6-6.

<sup>89</sup> Values for ecosystem services, such as recreation, are a function of site specific attributes (e.g., whether the beach being visited comes with amenities, such as a bath house), the nature of the change being measured (e.g., complete loss of the natural resource that provides the service or partial loss), and the method used to value the service (e.g., whether values were based on revealed (observed) behaviors of users or stated preferences (i.e., derived from surveys of the public), which might be seen as less reliable), among other factors. Benefits transfer functions explain differences in the results found across studies using these factors. In this manner a researcher wishing to transfer values can fit site attributes and valuation problem at hand into these equations, allowing for a more accurate value estimate. Unit value transfers, such as those performed by Neotrópica, apply simple averages (or even individual values) from the literature without adjustment to the specific valuation problem at hand. “If you can choose between transferring a function or a point estimate, you should transfer the entire demand function (referred to as benefit function transfer) rather than adopting a single point estimate (referred to as benefit point transfer.” U.S. Office of Management and Budget, Circular A-4: Regulatory Analysis (September 2003.)

<sup>90</sup> The uncertainty inherent in a “quick” unit value based benefits transfer can be highlighted by referring to a paper by one of Neotrópica’s reviewers, Rudolf De Groot. His report explores the variance in the estimates he gets for the ecosystem services provided by various habitat types. It is notable that while the average value obtained for coastal wetlands is about USD 190,000, the standard deviation is USD 384,000. This result implies that the true value could in fact be zero. The median is USD 12,162, providing strong evidence that the underlying estimates are not normally distributed. Such statistics clearly indicate that while ecosystem service estimates can be mathematically calculated using a unit transfer approach, the results can vary wildly depending on the services included, assumptions made, and studies relied upon. Rudolf De Groot, et al., *Global estimates of the value of ecosystems and their services in monetary units. Ecosystem Services 1*, 50-61 (2012).

<sup>91</sup> Fundación Neotrópica June 2016 Report CRMC, Vol. I, Annex 1, p. 110.

As noted above, Neotrópica’s understanding of the history of benefits transfer is incorrect. That said, in rejecting the use of “slow” methodologies (i.e., primary research on the marginal damages resulting from ecological changes at the harmed site), and putting forth an analysis based on a “quick” benefits transfer, Neotrópica is obliged to meet the best practices for that valuation approach.<sup>92</sup> This is particularly important in that the benefits transfer approach they use – the simple transfer of unit values – presents the greatest risk of error, since it presents the least opportunity to adjust the existing values to the issue at hand in this case.<sup>93</sup>

In circumstances where benefits transfer is used, its application must, at a minimum, satisfy certain conditions, including: (i) that the commodity or service being valued be very similar at the site where the estimates were made and the site where they are applied; (ii) that the (human) populations affected have very similar characteristics;<sup>94</sup> and (iii) that the original estimates being transferred must themselves be reliable. We believe, however, that the Neotrópica analysis fails to meet these criteria.

i. Is the commodity or service being valued similar to that considered in the literature?

An important component of sound transfer is to align the value reported in the literature with the valuation problem at hand. In performing this step, it is necessary to understand the difference between marginal and average values for environmental goods, since many values presented in the literature are average values (i.e., the average per hectare values for entire ecosystems, not values for small changes in components of ecosystems). Economists recognize that the total value of a resource can be quite large. For example, we would all pay a lot to avoid not having any fresh water, but we might pay very little to add one gallon to our current supply. Average values—such as those which Neotrópica uses—are calculated as the total value of an ecosystem divided by the total area of the resource. Marginal values, which reflect the loss experienced when a small portion of an ecosystem such as the Humedal Caribe Noreste wetland complex is harmed, can be far smaller. The correct measure of damages to apply to Costa Rica’s claim is the marginal value of the harmed wetland, not the average value that Neotrópica attempts to calculate by transferring values from the literature.

As noted in our original report, Neotrópica did not quantitatively identify the relationship between the harm and the change in ecosystem services. For example, while Neotrópica provides additional thinking on the importance of soils to healthy ecosystem function in their new report, they do not explain why a damages claim based on the volume of soil displaced is likely to be a good measure of the degree of harm. For example, if the caños were twice as deep, and thus the volume of soil displaced doubled, would the impact be twice as great? Similarly, Neotrópica uses a value for coastal protection drawn from a study of regional coastal mangrove loss in Thailand. In this case, the context and the extent of change are distinctly different. The degree of error inherent in such transfers is unknown but potentially large.

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<sup>92</sup> Compare to UNCC review of Kuwait’s contingent valuation-based claim, UNCC F4 Fifth Report, paras. 463-464 (serious technical problems with implementation of contingent valuation led to no award although it was likely that Kuwait suffered interim losses of recreational opportunities).

<sup>93</sup> See Section IV.B.iv. above.

<sup>94</sup> Freeman, A.M., III, Joseph A. Herriges, and Catherine L. Kling, *The Measurement of Environmental and Resource Values: Theory and Methods* 420 (Third Edition, Resources for the Future Press: New York, NY 2014).

- ii. Does the (human) population affected have very similar characteristics?

While some of the values used (e.g., timber market values) are specific to Costa Rica, Neotrópica makes no attempt to adjust the values they use for hazard mitigation or habitat and nursery services to the context of Costa Rica. As discussed at length in our original report, the hazard mitigation value was developed in 2002 in the context of valuing the services provided by coastal mangrove in Thailand, and the habitat and nursery services were drawn from 2002, 2007, and 2014 studies in the contexts of wetlands in Mexico, the Philippines, and Thailand. As such, no attempt is made by Neotrópica in its first or second report to meet the criteria that the population at the damage site be similar to the population studied in the reference study.

- iii. Are the original estimates being transferred reliable?

In conducting a benefits transfer, researchers should attempt to verify the reliability of the studies from which they draw values. Neotrópica appears to make little effort to review the underlying values they transfer for several of the services they include in their valuation. For example, as noted in our original report, the value they interpret as an annual value for carbon sequestration on a hectare of coastal wetland is in fact the present value of sequestration services available from coastal wetland. Even a casual review of this paper could have corrected this interpretation error; the second report did not resolve this shortcoming. Since the reliability of the damages estimate they develop is only as good as the value presented in the underlying study, rigorous review of studies relied upon is key to a sound benefits transfer.

#### *B. Despite Neotrópica's Clarification, the Approach Used Risks Double Counting*

In our 26 May 2017 report we raise concerns regarding the potential for double counting given the valuation approach used by Neotrópica. In their report, they state:

Aggregation of values is also a challenge identified by this study. BTM studies need to take care of summing across services with caution to avoid double counting of ecosystem service values. As long as the ecosystem services are entirely independent, adding up the values is possible. This is a much larger problem with aggregation of a large number of services, increasing the possibility of some being mutually exclusive or redundant.<sup>95</sup>

This response does not address the fact that the Neotrópica damages approach, outside of the selection of services to value, does not preclude double counting. In this case, it is not the listing of multiple services that generates the risk of double counting, but the way in which those services are valued.

Specifically, the Neotrópica analysis places a value on the lost timber and fiber production functions of the harmed area. The authors clarify in their report that they do not presume these resources would have been harvested, but use the foregone market value as a proxy measure of ecosystem value. The use of foregone economic opportunity to estimate the value the public holds for an ecosystem is not in itself flawed. For example, if a landowner is precluded from harvesting

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<sup>95</sup> Fundación Neotrópica August 2017 Report, p. 21 (CRRC, Annex I, p. 51).

trees on her property by a national law put in place to preserve the carbon sequestration and habitat values provided by mature trees, the value of the foregone harvest can be used to estimate a lower bound value the public holds for those services. That is, we know society is “willing to pay” at least that amount to protect those services – in the form of opportunity costs of economic activity foregone.

By also valuing the services that were protected, however, and adding these values to the foregone market value of the timber, Neotrópica risks double counting those values. In short, these are two distinct measures of the same thing – the first being a willingness to forego economic value to protect an ecosystem so that it can continue to provide services, and the second being measures of the value of the services themselves. By using timber market values as a proxy value for an undisturbed ecosystem, and then adding to this other services protected by not harvesting, Neotrópica risks double counting ecosystem values.

### *C. Misuse of Capitalized Values as Annual Values.*

In our May 2017 Report, we note that Neotrópica incorrectly takes asset values and present values for various resource services, expressed in 2010 dollars, and sums those values over 50 years, discounting at four percent. This mistake results in an overstatement of damages by a factor of 33.<sup>96</sup> The specific calculations performed by Neotrópica are highlighted below, as drawn from Neotrópica’s original report.

For example, in our initial report we show that the value used by Neotrópica for “gas regulation” services is already a present value (reported as USD 14,982), and thus does not need to be summed over 50 years to create an overall present value measure of damages, as is clearly done as demonstrated in the table below. As discussed later in this document, this amount, if paid today, would fully compensate for the ongoing loss in gas regulation services. This error was not corrected by Neotrópica in their new report, leading to a substantial overstatement of damages (by a factor of 20 times). Similarly, the “soil formation” value Neotrópica uses reflects the cost to replace soil at the site, with this cost estimate borrowed from a different study. There is no need to take actions to replace the soil each year for 50 years (if the soil is to actually be replaced it only needs to happen once; if this is a proxy measure of the value of soil services, we only need to value it once), and thus no need to sum this replacement value each year for 50 years. Doing so substantially overstates damages.

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<sup>96</sup> Above we note that the annual value of carbon sequestration services used by Neotrópica is more than two orders-of-magnitude higher than the average value for annual carbon sequestration reported by de Groot, and that we believe this difference is simply due to Neotrópica’s misinterpretation of the value they report to be an annual value.

**Exhibit 1: Summary of Neotrópica’s Damages Calculations<sup>97</sup>**

Ecosystem good or service	Affected area	Amount and reference unit of the loss	Monetary value by unit <sup>2</sup>	Estimated total of the loss in U.S. dollars (2016)	
<b>Provisioning</b>					
Standing timber (Includes the opportunity cost of forests, OCF <sup>2</sup> )	C2010	211 m <sup>3</sup> /ha for standing timber with a 50% harvesting rate and OCF of 6 m <sup>3</sup> /ha per year of growth with a 50% harvesting rate in 2.48 ha	\$64.65	\$19,558.64	The present value of timber removed.
	CE2013	211 m <sup>3</sup> /ha for standing timber with a 50% harvesting rate and OCF of 6 m <sup>3</sup> /ha per year of growth with a 50% harvesting rate in 0.43 ha	\$40.05	\$1,970.35	
Other raw materials (fibre and energy)	C2010 (includes cleared area)	Value of the service per ha. in 5.76 ha	\$175.76	\$794.06	
	CE2013	Value of the service/ha. in 0.43 ha	\$175.76	\$38.14	
<b>Regulating and supporting</b>					
Gas regulation/air quality (Includes stock and annual flow)	C2010	Value of the service/ha. in 2.48 ha	\$14,982.06	\$37,139.03	
	CE2013	Value of the service/ha. in 0.43 ha	\$14,982.06	\$6,502.21	
Natural hazards mitigation	C2010	Value of the service/ha. in 2.48 ha	\$2,949.74	\$7,312.11	
	CE2013	Value of the service/ha. in 0.43 ha	\$2,949.74	\$1,286.19	
Soil formation/erosion control	C2010	Replacement cost of 5,815 m <sup>3</sup> of removed soil (collection and transport)	\$5.87	\$33,610.69	
	CE2013	Replacement cost of 3687.72 m <sup>3</sup> of removed soil (collection and transport)	\$5.87	\$21,315.00	The cost of replacing soil at the harmed sites, once.
Habitat and nursery (Biodiversity)	C2010	Value of the service/ha. in 2.48 ha	\$855.13	\$1,613.52	
	CE2013	Value of the service/ha. in 0.43 ha	\$855.13	\$282.49	
<b>Total SC First year</b>	C2010			\$100,028.04	
	CE2013			\$31,388.38	
<b>Total SC 50 years</b>	C2010			\$2,148,820.82	
	CE2013			\$674,290.92	

\$2,148,820 is the present value, at 4 percent, of a series of \$100,028 values, each year for 50 years. As shown, Neotrópica assumes the annual loss calculated in the first year continues for 50 years, discounted at 4 percent.

<sup>97</sup> Fundación Neotrópica June 2016 Report, p. 60.

Neotrópica, in their report, defend this calculation by claiming that it is consistent with standards of wealth accounting for natural capital (i.e., the value of natural assets held by a nation, such as the value of the stock of all standing timber). For example, they state:

We do not assume that that it would have been possible to remove sustainably half of the annual growth of trees each year. We assume that the asset degradation will be reflected in Costa Rican physical natural and economic accounts every year as a decrease in the monetary value of the country's natural assets, until it is fully recovered. This is why we account for the loss annually, deducting from the annual value the recovery of volume that we account for through the use of the discount rate.<sup>98</sup>

Whether or not the harm continues for 50 years, there is no basis in economics, finance, or accounting to sum the values they present over 50 years. The **capital value** (of an ecosystem) is the present value of the stream of ecosystem services that an ecosystem will generate under a particular management or institutional regime.<sup>99</sup> If a hectare of forest contains USD 1,000 in standing timber, that asset value is correctly measured as USD 1,000. When the national account is recalculated the next year, the value (if unharvested, and absent major shifts in market values) would also presumably be on the order of USD 1,000. If someone illegally harvests the timber, the national account would drop by USD 1,000. However, if the party who harvested the trees pays damages equal to USD 1,000, the national account will now contain those funds. The harmed nation would not need to be compensated each year of the harm to maintain the same level of wealth.

In the Neotrópica analysis the various ecosystem services are valued as present values (such as timber, the cost of replacing soil, or the lost sequestration values), the value of which can be measured and compensated for once. This logical error is the most significant that we identified in the Neotrópica analysis. It alone accounts for an over-valuation of damages by nearly a factor of 20, and highlights why the analysis does not meet best practices and does not provide a sound basis on which to award damages.

This error can be described more formally in the context of natural capital accounting. While GDP measures a country's economic performance, natural capital accounting endeavors to capture the importance of natural assets (e.g., forests, fish) that affect people's social and economic well-being. Neotrópica describes the World Bank's Wealth Accounting and Valuation of Ecosystem Services (WAVES) initiative to measure the importance of environmental assets through natural capital accounting methods. The WAVES program refers to the UN Statistical Commission standard for natural capital accounting methods, referred to as the System of Environmental and Economic Accounts (SEEA).

The SEEA framework details how net present values of environmental assets should be calculated in the context of natural capital accounting. Specifically, for harvestable resources (timber or mineral extraction), the net present value is a function of the flows of resource rent over time and the discount rate. In turn, resource rent in any given year is itself a function of the extraction rate (i.e., harvest rate); the flow of resource rent over time should accordingly reflect fluctuations in extraction rates. Thus, if Neotrópica's analysis assumes the full volume of harvestable timber is

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<sup>98</sup> Aguilar-González, B., Carranza-Vargas, M., Hidalgo-Chaverri, M., Fernández-Sánchez, A., Monge-Vargas, R., Castro-Jiménez, M. 3 August 2017. Report by Fundación Neotrópica on the Question of the Methodology for the Assessment of Environmental Damage, p. 32.

<sup>99</sup> Millennium Ecosystem Assessment Glossary 893.



extracted in year 1, the subsequent years would reflect extraction rates of zero. The full extraction volume would not be included in each year.

As noted, Neotrópica states that the timber at this site would not actually be harvested. Thus, an *in situ* price of the standing timber should be used in estimating the resource rents. However, regardless of whether the timber is for harvest or not, valuing the stock of a natural resource using a present value of a flow framework requires some assumption regarding extraction rate. With respect to valuing standing timber not for harvest, SEEA states:

Next, a hypothesis has to be formed concerning the future profile of extractions and the expected price change... One simple possibility is to assume that the most recent quantity of extraction is the best estimate of future extractions... Another possibility is to assume a constant rate of extraction....<sup>100</sup>

Accordingly, Neotrópica's placing of its present value calculations in the context of natural capital accounting does not change the fact that it requires assumptions regarding a flow of changes in the stock of timber over time. Neotrópica could assume 1/50th of the timber would have been extracted in each future year or it could assume all of the timber is harvested in the first year and none after that. Assuming all of the harvestable timber (which is 50% of standing timber) could have been extracted each year is simply incorrect.

#### *D. Discount Rate Confusion*

In its initial report, Neotrópica discusses the selection of a discount rate for use in its calculations, and concludes that a four percent rate is supported. For example, they state:

Choosing the discount rate is a delicate matter, thoroughly discussed in the ecological economy literature. The discount rate is applied as a financial-economic conventionalism to determine the NVP, as it is considered that the opportunity cost of using that capital for other purposes should be taken into account for that future value.

and

This section concludes with the monetary estimation of the value of the environmental damage, performed over a 50-year horizon, during which the full recovery of the damage caused is expected, using an environmental discount rate of 4% for purposes of determining the net present value.<sup>101</sup>

There is nothing in that report that indicates that the discount rate they use has anything to do with the recovery path of the harmed ecosystem they attempt to value. However, in their new report, in addressing our concern that they did not consider the area's recovery over time, they state:

Finally, as we will comment more in detail later (Section VIII.E.), we have assumed a potential recovery of the standing volume when we decided the rate with which we discounted the net present value of the damage on a fifty-year time horizon. Recent studies estimate a median recovery rate in Central American forests from clearing to 95% recovery of 141 years (about 0.71% per year). Worldwide, the estimate from the same study states a 0.41% annual recovery rate from human disturbances to the same level of recovery, based

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<sup>100</sup> UN SEEA, 2015, p. 220.

<sup>101</sup> CRMC, p. 33.



on 166 events of such nature (Cole, et al., 2014). In such case, the recovery time would be close to 244 years. By assuming a 4% discount rate for the calculations of the Net Present Value in this monetary valuation, we are in fact assuming an ample average recovery rate of 1.71% per year.

and

Regarding the accounting for several of the ecosystem services chosen, Nicaragua argues that we made a mistake by not assuming any recovery in the supply of the services through time. This is not the case. One of the reasons for which we carefully justified the choice of the 4% discount rate used in our valuation is because it needs to be representative of the rate at which the ecosystem will recover.<sup>102</sup>

Notwithstanding this statement, as noted, there was no discussion or consideration of ecosystem recovery in the original Neotrópica report. While a discount rate works in some ways like a recovery rate, they are not the same thing, nor are they typically combined into one measure. In any case, this response serves to highlight the lack of analytic rigor in the Neotrópica analysis.

#### *E. Neotrópica's Analysis Falls Short of Methodological Standards*

Economists have overcome many of the limitations highlighted above in the development of ecosystem service values. For example, rather than a “quick” unit value benefits transfer approach, Neotrópica could have applied an ecosystem services model such as the one available from the Natural Capital Project,<sup>103</sup> and/or should have followed MEA framework for ecosystem services evaluation. Even limited reference to the MEA framework clarifies how the Neotrópica analysis falls short. We note that multiple other institutions provide very similar guidance with respect to ecosystem service valuation. These include the National Ecosystem Services Partnership’s (NESP) Federal Resource Management and Ecosystem Services Guidebook (NESP, 2016), and the Economics of Ecosystems and Biodiversity (TEEB, 2011), as discussed in our May 2017 Report.<sup>104</sup> In fact, the primary authority Neotrópica cites, the Institute of Policies for Sustainability’s (IPS) defined approach, is founded on careful consideration of the degree of change in ecosystem services. Specifically, Neotrópica states:

The third component of our methodological framework is the Institute of Policies for Sustainability (IPS) method for environmental damage valuation. It requires taking into account

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<sup>102</sup> Kondolf Report May 2017, Explanatory addenda to the report “Monetary value 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)”, p. 10.

<sup>103</sup> The Natural Capital Project is a collaboration of the Woods Institute for the Environment at Stanford University, the World Wildlife Fund, the Institute on the Environment at the University of Minnesota, and The Nature Conservancy. The Natural Capital Project has developed a series of modeling tools designed to evaluate changes and tradeoffs in ecosystem services, including the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) models. These models are focused on linking biophysical ecological production models with economic valuation methods. Information is available at <https://www.naturalcapitalproject.org/>.

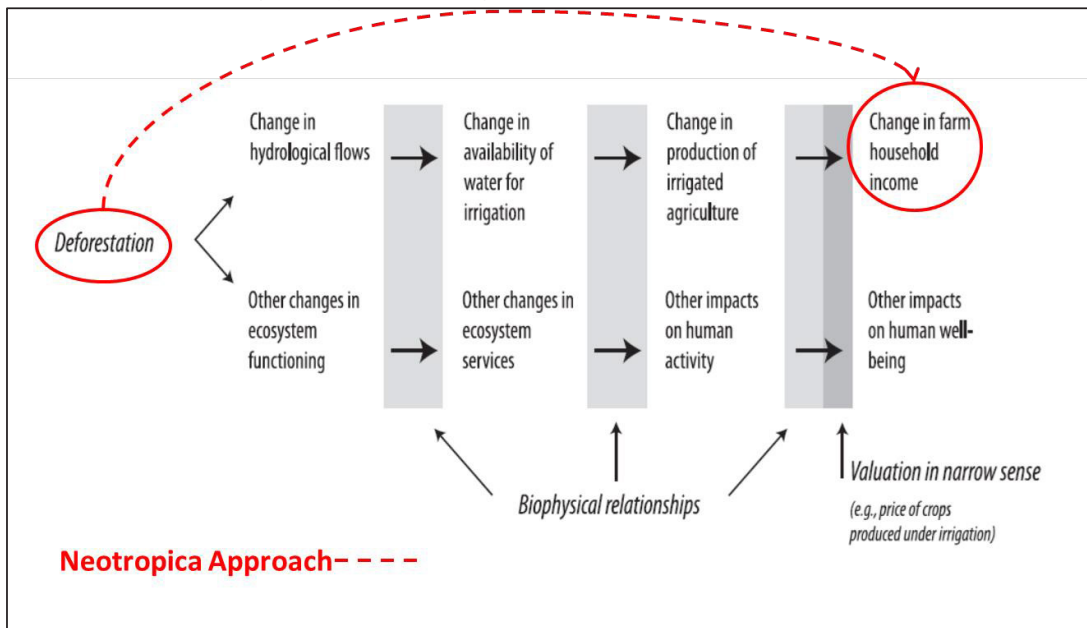
<sup>104</sup> National Ecosystem Services Partnership (NESP) (2016). *Federal Resource Management and Ecosystem Services Guidebook*. 2nd ed. Durham: National Ecosystem Services Partnership, Duke University, <https://nespguidebook.com>; and TEEB. February 2011. *The Economics of Ecosystems and Biodiversity for National and International Policy Makers*. <http://www.teebweb.org/publication/teeb-in-national-and-international-policy-making/>.

the state of things before the environmental damage in order to assign the percentage of responsibility attributable to the actions of the infractor. It recommends TVE estimation methods for the estimation of the social and biophysical monetary costs of the damage. It also prescribes the estimation of those costs into the future until the ecosystem recovers its capacity to provide its functions and services at the level they were before the environmental damage.<sup>105</sup>

This is a basic and well-accepted framework for ecosystem services assessment. It is important to note, however, that the IPS approach does not prescribe the “quick” benefits transfer approach Neotrópica uses, but instead defines a range of approaches that can be applied. It also requires careful comparison of services provided before and after the change being valued, including recovery of those services over time, not a simple accounting of the number of hectares impacted.

The MEA Framework chapter, “Concepts of Ecosystem Value and Valuation Approaches,” describes that the bulk of the work of any ecosystem services valuation actually concerns quantifying the biophysical relationships. That is, the first step is to answer the question: how did the change or harm to the ecosystem affect how it functions? The causal linkages between the ecosystem change and its biophysical functioning are represented by the solid “biophysical relationships” arrows in Exhibit 2.

**Exhibit 2: Valuing Ecosystem Change: Comparison with Neotrópica Approach**



Unfortunately, Neotrópica largely skips this important step, as shown in the red dashed line in Exhibit 2. For example, Neotrópica’s report repeatedly supports its values of natural hazard mitigation simply by stating that it is an important wetland ecosystem service and should therefore

<sup>105</sup> Fundación Neotrópica August 2017 Report, p. 12.

be included. The importance of wetland ecosystem services is not in question. At issue is how the various services provided by the harmed wetland changed, in a quantitative sense, given the actions of Nicaragua. As such the first step of an ecosystem service valuation would be to assess how a particular damage event affects the ability of this particular wetland landscape to perform this function.

## VI. REPLACEMENT COST PROVIDES A VALID AND FAIR MEASURE OF DAMAGES AND IS A GOOD FIT IN THIS MATTER

We believe that a direct replacement cost approach provides a more accurate and efficient means to establish damages in this matter. Specifically, we propose that damages be set equal to the cost of conservation actions to protect similar habitat at risk of development or loss, as a means to compensate Costa Rica. As noted above, this is the most common approach to environmental liability assessment, and avoids many of the challenges of monetary valuation using ecological economics and the benefit transfer approach.<sup>106</sup>

Neotrópica makes two principal arguments in rejecting our replacement cost approach for damages estimation in this matter:

1. That replacement cost, in general, is a poor "...proxy for the value (welfare effect) of the benefits of ecosystems (and their services) ...,"<sup>107</sup> and
2. That the specific replacement cost we apply, based on an existing program in Costa Rica for payment for ecosystem services, is not applicable to this setting.<sup>108</sup>

We address these comments in this section.

### i. There Is No Requirement that Compensation Take the Form of Social Welfare Values

Neotrópica references Rudolf de Groot in asserting that social welfare values should form the basis for compensation:

In the words of Dr. Dolf de Groot, "as far as I know the literature, and from my own studies, Replacement Cost (at the ecosystem level) is actually the least suitable of all ES-valuation methods as a proxy for the value (welfare effect) of the benefits of ecosystems (and their services) and thus what the welfare effects would be after the loss of an ecosystem, because it is unrelated to the actual benefits (value) provided by the intact ecosystem."<sup>109</sup>

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<sup>106</sup> As noted, we assume full replacement for 20 to 30 years of the harmed habitat. Given the scale of loss in this case (about six hectares) we do not adjust the required scale of replacement for the degree of harm or for recovery of the resource. These factors would typically be considered in an event or case involving greater harm (i.e., larger area of harm), and in this case would likely result in a lowering of the damage estimate.

<sup>107</sup> Fundación Neotrópica August 2017 Report, p. 41.

<sup>108</sup> Fundación Neotrópica August 2017 Report, pp. 41–42.

<sup>109</sup> De Groot, Rudolf. Appendix 2: Note from Rudolf de Groot, in Annex 1: Report by Fundación Neotrópica on the Question of the Methodology for the Assessment of Environmental Damage. 3 August 2017, p. 50.

This statement is premised on the assumption that damages in this matter should reflect lost social welfare values. In this context, social welfare values would reflect what society would be willing to pay to avoid the loss of an ecosystem services from the time of the harm through recovery of the resource to the condition that existed pre-harm. However, as discussed above, there is no basis in international law or economics to assume that ecological damages must be measured in terms of changes in social welfare. Simply put, if a sound replacement can be provided, the Court need not delve at all into ecological valuation, which de Groot notes is “...very time and context dependent and therefore subject to much uncertainty.”<sup>110</sup> In addition, economic theory requires that, if the cost of an equivalent replacement is less than the loss in economic value, compensation through replacement will reflect the efficient and appropriate payment of compensation. Since a replacement is available in this matter, it is our opinion that the cost of that replacement should be used to establish damages.<sup>111</sup>

The appropriate measure of damages to apply is dependent on the legal context. However, at least one of the reviews presented by Neotrópica presume a measure of loss in this case that is not consistent with international law. Joshua Farley states:

I conclude with a final but perhaps legally irrelevant observation. In Civil Court cases, the goal of Justice is typically to make the victim whole. This is certainly one of the goals in this case. In criminal cases however, the goal is often to deter future transgressions by penalizing the transgressor. In my view, the environmental destruction in question was a criminal act, and it would be more efficient to err on the side of excessive payment rather than underpayment.<sup>112</sup>

The obvious bias inherent in this statement favors, not a method that makes the Costa Rican public whole, but instead provides a penalty in the form of “excessive payment.” Reparations owed for environmental injury or loss caused as a result of Nicaragua’s breach of Costa Rica’s territorial sovereignty are restorative not punitive.<sup>113</sup> The International Law Commission stated, in the Commentary to the Draft Articles on State Responsibility, that “the award of punitive damages is not recognized in international law even in relation to serious breaches of obligations arising under peremptory norms.”<sup>114</sup>

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<sup>110</sup> De Groot, Rudolf. Appendix 2: Note from Rudolf de Groot, in Annex 1: Report by Fundación Neotrópica on the Question of the Methodology for the Assessment of Environmental Damage. 3 August 2017, p. 51.

<sup>111</sup> The implication of de Groot’s comments, and those of Neotrópica and other reviewers, is that replacement cost will always be less than the lost welfare value. There is no reason why this will always be the case (i.e., in some cases efficient replacement will be available; for some resources the cost of such replacement may exceed the welfare value the public holds for the harm).

<sup>112</sup> CRRC, Annex 1, Appendix 11, p. 137.

<sup>113</sup> *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).

<sup>114</sup> ILC, Draft Articles on Responsibility of States for Internationally Wrongful Acts, with commentaries, *Yearbook of the International Law Commission*, Vol. II, Part 2 (2001), 113; *Velásquez Rodríguez v. Honduras*, Reparations and Costs, Inter-American Court of Human Rights, (Series C, No. 7 (1989)) (“The expression ‘fair compensation,’ used in Article 63 (1) of the Convention to refer to a part of the reparation and to the ‘injured party,’ is compensatory and not punitive. Although some domestic courts, particularly the Anglo-American, award damages in amounts meant to deter or to serve as an example, this principle is not applicable in international law at this time.”). *See also*, The Ramsar Convention

There is no basis in economics or law for assuming that replacement cost measures that are less than social welfare values will undercompensate the harmed party. In short, if the Court can provide compensation that allows Costa Rica to undertake replacement of the lost services, the Costa Rican public will have been made whole.

ii. The Replacement Cost Estimate Is Reasonable

As noted, the damages approach we propose is to estimate the cost of fully replacing habitat to compensate for the injured area for 20 to 30 years, or until the site recovers from the harm. This cost estimate is based on reported payments to private parties to protect forested habitats on their lands, through a well-established habitat conservation program in Costa Rica.<sup>115</sup> This practice is commonly referred to as “payment for ecosystem services” (PES). Under a PES plan, landowners and communities with rights to develop natural areas are compensated to provide incentives to instead protect these areas. By protecting areas at risk of development and ecosystem harm, the public can be made whole for losses at the site harmed by Nicaragua’s actions.

Neotrópica makes four arguments in rejecting the replacement cost estimates we apply. The first is that the rates paid by FONAFIFO (National Fund for Forest Finance) “are far from being a pure market tradeable permit system.” (p 41). Whether this implies that the value used is too high or too low is not stated. However, the implication is that such payments are not reflective of economic value. In fact, we would not expect the payments to reflect social values for habitat. That is, incentive payments are provided to private parties under a PES program to encourage actions to protect habitat, and reflect the opportunity cost to the participating landowners of not maximizing the economic opportunity of the land. These payments are the cost of replacement services, not the monetary value of those services. In this case, the objective is the protection of habitat similar to that harmed by Nicaragua’s actions, which we believe can be achieved through a PES program.

Second, Neotrópica argues that these funds are not used for public protected areas, but are made only to private landowners.<sup>116</sup> Similarly, in a separate letter, a representative of FONAFIFO, Jorge Mario Rodríguez Zuñiga, highlights that the existing PES programs are not designed to incentivize government land managing agencies to take conservation measures, but are focused on payments to private landholders. As noted above, this is not a limitation of our damages estimate, as there is no reason why restoration of lost ecosystem services in this case could not take place on private lands. This makes sense, since the economic incentive is for private landowners to maximize the economic value of their lands and often this incentive is required to achieve conservation goals. In short, there is no reason why compensation in this matter could not be provided through replacement of ecosystem services, to be enjoyed by the public, on private lands.<sup>117</sup>

Third, Neotrópica argues that no PES program in Costa Rica is designed for wetlands. However, the habitats being protected by the FONAFIFO—forested areas—exist at the harmed site. Costa Rica has not suggested it would not be feasible to protect such a habitat elsewhere

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Manual, 1.7.5 (6<sup>th</sup> ed. 2013) (“The Ramsar Convention is not a regulatory regime and has no punitive sanctions for violations of or defaulting upon treaty commitment”). *Cf.*, U.S. Superfund Act, 42 U.S. Code § 9607 (c)(3) (allowing punitive damages for responsible party’s failure to remediate damage when so ordered).

<sup>115</sup> Payne & Unsworth, May 2017, p. 33.

<sup>116</sup> CRRC, p. 11.

<sup>117</sup> We note that none of the services assumed to be lost by Neotrópica require public access.

pursuant to the PES program. The expected cost of a PES program is a function of the opportunity costs incurred by the private party. That is, the incentive paid needs to offset the financial loss to the landowner. Use of the highest rate paid by the existing program, as we have done, is a reasonable proxy measure for what the cost would be in this context. Notably Neotrópica and its reviewers do not provide an independent estimate of the cost of a PES program that would address this harm, instead focusing on their belief that only valuation of ecosystem services can appropriately compensate for the harm caused by Nicaragua's actions.

Fourth, Neotrópica argues that the PES program run by FONAFIFO was not developed for the purpose of compensation for environmental harms. To support this position, Neotrópica cites the letter from Mr. Zuñiga, in which he states that the program developed for conservation of forest land was not conceived as a program for compensation for lost environmental services. We understand that this existing program was not established with the purpose of providing a mechanism for compensation; that said, the very goals of this program are consistent with the replacement goals in this case. As described by Mr. Zuñiga, for the National Forestry Financing Fund, the rates established for the different categories of payment for environmental services have been established as a way to promote conservation efforts and allow owners to finance sustainable initiatives.”<sup>118</sup> This is precisely the goal in this matter as it relates to replacement of lost services.

It is our opinion that the replacement cost approach for compensatory damages in this case reflects best practices, and is a good fit to the problem at hand. As such we believe that our estimate of USD 27,034 to USD 34,987 is a reliable and appropriate measure of damages, which, if awarded, would make Costa Rica whole for any loss in ecosystem services in this matter.

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<sup>118</sup> Fundación Neotrópica August 2017 Report, CRRC, Annex 1, pp. 130-131.

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## GLOSSARY

**Benefits transfer:** “Economic valuation approach in which estimates obtained (by whatever method) in one context are used to estimate values in a different context.”<sup>119</sup> US regulations refer to this as the unit value methodology, and focus on human use losses of natural resources in their definition of this approach. US CERCLA regulations explain, “unit values are preassigned dollar values for various types of nonmarketed recreational or other experiences by the public. Where feasible, unit values in the region of the affected resources and unit values that closely resemble the recreational or other experience lost with the affected resources may be used.”<sup>120</sup>

**Capital value of an ecosystem:** The present value of the stream of ecosystem services that an ecosystem will generate under a particular management or institutional regime.<sup>121</sup>

**Compensatory Restoration:** also called secondary restoration, interim damages.

**Damages:** the “amount of money sought by the natural resource trustee as compensation for injury, destruction, or loss of natural resources paid for ecosystem harm.”<sup>122</sup>

**Damage:** may refer to damages, but also refers to harm. The EU ELD defines damage as “a measurable adverse change in a natural resource or measurable impairment of a natural resource service which may occur directly or indirectly”.<sup>123</sup> The Nagoya Protocol on Liability and Redress defines “damage” as: “an adverse effect on the conservation and sustainable use of biological diversity, taking also into account risks to human health, that: (i) Is measurable or otherwise observable taking into account, wherever available, scientifically-established baselines recognized by a competent authority that takes into account any other human induced variation and natural variation; and (ii) Is significant [as defined elsewhere]”.<sup>124</sup> Under U.S. regulations: harm, injury or loss (“a measurable adverse change, either long- or short-term, in the chemical or physical quality or the viability of a natural resource”), destruction (“the total and irreversible loss of a natural resource”).<sup>125</sup>

**Ecosystem approach:** The “ecosystem approach” is an analytical approach that takes the ecosystem as the unit to be studied, “based on the application of appropriate scientific methods focused on levels of biological organization, which encompass the essential structure, processes, functions, and interactions among organisms and their environment.”<sup>126</sup> It can be used for regulation and management.<sup>127</sup>

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<sup>119</sup> Millennium Ecosystem Assessment Glossary 895.

<sup>120</sup> 43 CFR 11.83 (c)(2)(vi).

<sup>121</sup> Millennium Ecosystem Assessment Glossary 893.

<sup>122</sup> US Code of Federal Regulations, 43 CFR 11.14.

<sup>123</sup> EU ELD Article 2.2.

<sup>124</sup> Nagoya–Kuala Lumpur Supplementary Protocol on Liability and Redress to the Cartagena Protocol on Biosafety, 2010 (not in force) Art. 2.

<sup>125</sup> US Code of Federal Regulations, 43 CFR 11.14.

<sup>126</sup> Millennium Ecosystem Assessment Glossary, 894.

<sup>127</sup> Douglas P. Wheeler, Keynote Address, 24 Ecology L.Q. 623, 630 (1997) (describing ecosystem approach to environmental management in California).

**Ecosystem services, environmental services:** “functions performed by a natural resource for the benefit of another natural resource or the public.”<sup>128</sup> The concept can be used to qualify and scale harm to an environment that has suffered negative impacts. We use the concept of ecosystem services as an intermediate step in valuing injured environment.

**Ecosystem functions:** ecosystem functions 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 (e.g., gas regulation is a function provided by ecosystems, not a service).<sup>129</sup>

**Habitat Equivalency Analysis** – the assessment of the required scale of compensatory restoration required to offset a particular harm, but establishing equivalency between the scale of the harm, using a service measure, and the benefits of a compensatory action.<sup>130</sup>

**Interim damages** – see compensatory restoration

**Present value:** The equivalent value of a projected stream of future benefits (or costs), accounting for a time-dependent weight (discount rate), expressed as a single sum today.<sup>131</sup> Calculation of a present value of ecosystem services typically involves the use of a positive social discount rate.

**Replacement cost:** are typically used as a measure of “compensatory restoration” where primary restoration is not feasible, or where natural recovery will take time. For example, U.S. law defines replacement as “the substitution for an injured resource with a resource that provides the same or substantially similar services, when such substitutions are in addition to any substitutions made or anticipated as part of [removal or remedial actions] and when such substitutions exceed the level of response actions determined appropriate to the site [by regulation].”<sup>132</sup>

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<sup>128</sup> EU ELD, Article 2.13.; see also Rashid Hassan, Robert Scholes, Neville Ash, eds., *Ecosystems and human well-being: current state and trends: Findings of the Condition and Trends Working Group* (Island Press 2005) Appendix D, Glossary, 895, available at <https://www.millenniumassessment.org/en/Condition.html#download> (Millennium Ecosystem Assessment Glossary); U.S. CERCLA regulations, “services means the physical and biological functions performed by the resource including the human uses of those functions. These services are the result of the physical, chemical, or biological quality of the resource.” US 43 CFR 11.14. Also “For the purposes of this part, services include provision of habitat, food and other needs of biological resources, recreation, other products or services used by humans, flood control, ground water recharge, waste assimilation, and other such functions that may be provided by natural resources.” US 43 CFR 11.71(e).

<sup>129</sup> For example, “Ecosystem processes and functions are the biological, chemical, and physical interactions between ecosystem components. Functions and processes are not end-products; they are intermediate to the production of final ecosystem services.” (Boyd, James and Spencer Banzhaf. 2007. “What are Ecosystem Services? The Need for Standardized Environmental Accounting Units.” *Ecological Economics* 63, p. 620.) Similarly, the Millennium Ecosystem Assessment Glossary defines “Ecosystem Function” as an intrinsic ecosystem characteristic related to the set of conditions and processes whereby an ecosystem maintains its integrity (such as primary productivity, food chain, biogeochemical cycles). Ecosystem functions include such processes as decomposition, production, nutrient cycling, and fluxes of nutrients and energy.” (Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-Being: A Framework for Assessment*. Appendix 4: Glossary, p. 210.)

<sup>130</sup> Zafonte, Matthew and Steve Hampton. 2007. “Exploring Welfare Implications of Resource Equivalency Analysis in Natural Resource Damage Assessments. *Ecological Economics*. 61 (134-145).

<sup>131</sup> U.S. Environmental Protection Agency, National Center for Environmental Economics. May 2014. *Guidelines for Preparing Economic Analyses*.p.6-2.

<sup>132</sup> US Code of Federal Regulations, 43 CFR 11.14; see also EU ELD, Art 2.11, Annex II 1.2.3.

**Restoration cost:** the monetary cost to put a harmed ecosystem back to its pre-harmed state at the location of the harm (e.g., the planting of trees at a harmed site).<sup>133</sup> Restoration costs are typically discussed in the context of “primary restoration”, or actions to fix a harmed ecosystem.<sup>134</sup>

**Social discount rate:** The risk-free rate at which society trades off current consumption of goods and services for future goods and services.<sup>135</sup> This is the rate that is used to convert a stream of damages in the future into a single current value.

**Secondary restoration** – see compensatory restoration

**Valuation:** “The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on).”<sup>136</sup>

**Value:** In economic terms, the economic willingness-to-pay of humans for an ecosystem service. Social welfare values, or “surplus” values, are the values held by the public for an ecosystem service above the cost of providing that service.<sup>137</sup> “The contribution of an action or object to user-specified goals, objectives, or conditions.”<sup>138</sup>

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<sup>133</sup> Convention on Biological Diversity, Synthesis report on technical information relating to damage to biological diversity and approaches to valuation and restoration of damage to biological diversity, as well as information on national/domestic measures and experiences, UNEP/CBD/COP/9/20/Add.1 (20 March 2008)UNEP/CBD/COP/9/20/Add.1, para. 77.

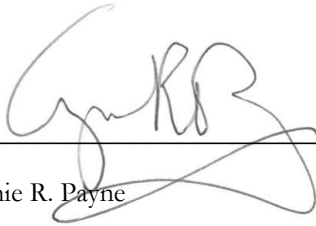
<sup>134</sup> 43 CFR 11.14 and 43 CFR 11.15.; EU ELD, Annex II, 1.

<sup>135</sup> *Ibid.*, p. 6-6.


<sup>136</sup> Millennium Ecosystem Assessment Glossary, p. 902.

<sup>137</sup> See, for example: Freeman, A.M., III, Joseph A. Herriges, and Catherine L. Kling. 2014 *The Measurement of Environmental and Resource Values: Theory and Methods*. Third Edition. Resources for the Future Press: New York, NY. pp. 12-13, 46-47.

<sup>138</sup> Millennium Ecosystem Assessment Glossary, p. 902.

A handwritten signature in black ink, appearing to read 'Cymie R. Payne', written over a horizontal line.

Cymie R. Payne

A handwritten signature in black ink, appearing to read 'Robert E. Unsworth', written over a horizontal line.

Robert E. Unsworth

Date: 25 August 2017

**Annex 2**

**G. Mathias Kondolf, PhD, Response to “Review of the report by  
G.M. Kondolf PhD (Annex 2)” by Dr. Colin R. Thorne**

**24 August 2017**





## **Response to “Review of the report by G.M. Kondolf PhD (Annex 2)” by Dr. Colin R. Thorne**

G. Mathias Kondolf, PhD  
August 24, 2017

### **I. 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.

In May 2017, I submitted a report, annexed to Nicaragua’s Counter-Memorial, reviewing Costa Rica’s claims for compensation for alleged environmental harm in the Río San Juan Delta (“Kondolf 2017,” NCMC Annex 2). In a report dated 25 July 2017, Dr. Colin Thorne commented on my report, criticizing my methods and conclusions, and adding his own conclusions regarding environmental impact (“Thorne 2017,” CRRC Annex 2). In this report I respond to those comments.

As a preliminary matter, I note that a significant portion of Dr. Thorne’s report argues for the importance of wetlands. I agree that wetlands are valuable and important, but that is not the issue. The issue is the proper method for valuing the material damage caused to the wetland by Nicaragua’s activities.

With respect to that issue, as explained below, Dr. Thorne’s criticisms and conclusions are premised on incorrect assumptions about the environment of the Río San Juan Delta and the geomorphological processes active there, and/or are unsupported by evidence from that location.

### **II. Soil Formation and Erosion Control**

My May 2017 report addressed Costa Rica’s claim for compensation for “soil formation” and “erosion control” services, observing that there is no evidence that those services were impacted by Nicaragua’s works. Nothing in Dr. Thorne’s report provides reason to depart from that conclusion.

Much of Dr. Thorne’s response addresses processes and concepts that are separate from soil formation and erosion control, as those terms are generally understood. The term “soil formation” refers to the processes by which soil is formed over time, while “erosion control” refers to conditions or practices that prevent erosion or reduce its rate. Accordingly, as explained in my prior report, the concepts of soil formation and erosion control services are relevant to sites where soil-forming processes are converting rock into soil, and where erosion is likely to mobilize soils and transport particles downstream, *i.e.*, in upland sites at risk of erosion. Neither is

the case in the Río San Juan Delta, where Nicaragua's works took place, and which is located within the zone of deposition in the Río San Juan system, and receives tremendous loads of sediment from the upstream catchment. In the delta region, the dominant process is not erosion but deposition. With the river's high sediment load and the nearly flat gradient of the delta, the caños rapidly filled in. Notably, Dr. Thorne does not dispute that this occurred.

Dr. Thorne asserts that I have overlooked differences between the material excavated from the caños and the material with which the caños have since been filled. In that regard, his report focuses on the role of microbes in the soil, using diagrams illustrating relationships among decomposers, microbiomes, and plants (Thorne 2017, pp. 7–10). However, those relationships are not "soil formation" but are rather related to other services such as "nutrient cycling," "pest and disease control" and "regulation of other wastes." I note that Fundación Neotrópica treated all of these separately from "soil formation" in its report annexed to Costa Rica's Memorial on Compensation, and expressly excluded them from its valuation due to lack of sufficient evidence (Fundación Neotrópica 2016, p. 46).

In any event, Dr. Thorne is incorrect that the sediment with which the caños have been filled since their clearing is insufficient for plant growth. He conflates long-term soil formation on weathered bedrock with soil formation on recently deposited alluvial silts, which are fertile upon arrival. While Dr. Thorne's report discusses the former process, it is the latter that is occurring in the Río San Juan Delta.

There is no evidence that supports Dr. Thorne's assertion that it would take decades for the biological community to develop in the refilled caños. Plant growth (which can be readily observed in photographs of the caños and is conceded by Dr. Thorne) leads to organic material and related processes; mature, later-successional-stage trees are not required. The fact that rich alluvial deposits do not need centuries of soil-formation processes to be fertile is reflected in the fact that floodplain and delta farmers from earliest times have welcomed floods because they form, from one year to the next, the soils that support good harvests, such as the early wheat-based agriculture in the deltas of the Nile and Mesopotamia. To imply, as Dr. Thorne does, that these alluvial deposits are sterile is incorrect.

Furthermore, no evidence has been presented to suggest that the material that has refilled the caños is materially different from what was extracted. The area in which the caños are located was also formed through a process of alluvial deposition. The only significant changes in the recent past to the process of deposition in the delta region have been: 1) the enormous increase in the sediment load of the Río San Juan resulting from massive deforestation of the tributary river basins draining mountainous regions of Costa Rica since the 1970s, and 2) the shift of most flow and sediment load in the Río San Juan to the Colorado River tributary beginning in the 19<sup>th</sup> century. Neither of these changes is likely to have meaningfully changed the calibre or composition of sediment deposited by the river in this setting. There is thus no reason to expect the material recently deposited in the caños to be

substantively different from that deposited in the past, which was excavated by Nicaragua.

Notably, in its reports regarding the disputed area, Ramsar has made no recommendations regarding the need to undertake any further restoration measures as a result of Nicaragua's works. It did not indicate that the materials which refilled the caños are insufficiently erosion-resistant for the wetland to be healthy; nor that those materials need more or different microbes or nutrients.

Dr. Thorne states: "Based on field photographs and samples, it appears that the sediment infilling the caños and accumulating in cleared areas is mostly deposited river bed sediments; i.e., a mixture of sand and silt, but with some clay" (Thorne 2017, p. 8). However, Dr. Thorne presents neither actual data nor any scientific analysis to substantiate the claim. Dr. Thorne's reference to "samples" is intriguing, raising the question of what those samples indicate, when they were collected, how they were analysed, and why the data from those samples was not presented. With the actual field sampling that Dr. Thorne refers to, it should be possible to make direct statements about the sediments, without resort to vague statements such as "it appears that ..." (Thorne 2017, p. 8). Similarly, Dr. Thorne's statements about the size ranges of sediments infilling the caños and what is "known" about such materials in general are presented without providing the basis for these assertions (Thorne 2017, p. 10).

Dr. Thorne's lack of data contravenes his own observation that a "scientific and technically-sound methodology" would include "measurements defining the properties of sediments in-filling the caños" (Thorne 2017, p. 3). Curiously, he faults me for not taking such measurements. But as Costa Rica has exclusive access to the caños, only Dr. Thorne or other Costa Rican consultants could take these measurements and collect samples.

### **III. Natural Hazards Mitigation**

In my May 2017 report, I observed that Neotrópica and Costa Rica had not presented any evidence that Nicaragua's works had caused a loss in the natural hazards mitigation services provided by the impacted area (Kondolf 2017, pp. 4-5). In response, Dr. Thorne argues that I have not accounted for the range of potential hazards, and cites a number of additional alleged risks (Thorne 2017, pp. 12-16). However, his assertions fail to address the central point of my report: that Costa Rica has not provided any affirmative evidence of the loss of the ecosystem service of mitigating natural hazards.

Dr. Thorne first discusses "coastal flooding and saltwater intrusion," pointing to the 2010 Ramsar report (Ramsar 2010, pp. 12-13). However, the 2010 report cited by Thorne included dire predictions of harm if the Río San Juan was re-routed to Harbour Head Lagoon, before the caño refilled. The scenario it envisioned did not materialize. Ramsar has not indicated, either in that or subsequent reports, that any

measures need to be taken to protect the wetland from coastal flooding or saltwater intrusion. Rather, its 2014 report found the risk of saltwater intrusion to be low in the context of the Caño Este (Ramsar 2014, p. 18). While that low risk prompted it to take the precaution of recommending building the dyke installed by Costa Rica, the fact that no further recommendations were made indicates that it viewed the risk of further saltwater intrusion or flooding as having been mitigated.

Dr. Thorne also focuses on what he characterizes as “the much greater risk of coastal erosion” that “threaten[s] the wetland” (Thorne 2017, p. 13). However, it is one thing to say that coastal erosion is a hazard that threatens the Río San Juan Delta. It is quite another to say that Nicaragua’s works have increased the risk of such erosion. Dr. Thorne’s report conflates the two.

For example, Dr. Thorne cites a series of maps and satellite images in one of his earlier reports as evidence of historical erosion. Those maps and images reinforce the point, made in my earlier reports, that coastal erosion in the Río San Juan Delta is a large historical and ongoing process. What they show is that coastal erosion over the past centuries has proceeded in a largely uniform and consistent pattern, indicating that the power of Caribbean Sea to erode the land is stronger than local variations in vegetation, roots, particle size, and other factors, as reflected in the sequential positions of the coastline since the earliest aerial photography in 1940 (Fouache and Gutiérrez 2017, Figure 87).

Dr. Thorne’s assertions that Nicaragua’s works have decreased the Río San Juan Delta’s ability to resist that steady process of erosion are speculative and unsupported by any evidence. None of the imagery shows that the pattern of coastal erosion has changed over the last seven years as a result of those minor works. Nor have Dr. Thorne or Costa Rica presented any other data.

To the contrary, while Dr. Thorne’s report includes predictions of accelerated erosion localized in the area of the caños, he fails to mention that none of this actually occurred during Hurricane Otto, which struck the Río San Juan in late November 2016. The fact that none of Dr. Thorne’s predictions materialized during Hurricane Otto, which was an excellent “test” of the predictions, severely undermines his assertions. Moreover, Ramsar has not recommended that any actions be taken with regard to coastal erosion. There is no indication that it believes the wetland is in different or greater danger from natural hazards than it was before Nicaragua’s works.

It also bears noting that Dr. Thorne’s discussion of coastal erosion goes far beyond the basis identified by Fundación Neotrópica for its valuation. Nothing in the Fundación Neotrópica report focuses on coastal erosion with respect to natural hazards; Fundación Neotrópica included coastal erosion only within the “erosion control” topic in Table 9 (Fundación Neotrópica 2016, p. 46).

Even if there were evidence of a reduction in natural hazard mitigation services, Fundación Neotrópica purported to value such a loss by transferring a value from a Thailand-specific study published in 2002 (Barbier et al., 2002). Conspicuously, Dr. Thorne does not say anything about this study and the transfer of its values to the present situation. This omission is significant because the environment at issue in this case is entirely different (i.e., it is a depositional zone, there is no linear protective structure as existed the Thailand context, etc.), and Dr. Thorne has not provided any reason to believe that the two situations are remotely comparable.

#### **IV. Recovery Period**

Finally, Dr. Thorne disagrees that the recovery of the area disturbed by Nicaragua's works achieved 20 years from now will be sufficient to replicate at least the majority of the services provided by the wetland prior to the disturbance. However, his conclusion is premised on many of the erroneous assumptions described above.

With regard to soil formation and erosion control services, Dr. Thorne states broadly that it takes “decades to millennia” (Thorne 2017, pp. 7-8) or “decades to centuries” (Thorne 2017, p. 8) for these services to establish themselves. But, as noted above, these services have not been impaired. The long recovery periods cited by Dr. Thorne (up to centuries or millennia) apply to the process of weathering bedrock into soil, not to recently deposited, fertile silts, which globally are used for agriculture and support important ecosystems. In any event, the landforms into which the caños were dug were deposited within recent historical time, as reflected by the appearance of the landforms on 18<sup>th</sup> and 19<sup>th</sup> century maps. Thus, the historical evidence suggests that these landforms were only a few centuries old, not the ancient stable features implied by Dr. Thorne's description. Moreover, there is no evidence that the material deposited in the caños after their clearing is meaningfully different from the material that was excavated, because, as noted above, the alluvial processes that deposited the sediment then and now are essentially unchanged.

Likewise, although Dr. Thorne claims that the capacity of the area to mitigate natural hazards such as erosion “has been permanently reduced by Nicaragua's activities” (Thorne 2017, p. 16), neither he nor Costa Rica have provided any affirmative evidence that this is the case, as discussed above.

Most of Dr. Thorne's discussion of recovery time is focused on how long it takes biodiversity to recover in an impacted area, with his ultimate conclusion being that some of the functions will never recover (Thorne 2017, pp. 16–23). However, he has provided no site-specific evidence to dispute my position that “[t]he 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.” (Kondolf 2017, p. 6). In fact, Dr. Thorne acknowledges that “[r]egrowth of grass,

shrubs and pioneer tree species in the areas cleared by Nicaragua has indeed been rapid” (Thorne 2017, p. 23).

Dr. Thorne’s failure to provide site-specific evidence in support of his claim is particularly notable in light of his criticism that I did not directly measure the size of trees establishing in the filled caño, which he calls his “most serious criticism” of my methods (Thorne 2017, p. 23). He states that “[a] rigorous environmental scientist would have made accurate measurements of tree heights (old and new) in the field ... using a surveying tape and inclinometer – a simple but effective methodology” (Thorne 2017, p. 23). He also states that “[a] rigorous environmental scientist would have used a quadrat survey to count and identify colonizing vegetation, allowing direct comparisons to be made with vegetation assemblages in adjacent areas that were not cleared by Nicaragua” (Thorne 2017, p. 23).

Dr. Thorne’s criticism is misdirected. Costa Rica has exclusive access to the site, and thus Dr. Thorne or other Costa Rican consultants could have undertaken the measurements he advocates. I, on the other hand, could not. Accordingly, Dr. Thorne’s criticism that the absence of such measurements is “a serious methodological error” (Thorne 2017, p. 23), is properly applied to Costa Rica.

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