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Technical Reports

Witness Statement

VOLUME II

TECHNICAL REPORTS

Annex 1

Fundación Neotrópica,

"Monetary Valuation of the environmental damages arising from the construction of caños and clearing of trees and vegetation performed by the Government of Nicaragua in the Costa Rican territory on Isla Portillos, as required by the Judgment of the International Court of Justice of 16 December 2015"

3 June 2016

English translation

Monetary Valuation

of the environmental damage arising from the construction of artificial caños and clearing of trees and vegetation performed by the Government of Nicaragua in Costa Rican territory on Isla Portillos, as required by the Judgment of the International Court of Justice of 16 December 2015

FUNDACIÓN NEOTRÓPICA
CRECIENDO COMO LA NATURALEZA

Bernardo Aguilar González
Marcia Carranza Vargas
Marco Hidalgo Chaverri
Adriana Fernández Sánchez

Technical team:

Coordinator: Bernardo Aguilar González *(Executive Director, Ecological Economist and Attorney specialized in agricultural and environmental law, Fundación Neotrópica)*

Technicians: Marcia Carranza Vargas *(Analysis Unit Coordinator)*

Marco Hidalgo Chaverri *(Technician in tropical biology, Analysis Unit, Fundación Neotrópica)*

Adriana Fernández Sánchez *(Technician in environmental Management, Analysis Unit, Fundación Neotrópica)*

Cite as:

Aguilar González, B.; Carranza Vargas, M.; Hidalgo Chaverri, M. and Fernández Sánchez, A. (2016) Monetary valuation of the environmental damage arising from the construction of artificial *caños* and clearing of trees and vegetation performed by the Government of Nicaragua in Isla Portillos, *Humedal Caribe Noreste*, Costa Rica, in conformity with the Judgment of the International Court of Justice, The Hague. Fundación Neotrópica, San José, Costa Rica.

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I- Introduction

Fundación Neotrópica was established in 1985 with a pioneering mission for environmental history in Costa Rica. Its first steps were characterized by the application of innovative models within the sustainable development framework in a country that, in a tumultuous regional context, established ambitious goals for itself regarding the protection of its forest resources and the bioregional management of socio-environmental systems.

Its mission is to seek a fair balance between the costs and benefits of conservation and development. With over 31 years of experience, its technical work areas have included: sustainable development models, community conservation focusing on coastal wetlands, participative management of protected wildlife areas, community rural tourism, socio-environmental conflicts and the valuation of ecosystem services and environmental damage in Costa Rica and abroad (Evans, 1999; Aguilar, et al., 2012; Aguilar, et al., 2013; Aguilar González, 2014; Aguilar, et al., 2015).

In the 1980s it positioned itself among the first non-governmental organizations to implement fund management for debt-for-nature swaps. At that time it led pioneering projects in local sustainable development such as BOSCOSA, as well as the Pocotsi project in the North Caribbean area, which sought to reduce socio-environmental conflict in the buffer zones between national parks and other protected areas.

Its experience regarding coastal wetlands has been reiterative, consisting of the application of monetary and multiple-criteria valuations of ecosystem functions and services to strengthen protected wildlife areas (Aguilar-González & Moulaert, 2013). Furthermore, it has concentrated its efforts in promoting and developing community conservation models in these ecosystems since 2009 (Sepúlveda-Machado & Aguilar-González, 2015).

In compliance with its mission, Fundación Neotrópica seeks to contribute to the resolution of the cross-border conflict that has resulted in the legally recognised damage to the *Humedal Caribe Noreste* (HCN, Northeast Caribbean Wetland), applying its technical experience to grounds that could lead to a positive conclusion of the case between Costa Rica and Nicaragua. Furthermore, it seeks to guarantee full restoration of the valuable cross-border wetland. Finally, it hopes that the resolution of the case and the attention that both countries have paid to this region will lead to a commitment to improve the living conditions of the communities that depend directly on the affected ecosystem. We appreciate the trust which the government has placed in our organization to perform this task during the periods from 2010-2014 and 2014-2018.

The goal of this report is to perform a monetary valuation of the environmental damage arising from the construction of *caños* and clearing of trees and vegetation performed by the government of Nicaragua in Costa Rican territory on Isla Portillos, within the aforementioned wetland, as required by the Judgment of the International Court of Justice of 16 December 2015. To provide the technical basis for this valuation, this report has been structured into four sections, followed by a summary and conclusion.

The second section presents the factual and legal background of the valuation, in conformity with the final and definitive judgment of the International Court of Justice in the case between both countries. This is complemented by the technical-ecological background derived from the reports that documented the environmental damage on record, and which were recently verified (section 3).

The fourth section presents the relevant state of the art in the valuation of ecosystem services and environmental damage, and provides the basis for the methodological approach used for monetary valuation. The regional and national application of both frameworks is presented. Furthermore, the application of the recommendations made by the RAMSAR Convention to wetland ecosystems is analysed.

The fifth section consists of the monetary valuation per se, focusing on the environmental assets and services included, the recently performed data collection processes, and the selection of the methodology used. 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.

Finally, the conclusion is presented, followed by the bibliographical sources used in this report. Thus, the factual and legal background established in the context of the case heard by the International Court of Justice is now explored.

II- Factual and legal background of the monetary valuation of damage: Judgment of the International Court of Justice of 16 December 2015

This report was prepared in response to the Judgment of the International Court of Justice of 16 December 2015, whereby the Court determined that sovereignty over the disputed territory belongs to Costa Rica, and that Nicaragua, by establishing a military presence and excavating three artificial *caños* in such territory, violated the territorial sovereignty of Costa Rica. Furthermore, the Court adjudged that by excavating two new *caños* and establishing a military presence in the disputed territory, Nicaragua breached the provisional measures indicated by the Court on 8 March 2011. The Court also decided that Nicaragua has the obligation to compensate Costa Rica for material damage caused by Nicaragua's unlawful activities on Costa Rican territory (Certain Activities Carried out by Nicaragua in the Border Area (Costa Rica v. Nicaragua). Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica), 2015).

The case was initially filed by Costa Rica on 18 November 2010, claiming, among others, that Nicaragua had occupied Costa Rican territory and caused environmental damage in that area. Costa Rica requested provisional measures on that same date, which the Court adjudged in the Order of 8 March 2011.

Table 1 below provides a summary of the facts ascertained by the Court in its Judgment that are relevant to this valuation.

Table 1- Factual Background – Facts ascertained in the Judgment of 16 December 2015. Source: Certain Activities Carried out by Nicaragua in the Border Area (Costa Rica v. Nicaragua). Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica), 2015.

Paragraphs	Subtitle in the Judgment	Summary of the facts
65-99	**III.A. Sovereignty over the disputed territory and alleged breaches thereof**	The right bank of the *caño* excavated by Nicaragua in 2010 is not part of the border between Costa Rica and Nicaragua. The territory under Costa Rican sovereignty goes from the right bank of *Bajo Río San Juan* to its mouth in the Caribbean Sea. Sovereignty of the disputed territory thus corresponds to Costa Rica. In addition, it was determined that ***Nicaragua performed certain activities in the disputed territory since 2010, including the excavation of three caños and establishing military presence in parts of that territory. Such activities were performed in violation of the territorial sovereignty of Costa Rica. Nicaragua is responsible for such acts; consequently, it has the obligation to compensate Costa Rica for the damage caused by its unlawful acts.***
121-129	**III.C. Compliance with the provisional or precautionary measures**	In its Order of Provisional Measures of 8 March 2011, the Court indicated that the parties had to refrain from sending to, or maintaining in the disputed territory, including the *caño*, any personnel, whether civilian, police or security. It also required the parties to refrain from any action which might aggravate or extend the dispute before the Court or make it more difficult to resolve. ***Based on the uncontested facts, the Court concludes that Nicaragua breached the obligations established in the aforementioned order by excavating two additional caños and establishing a military presence in the disputed territory. Independent of the conclusion in section III.A., the Court determines that such conduct also constitutes a violation of the territorial sovereignty of Costa Rica.***
137-144	**III.E. Reparation**	***The Court finds that Costa Rica is entitled to receive compensation for the material damage caused by those breaches of obligations by Nicaragua that have been ascertained by the Court.*** It declares that the relevant material damage and the compensation amount can be assessed by the Court only in separate proceedings. The Court is of the opinion that the parties should negotiate to reach an agreement on these issues. However, if they fail to reach such an agreement within 12 months to the date of the Judgment, at the request of either party the Court will determine the compensation amount based on further written pleadings limited to this issue.

The Judgment includes the image presented in Figure 1 below to illustrate the location of the facts. The territory of Isla Portillos and an enlargement of the northern part of the island, where the excavation of an artificial *caño* in Costa Rican territory at the end of 2010 had been confirmed, can be seen.

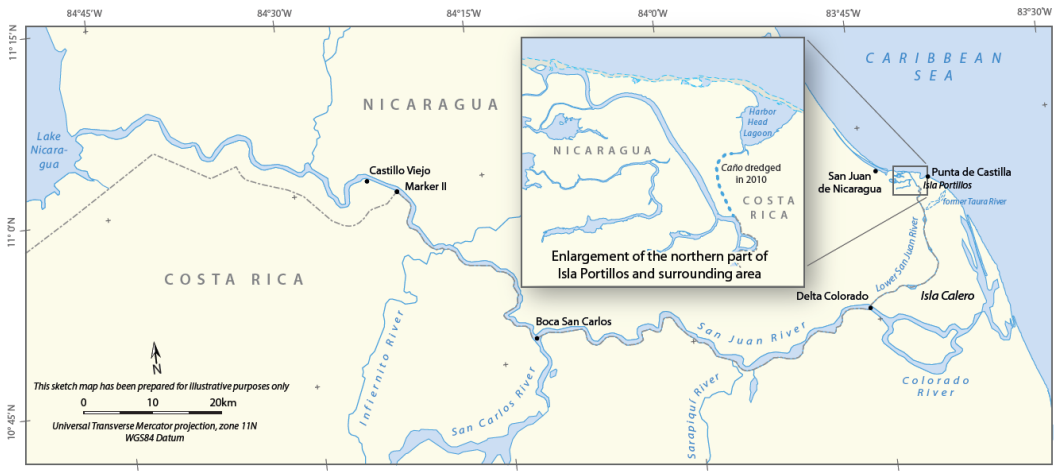


Figure 1- Map indicating the disputed territory, which the Judgment confirmed as Costa Rican territory in Isla Portillos, *Humedal Nacional Caribe Noreste*. Source: Certain Activities Carried out by Nicaragua in the Border Area (Costa Rica v. Nicaragua). Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica), 2015.

The ascertained facts are a result of the technical body of evidence provided by Costa Rica in several volumes of the Memorial and in additional documentation. For purposes of the valuation of damage, the following chapter provides a summary of the relevant evidence.

III- Technical-Environmental background for the monetary valuation of damage

Table 2 summarizes the evidence provided in the records of the proceedings that are relevant to the valuation of the environmental damage. A total of 13 technical reports used by Costa Rica to support its claims are listed. These were selected from the entire body of evidence as they were considered relevant to this valuation exercise. It is assumed that they substantiated the relevant facts ascertained in the records and which are included in Table No 1. This list does not include additional audio-visual evidence included in the records, including numerous maps, photographs, and videos, which are listed separately and were used to support this report.

Figure 2 presents the location of Isla Portillos, *Humedal Nacional Caribe Noreste*, of the artificial *caño* excavated in 2010 and of the two *caños* (west and east) excavated in 2013. This image was included in the report of the Costa Rican Ministry of Environment, (*Ministerio del Ambiente de Costa Rica*, MINAE), "Assessment of the environmental damage caused by the Government of

Nicaragua by constructing new artificial *caños* at the north end of Isla Portillos in September 2013" prepared for the Secretariat of the Ramsar Convention (MINAE, 2014).

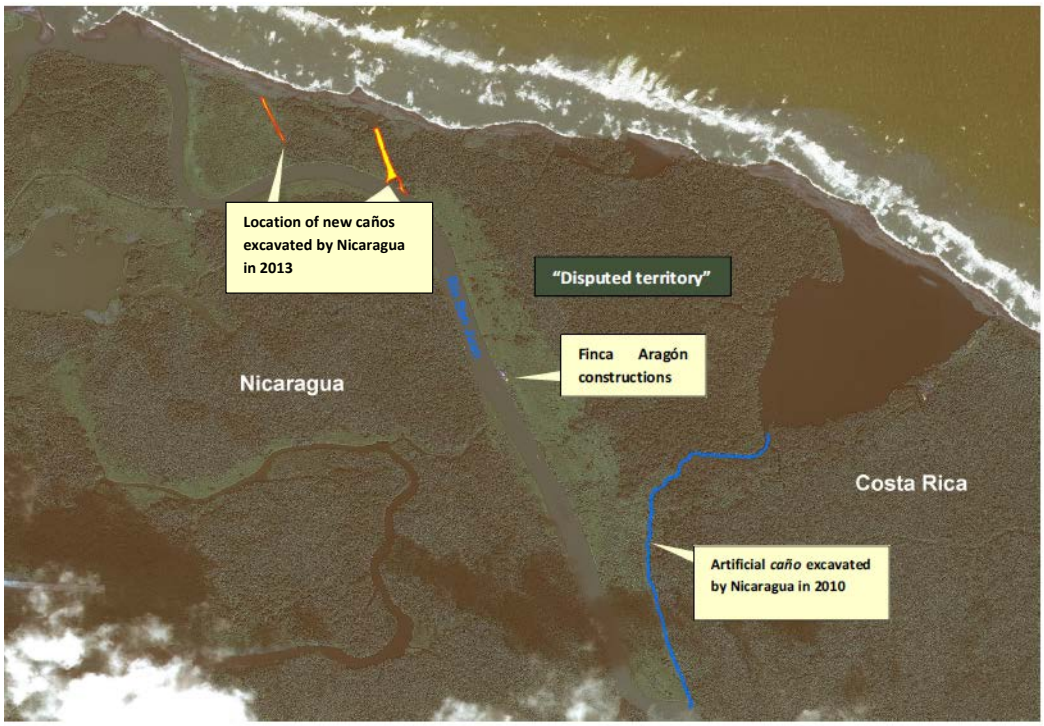


Figure 2- Location of the artificial *caños* excavated on Costa Rican territory through intrusions ordered by the Government of Nicaragua in 2010 and 2013. Source: MINAE (2014)

The technically-confirmed facts included in Table 2 can be divided into two parts. The first part focuses on the technical facts of the damage caused by the construction of the first *caño* in 2010 (C2010). This damage is confirmed in eight technical reports from international experts, the Secretariat of the Ramsar Convention, a Costa Rican NGO, MINAE and the *Sistema Nacional de Áreas de Conservación* (National System of Conservation Areas, SINAC).

Table 2- Body of evidence presented by the Government of Costa Rica relevant to the establishment of the technically relevant facts for the monetary valuation of the damage caused. Source: Prepared by the authors based on the cited sources.

NUMBER AND LOCATION	TITLE	PREPARED BY AND DATE	TECHNICALLY RELEVANT FACTS
1. COSTA RICA MEMORIAL (CRM), VOLUME 1 (V1), APPENDIX 1	Assessment of the physical impact of works carried out by Nicaragua since October 2010 on the geomorphology, hydrology and sediment dynamics of the San Juan River and the environmental impacts on Costa Rican territory	Prof. Colin Thorne, University of Nottingham, UK, October 2011	1. Detailed description of the artificial *caño* excavated in 2010 (C2010), its chronology and alteration of the original landscape; 2. Description of the clearing of trees due to the construction of C2010, physical characteristics and approximate age of the trees; 3. Description of the clearing of undergrowth vegetation, due to the construction of C2010; 4. Physical description of the size and volume of C2010; 5. Current and potential impact of the construction of C2010 on the wetland ecosystems, including ecosystem services, impact on hydrology, erosion, biological diversity, etc.; 6. Economic-ecological value of the damage caused by the actions of the government of Nicaragua as of 2010, including C2010.
2. CRM, VOLUME IV (V4), APPENDIX 143	Report ACTO-RNVSBC-CyP-057-2010	Sistema Nacional de Áreas de Conservación (SINAC) Ministerio de Ambiente, Energía y Telecomunicaciones (MINAE)- 22 October 2010	1. Detailed description of C2010 and of the alteration of the original landscape; 2. Summarized description of the clearing of trees due to the construction of C2010; 3. Description of the clearing of undergrowth due to the construction of C2010.
3. CRM, V4, APPENDIX 145	Appraisal of the maximum average age of trees felled in primary forest areas in the Punta Castilla, Colorado, Pococí and Limón sectors of Costa Rica, as a result of the Nicaraguan Army's occupation for the apparent restoration of an existing *caño*	Miguel Araya Montero (SINAC-MINAE)- December 2010	1. Description of the clearing of trees due to the construction of C2010, physical characteristics and approximate age of the trees.
4. CRM, V4, APPENDIX 147	Ramsar Advisory Mission Report N. 69: North-eastern Caribbean Wetland of International Importance (*Humedal Caribe Noreste*), Costa Rica.	Ramsar Secretariat	1. Current and potential impact of the construction of C2010 on the wetland ecosystems, including ecosystem services, impact on hydrology, erosion, biological diversity, etc.; 2. Recommended preventive and monitoring/restoration measures.
5. CRM, V4, APPENDIX 154	Age approximation of trees cut in the Area under Costa Rica's Environmental Management located on the causeway of the artificial channel built on a portion of territory of Calero Island to connect the San Juan River with Portillos Lagoon.	Miguel Araya Montero (SINAC-MINAE) - August 2011	1. Description of the clearing of trees due to the construction of C2010, physical characteristics and approximate age of the trees; 2. Description of the clearing of undergrowth, due to the construction of C2010; 3. Physical description of the size and volume of C2010;
6. CRM, V4, APPENDIX 155	Assessment and Evaluation of the Environmental situation in the *Humedal Caribe Noreste* within the framework of the Order of the International Court of Justice	MINAE- 28 October 2011	1. Description of the clearing of trees due to the construction of C2010, physical characteristics and approximate age of the trees; 2. Description of the clearing of undergrowth, due to the construction of C2010; 3. Physical description of the size and volume of C2010; 4. Current and potential impact of the construction of C2010 on the wetland ecosystems, including ecosystem services, impact on hydrology, erosion, biological diversity, etc.; 5. Time for recovery of the ecosystem.

NUMBER AND LOCATION	TITLE	PREPARED BY AND DATE	TECHNICALLY RELEVANT FACTS
7. CRM,V4, APPENDIX 157	A summary of Actual and Potential Environmental Service Losses Due to the Current Ecological Conflict in the Portillos/Calero Island Region in the Caribe Noreste Wetland in North-eastern Costa Rica	Bernardo Aguilar González et. al. (Fundación Neotrópica)- 10 October 2011	1. Description of the clearing of trees due to the construction of C2010, physical characteristics and approximate age of the trees; 2. Description of the clearing of undergrowth, due to the construction of C2010; 3. Current and potential impact of the construction of C2010 on the wetland ecosystems, including ecosystem services, impact on hydrology, erosion, biological diversity, etc.; 4. Time for recovery of the ecosystem.
8. APPENDICES TO THE REQUEST FOR THE INDICATION OF NEW PROVISIONAL MEASURES (ARINPM) PM-6	Log of the visit to the disputed territory	Miguel Araya and Olman Mena (MINAE-SINAC). 18 September 2013	1. Physical description and description of the alteration of the landscape due to the new artificial *caño* excavated in 2013 to the north of C2010: *Caño Este* (CE2013); 2. Description of the clearing of trees due to the construction of CE2013.
9. ARINPM PM-33	Report on the Impact of the Construction of two New Caños on Isla Portillos	Prof. Colin Thorne, The University of Nottingham, UK – 10 October 2013	1. Physical description and description of the alteration of the landscape of due to the new artificial *caños* excavated in 2013 to the northwest of C2010: *Caño Este (CE2013)* and *Caño Oeste (CO2013).* 2. Summarized description of the current and potential impact on the wetland ecosystems of the construction of CE2013 and CO2013 including ecosystem services, impact on hydrology, erosion, biological diversity, etc.
10. ARINPM PM-19	Technical assessment of the artificial *caños* on Isla Portillos	Eng. Rafael Oreamuno Vega, M. Eng. Roberto Villalobos Herrera (CIEDES, Universidad de Costa Rica) - October 2013.	1. Physical description and description of the alteration of the landscape, from an engineering perspective, due to the construction of CE2013 and CO2013; 2. Engineering restoration measures.
11.	Preliminary estimation of the impact of the opening of two new artificial channels on the north end of Isla Portillos between June and September 2013	Miguel Araya Montero (SINAC-MINAE) - October 2013	1. Physical description and description of the alteration of the landscape due to the construction of CE2013 and CO2013; 2. Description of the clearing of trees due to the construction of CE2013, physical characteristics and approximate age of the trees; 3. Description of the vegetation eliminated due to the construction of CO2013; 4. Description of the clearing of undergrowth due to the construction of CE2013; 5. Summarized description of the current and potential impact on the wetland ecosystems of the construction of CE2013 and CO2013, including ecosystem services, impact on hydrology, erosion, biological diversity, etc.
12. APPENDIX TO THE SECOND REPORT ON COMPLIANCE WITH PROVISIONAL MEASURES DATED 21 MAY 2014 SRCPM CR-1	Final Report for the Secretariat of the Ramsar Convention. Assessment of the environmental damage caused by the Government of Nicaragua by constructing new artificial *caños* at the north end of Isla Portillos in September 2013	MINAE - March 2014	1. Physical description and description of the alteration of the landscape due to the construction of CE2013 and CO2013; 2. Description of the clearing of trees due to the construction of CE2013, physical characteristics and approximate age of the trees; 3. Summarized description of the current and potential impact on the wetland ecosystems of the construction of CE2013 and CO2013, including the impact on hydrology and biological diversity, etc.; 4. Immediate restoration measures.

NUMBER AND LOCATION	TITLE	PREPARED BY AND DATE	TECHNICALLY RELEVANT FACTS
13. APPENDIX TO THE THIRD REPORT ON COMPLIANCE WITH PROVISIONAL MEASRES DATED 21 AUGUST 2014 TRCPM CR-1	Final Report of the Ramsar Advisory Mission No. 77, Wetland of international importance Caribe Noreste, Costa Rica	Secretariat of the Ramsar Convention - August 2014	1. Physical description and description of the alteration of the landscape due to the construction of CE2013; 2. Description of the clearing of trees due to the construction of CE2013; 3. Description of the current and potential impact on the wetland ecosystems of the construction of CE2013, including the impact on hydrology and biological diversity, etc.; 4. Restoration measures and monitoring of CE2013.
14. HTTP://WWW.ICJ-CIJ.ORG/DOCKET/FILES/150/18484.PDF	Written Statement. Dispute Concerning Certain Activities Carried out by Nicaragua in the Border Area (Costa Rica v. Nicaragua)	Prof. Colin Thorne, The University of Nottingham, UK - March 2015	1. Reiterates the description from 2010 and the alteration of the original landscape; 2. Reiterates the description of the clearing of trees and undergrowth due to the construction of C2010; 3. Current and potential impact of the construction of C2010 on the wetland ecosystems, including ecosystem services, impact on hydrology, erosion, biological diversity, etc.; 4. Physical description and description of the alteration of the landscape due to the construction of CE2013 and CO2013; 5. Summarized description of the clearing of trees and removal of vegetation due to the construction of CE2013 and CO2013; 6. Summarized current and potential impact of the construction of C2010 and CE2013 on the wetland ecosystems, including impact on hydrology, biological diversity, etc.

These are included in the Costa Rica Memorial (CRM), as appendices to the Request for the indication of new provisional measures filed by Costa Rica before the International Court of Justice on 24 September 2013, as appendices to the second and third report on compliance with provisional measures filed by Costa Rica before the ICJ on 21 May 2014, and the final written statement by Professor Colin Thorne from The University of Nottingham, UK.

These documents include eight (8) confirmed tables of technically relevant facts: 1- a detailed description of C2010, its chronology and alteration of the original landscape; 2- a description of the clearing of trees due to the construction of C2010, with the physical characteristics and approximate age of the trees; 3- a description of the clearing of undergrowth vegetation, due to the construction of C2010, and 4- a physical description of the size and volume of C2010. Furthermore, these documents confirm: 5- the description of the current and potential impact of the construction of C2010 on the wetland ecosystems, including ecosystem services, impact on hydrology, erosion, biological diversity, etc.; 6- the preliminary estimate of the economic-ecological value of the damage caused by the actions of the government of Nicaragua as of 2010, including C2010; 7- recommended preventive and monitoring/restoration measures, and 8- the estimated time of recovery of the ecosystem.

The second part is composed of the appendices presented and produced between 2013 and 2014, as support for the request for provisional measures due to the opening of two new *caños* to the northwest of C2010: *Caño Este* (CE2013) and *Caño Oeste* (CO2013). These documents come from similar sources, and confirm: 1- the physical description and description of the alteration of the landscape due to the construction of CE2013 and CO2013; 2- the description of the clearing of trees due to the construction of CE2013, physical characteristics and approximate age of the trees; 3- the description of the vegetation eliminated due to the construction of CO2013, and 4- the description of the clearing of undergrowth due to the construction of CE2013. The following are also confirmed: 5- the description of the current and potential impact on the wetland ecosystems of the construction of CE2013 and CO2013, including ecosystem services, impact on hydrology, erosion, biological diversity, etc.; 6- the engineering restoration measures, and 7- the immediate restoration measures and monitoring.

Each of these tables of facts will be detailed in the results section of this report and in the monetary valuation of the damage per se. In addition, the relevant audio-visual material is included as considered necessary. Next, the basis for the methodology used for the valuation exercise from an ecosystem services perspective and its monetary valuation, as well as that of the environmental damage will be established. The necessary methodological background will thus be completed.

IV- Background on the international state of the art in the monetary valuation of environmental damage

As previously indicated, this section details the state of the art, in the fields of natural resource/environmental and ecological economics that provide the basis for the international state of the art. We begin with the framework regarding ecosystem or environmental goods and services.

A- Ecosystem or environmental goods and services

Ecosystem or environmental services were defined in the document "Millennium Ecosystem Assessment" as "the benefits that people obtain from ecosystems, whether economic or cultural" (Working Group MEA-UNEP, 2003). It can be argued that human beings and different species depend on the environmental or ecosystem services of the environment or biodiversity in which they are immersed; therefore, all species benefit from the natural cycle of processes of growth and biodiversity development and of the ecosystem as a whole. The difference lies in the value that human beings, unlike other species, can assign to such ecosystem services, whether economic or cultural.

Another definition of ecosystem services presented by the United Nations Environment Programme (UNEP) is that "ecosystem services are the benefits that people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth" (Working Group MEA-UNEP, 2003).

Environmental services are affected, altered or destroyed due to the negative impacts of unsustainable production systems. Until quite recently, human production processes did not consider important the negative impacts on ecosystems of the expansion of the agricultural frontier, such as deforestation, to name one example. In economics these effects are called negative externalities, which are produced and affect the community of living things throughout the production process.

According to the Millennium Ecosystem Assessment (2005), approximately 60% (15 of 24) of the ecosystem services assessed are being degraded or used unsustainably, including fresh water, fisheries, air and water purification, regional and local climate regulation, and the control of natural risks and pests. All of the above are a cause for concern and to search for a way to act immediately so as to stop and reverse these trends. To change this situation, different types of economic incentives or disincentives, including penalties proportional to the environmental damage caused to the altered area, can be used.

As mentioned above, ecosystems generate different types of environmental services. Figure 3 "Ecosystem Services" divides them into four groups: 1) provisioning services; 2) regulation services; 3) supporting services, and 4) cultural services. All of these services are linked to components of human well-being and are fundamental to the comprehensive analysis of living ecosystems.

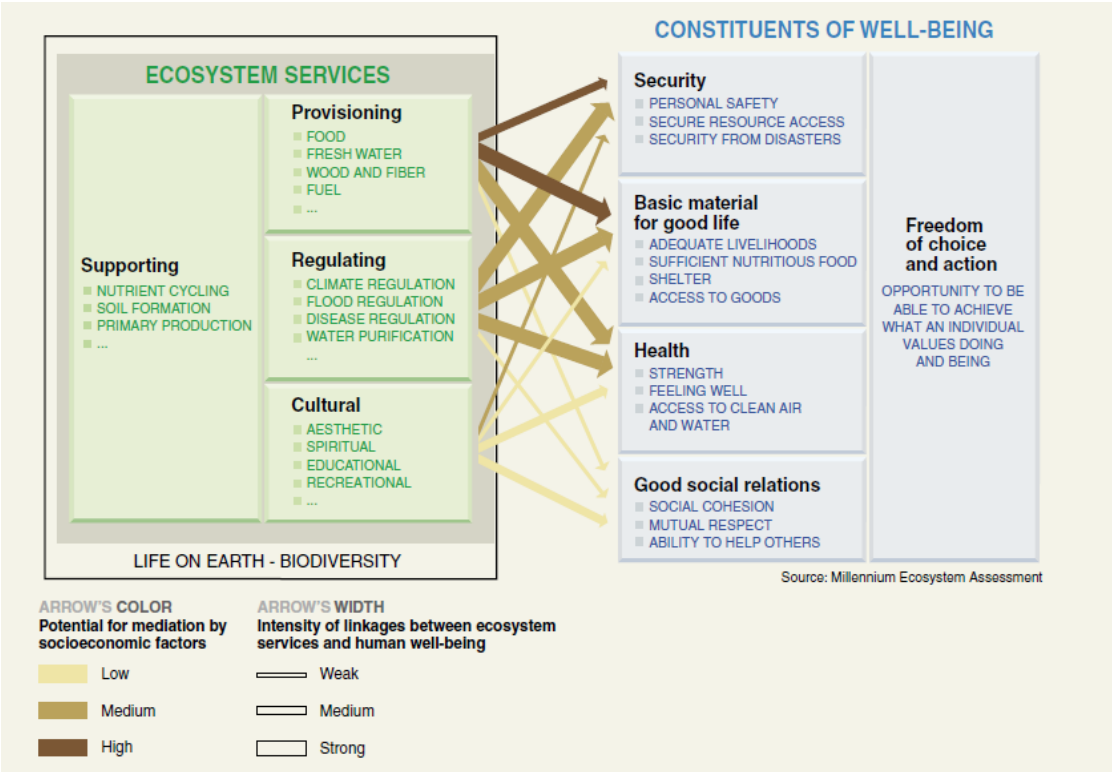


Figure 3- Ecosystem Services. Source: Working Group MEA-UNEP, 2003.

Table 3 summarizes the classification of ecological services in the Millennium Ecosystem Assessment. The characteristics of each of the four types of ecological services are presented below.

1. Provisioning services

Provisioning services are the products people obtain from ecosystems, sometimes referred to as production services (Beaumont & al., 2007). These include:

1. Food: ecosystems provide a vast range of provisioning services, including fruit, vegetables, edible forest species, as well as marine and freshwater products.

Table 3- Ecosystem services of the Analysis Framework based on the Millennium Ecosystem Assessment. Source: Adapted from Kocian, Batker & Harrison-Cox, 2011, based on (De Groot, et al., 2002)

	Ecosystem goods and services	Examples of benefits
Provisioning	Water supply	Provisioning of water for consumption, including quality and quantity
	Food	Hunting, fruit gathering, agriculture and small-scale subsistence fishing
	Raw materials	Construction and production, fuel and energy, forage and fertilizers
	Genetic resources	Improving crop resistance to pathogens and pests
	Medicinal resources	Traditional medicines, pharmaceuticals, chemical models, tools and assay organisms
	Ornamental resources	Providing resources for clothing, handicraft, jewellery, pets, worship, decoration and souvenirs
Regulating	Gas regulation	Providing clean, breathable air, disease prevention, a habitable planet
	Climate regulation	Maintaining a favourable climate promotes human health, crop productivity, recreation and other services
	Natural hazard regulation	Preventing and mitigating risk and natural hazards, such as storms and other adverse weather conditions
	Soil retention	Retaining arable land, preventing erosion and promoting agricultural productivity
	Water regulation	Providing natural irrigation, drainage, groundwater recharge, river flow and navigation
	Biological control	Providing pest and disease control, reducing crop damage
	Waste treatment	Controlling pollution/detoxification, dust particle filtering through canopy services
	Soil formation	Promoting agricultural productivity and ecosystems integrity
	Pollination	Pollination of wild and domestic plan species
	Nutrient cycling	Promotes health and productive soils, gas, climate and water regulation
Habitat	Habitat and biodiversity	Maintaining genetic and biological diversity (and thus most other functions)
	Nursery cycling	Maintaining commercially exploited species
Cultural/Information	Natural beauty	Enjoying scenery
	Recreation	Experiencing the natural world and enjoying outdoor activities
	Science and education	Using natural systems for education and scientific research
	Historic and spiritual	Using nature for religious or historic purposes
	Cultural and artistic information	Using nature as motifs in books, film, painting, national symbols, architecture, advertising, etc.

2. Fibre, wood and fuel: forest and coastal ecosystems contain this type of goods. In coastal areas, mangroves are an important source of wood, charcoal, tannins, alcohols, etc.

3. Medicine and other resources: a wide range of microbial, vegetable and animal species (and their genes) contribute to commercial products in industries such as pharmaceutical, botanical medicine, crop protection, cosmetics, horticulture, agricultural seeds, environmental monitoring, and a number of manufacturing and construction sectors. Products with ornamental value are included in this category, such as plants used to decorate homes.

2. Regulating services

Regulating services are the benefits obtained by humans from the regulation of ecosystem processes.

1. Biological regulation: interactions between different trophic levels that preserve functional diversity and interactions. Some literature classifies this service as a supporting service. The biological control of pests and pollination are recognized as supporting functions. Table 3 presents this service along with disease prevention. Due to its importance, the pollination service and function is separated.

2. Freshwater storage and retention: water storage and retention, provision of water for irrigation and human consumption. This ecosystem service is the most relevant in freshwater estuaries and wetlands.

3. Water regulation: this concerns groundwater recharge/discharge in land and forest ecosystems. It affects irrigation, navigation and river flow.

4. Climate, atmosphere and gas regulation: forest cover and marine ecosystems affect and are affected by climate and atmospheric conditions. For example, they contribute toward air purification. They also contribute to the balancing of greenhouse gases. Table 3 separates this service into two components.

5. Human disease control: the MEA focuses on the role of ecosystems in controlling infectious human diseases that affect public health. Table 3 joins this service with biological control.

6. Flood and storm protection: this function is related to the ability of ecosystems to reduce natural hazards and disasters.

7. Erosion control: the soil retention function primarily depends on structural aspects of the ecosystems, especially vegetative cover and root system.

8. Waste treatment: the ability of ecosystems for waste assimilation, detoxification, processing and sequestering varies depending on the type of waste, concentration, load ratios and type of ecosystem (Naber, Lange, & Hatziolos, 2008).

3. Cultural services

These are the non-material benefits that people obtain from ecosystems (Beaumont, et al., 2007).

1. Cultural and enjoyment: communities have an impact on their surrounding ecosystems and are in turn affected by the nature that surrounds them. Nature moulds the traditions and beliefs of communities, and the cultural value of those ecosystems persists in spite of lifestyle changes. Table 3 separates this service into spiritual and historic on the one hand and cultural and enjoyment on the other.
2. Recreation: the recreational value of ecosystems is a large part of valuation studies, which is not surprising due to the growth in the tourism industry. According to the Millennium Ecosystem Assessment (2005), trips to enjoy nature increased 10-30% annually at the beginning of the 90s.
3. Natural beauty: a large number of people enjoy landscapes and natural areas, which is clearly reflected in their preference to live and visit aesthetically pleasing environments.

4. Education and research: forest and marine ecosystems provide numerous research and education opportunities, through excursions, field studies and reference areas to monitor environmental changes (De Groot, Wilson, & Boumans, Ecosystem functions, goods and services: Classification, description and valuation guidelines, 2002).

4. Supporting services

Supporting services are those that are necessary for the production of all other ecosystem services. They produce benefits for humans through regulation, provisioning and cultural services (Beaumont, et al., 2007). The valuation literature makes a weak distinction from regulation services.

1. Habitat and nursery: defined as a habitat provided by living organisms (Beaumont, et al., 2007). Table 3 groups habitat with biological diversity and separates nursery services.
2. Nutrient cycling and fertility: ecosystems regulate nutrient flows and concentrations through a number of complex processes that allow these elements to be extracted from mineral sources (atmosphere, hydrosphere, and lithosphere) or recycled from dead organisms. This service is supported by the diversity of species (Naber, Lange, & Hatziolos, 2008). Table 3, as done in other literature, groups this as a regulation service. Soil formation is also considered a function and a service.

There are other ecosystem characteristics that some literature classify as services but that need to be distinguished as functions, since they are key to the existence of ecosystems. This is the case of resilience, which is considered by some literature as a service (Beaumont, et al., 2007).

Having developed the framework of ecosystem services, we now move on to the valuation of ecosystem services and of the environmental damage.

B. Theoretical approaches to natural resource economics and ecological economy on the valuation of ecosystem services and environmental damage

1. Existence of various types of capital

In their technical report on the analysis of the environmental damage caused by the Crucitas mining project in Costa Rica, Aguilar et. al. (2012) indicate that there are at least two theoretical branches that have studied the valuation of environmental services. These are the school of environmental and natural resource economics and the school of ecological economy.

Environmental/natural resource economics was established with the goal of addressing the issues of optimizing the use and extraction of natural resources (according to sustainable extraction rates, extinction rates, monetary costs and benefits) and the relationship between the social cost of environmental damage and the private benefits of productive activity. It is an economic exercise that has gained more attention from traditional or neoclassic economics due to the need to address the environmental crisis initially identified in the seventies, now consolidated in problems such as climate

change. This approach has achieved academic success thanks to the development of the techniques for monetary valuation of the environment (Aguilar, et. al, 2012).

Ecological economy suggests that in development and conservation processes we use various types of capital, proposing a capital system that goes beyond the traditional concepts. Traditionally, capital is understood as the production factors that have gone through a production or manufacturing process. Ecological economy adopts a more functional definition of capital, as stock that produces flows of valuable goods or services. These flows can be considered income. Eroding the stock is capital consumption (Aguilar, 2007).

This functional definition of capital provides us with a comprehensive view that can help us achieve sustainability. Natural capital is comprised of all stocks of resources in the biosphere that enable the flows of environmental goods and services. Natural capital is different from manufactured capital, as it does not entail transformation by humans (Aguilar, 2007).

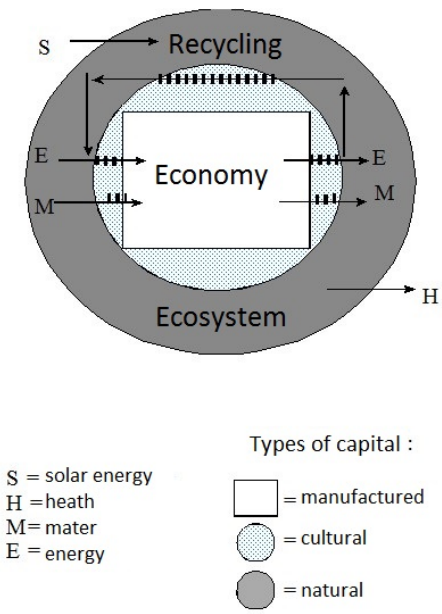


Figure 4- Joint schematic view of the various components of capital in the biosphere. Source: Aguilar (2007)

The entire capital system is presented in Figure 4, which illustrates the interactions between the different categories of capital and the limits on scale imposed by such interactions. Capital is composed of stocks of natural capital, cultural (or social) capital, and manufactured capital. The material and energy flows through these subsystems make possible all natural, social, and economic processes. In this model, the conceptualization of economy goes from a closed system to an open system, sustained by the flow of energy and materials. Growth limits are determined by the underlying layer (cultural capital and natural capital). The adaptation between natural capital and manufactured capital is possible thanks to cultural/social capital (Aguilar, 2007).

The principles of sustainability affect all levels of capital. Since they are complementary, investment must be made in their maintenance and qualitative growth as a whole. Thus, the comprehensive view of capital justifies the adoption of a comprehensive valuation framework, or a multidimensional theory of value (Aguilar, 2007).

2. Monetary valuation of ecosystem services

The UNEP's TEEB (The Economics of Ecosystems and Biodiversity) report confirms the coexistence of valuation approaches as an expression of a comprehensive approach. It includes (monetary and qualitative) preference-based and biophysical approaches (Figure 5).

The most comprehensive monetary valuation methodological framework that has been developed and used both in environmental economics and ecological economics, presented in the TEEB report under the neoclassical economics approaches, is the total value equation (Dixon & Sherman, 1990; Pearce & Turner, Economics of Natural Resources and the Environment, 1990; De Groot, Environmental Functions and the Economic Value of Natural Ecosystems, 1994; Pearce & Moran, The Economic Value of Biodiversity, 1994; Aguilar B. , Paradigmas Económicos y Desarrollo Sostenible: La Economía al Servicio de la Conservación, 2002; TEEB, 2010). This method has the advantage that it allows systematically classifying the different services described in the proposed analysis framework. According to this perspective, the value of environmental services can be classified into two main groups, direct use values and indirect use values. Direct use values (DV) are related to the consumption of the service and the existence of capital. Indirect use values (IV) are usually related to changes in human well-being, which do not originate in physical consumption and that recognize the intrinsic value of nature (Aguilar B. , Paradigmas Económicos y Desarrollo Sostenible: La Economía al Servicio de la Conservación, 2002).

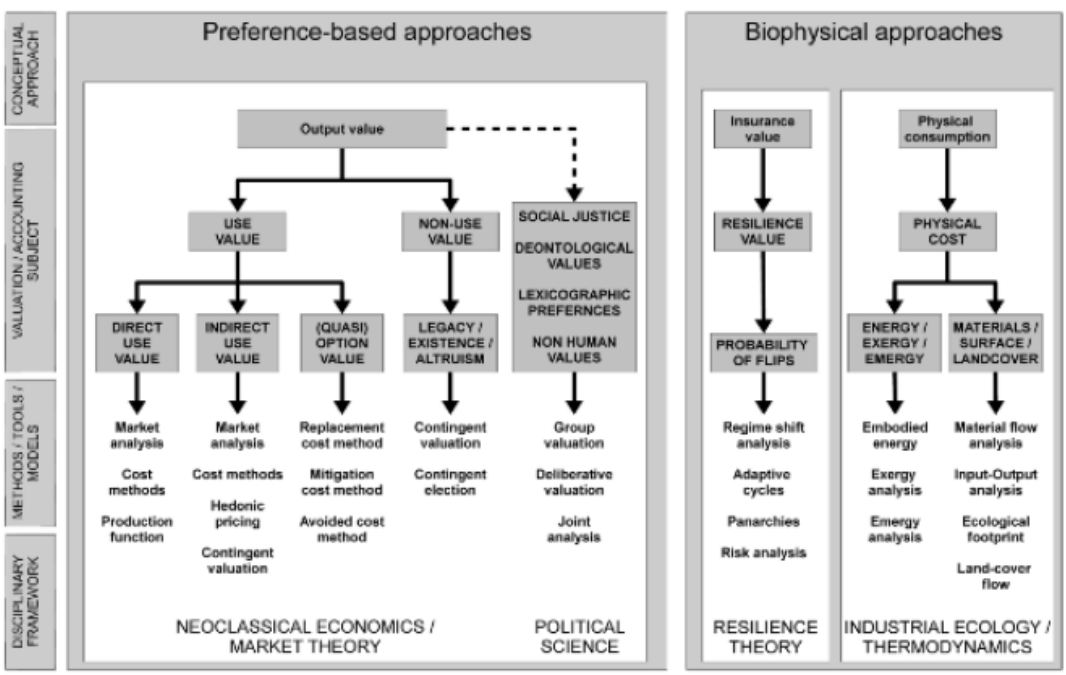


Figure 5 – Synthesis TEEB Report, Approaches for the estimation of nature's values. Source: TEEB (2010).

Direct use values can be divided into Productive Use Values (PUV) and Consumptive Use Values (CUV). The PUV is the value of environmental goods and services that are commercially exchanged. This value can be identified with the market price. The CUV is the value of environmental goods and services that are consumed without having been taken to the market for valuation, though they could be. This consumption implies an increase in welfare that arises from the utility derived and the savings from the potential value that would have been paid in the market. Self-consumption products are a typical example of this value. Consumption is understood in this scenario in its strict sense of ingesting, expending, or using up (Aguilar B. , Paradigmas Económicos y Desarrollo Sostenible: La Economía al Servicio de la Conservación, 2002).

Indirect values are usually related to natural or cultural capital services that generate human welfare that does not originate in consumption, and acknowledge the intrinsic value of nature. They can be divided into non-consumptive use values (NCUV), option values (OV) and existence values (EV) (Aguilar B. , Paradigmas Económicos y Desarrollo Sostenible: La Economía al Servicio de la Conservación, 2002). NCUVs derive from natural or cultural capital services that provide increases in welfare without being consumed or traded in the marketplace. They also derive from uses that do not imply consumption of the good or service involved, such as recreation, tourism or education. Option values are a type of insurance premium on future access to ecosystem services. The uncertainty of the future offer of given environmental services justifies the need for that value, as well as human risk aversion. OVs include the value of potential discovery of goods or services that can increase human welfare in the future. EV is the intrinsic, intangible and ethical value of goods and services that is not related to human welfare. It arises from a consideration for non-human entities. It is not necessary to estimate it, and its inclusion in the equation derives from the logical imperative of assuming a position that is not exclusively utilitarian (Aguilar B. , Paradigmas Económicos y Desarrollo Sostenible: La Economía al Servicio de la Conservación, 2002).

Thus, the Total Value Equation can be expressed as:

$$(1) TEV_t = DV_t + IV_t;$$

where

$$(2)\ DV_t = PUV_t + CUV_t;$$

and

$$(3)\ IV_t = NCUV_t + OV_t + EV_t;$$

Figure 6 shows a synthesis of the reference framework for the valuation of ecosystem services set forth thus far. Note that it considers that direct use values will include provisioning services and that regulation services, habitat and information are located among non-consumptive use values as they generally do not

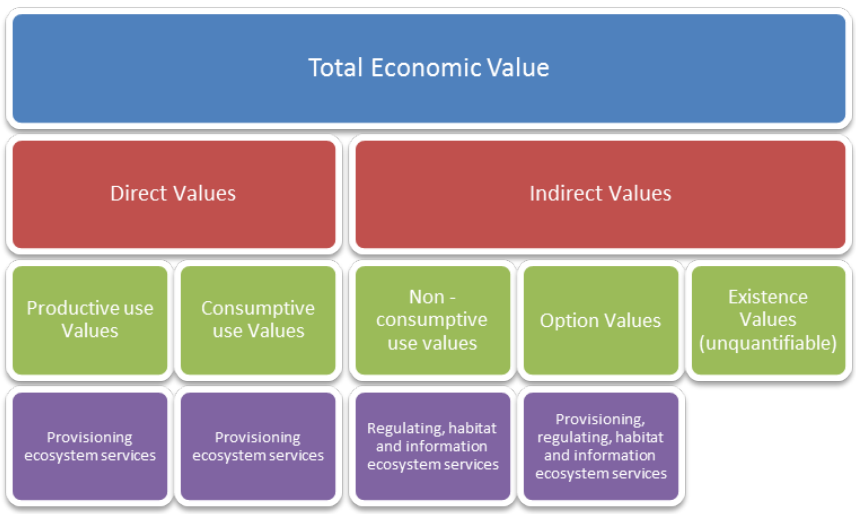


Figure 6-Synthesis of the monetary valuation framework adopted. Source: Aguilar, et al. (2012).

imply physical consumption. Option values will be a projection of all categories. The total economic value (TEV) estimation techniques depend on available information. They vary from valuation with market prices to the use of shadow prices and survey-based techniques (Aguilar B. , Paradigmas Económicos y Desarrollo Sostenible: La Economía al Servicio de la Conservación, 2002). Simple valuation techniques are applied in cases where complete and reliable information is available on the prices of capital stock or flows therefrom. Basically, an attempt is made to account for the costs and benefits according to market price information (Aguilar B. , Paradigmas Económicos y Desarrollo Sostenible: La Economía al Servicio de la Conservación, 2002).

Shadow prices (or substitutes) valuation techniques are also frequently used. These are also known as revealed preference approaches. These techniques estimate the value of goods and services through the price of other related goods and services. Thus, among the methods used we find techniques such as changes in productivity, changes in income, hedonic pricing, replacement cost, and travel cost, among others. (Aguilar B. , Paradigmas Económicos y Desarrollo Sostenible: La Economía al Servicio de la Conservación, 2002).

Stated preference approaches are also used (surveys or contingent valuation). These are essentially based on the opinion of interested parties; they are asked how they would react in certain

circumstances. Basically you try to simulate a market through interview techniques (Aguilar B. , Paradigmas Económicos y Desarrollo Sostenible: La Economía al Servicio de la Conservación, 2002).

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 90s is benefits transfer. It is a quick technique that became popular thanks to the work of Costanza et al. (1997) which has been disseminated in our hemisphere by the Gund Institute of Economics of the University of Vermont, USA, and the U.S. NGO Earth Economics, among others. To address situations where obtaining information for slow methodologies is very expensive or impossible to acquire (such as in a highly conflictive situation), or in which the time factor is very limited or a preliminary estimate is sought, what this method proposes is basically the extrapolation of values from other studies to the case under analysis, based on the different soil covers found at the site. This technique depends on the existence of studies of ecosystems with similar conditions to those of the ecosystem under analysis, and on the existence of reliable information regarding land use percentages of the area under study.

This methodology is extensively used nowadays, and it is recognized in the influential TEEB study (Pascual, Muradian, Brander, Gómez-Baggethun, & Martín-López, 2010) as one of the valid alternatives in conflict situations, or limited time and access to information. In the United States it is also applied in environmental forensics (Aguilar, et al., 2012).

Due to its popularity, important studies have defined several parameters to be observed to prevent biases and errors in the transfer. Two significant parameters relate to verifying that the methods used in the study or base study are adequate, and that the transferability of values is adequate. In this regard, Table 4 shows us what the state of art in literature recommends in this regard (Liu, Costanza, Farber, & Troy, 2010).

Table 4- Suitability of the valuation methodologies for environmental services and transferability according to the types of ecosystem services included. Source: Liu, et al. (2010).

Environmental service	Suitability for economic valuation	Most appropriate method used in the valuation	Transferability between sites
Gas regulation	Medium	CV, AC,RC	High
Climate regulation	Low	CV	High
Regulation of floods, disasters and similar events	High	AC	Medium
Biological regulation	Medium	AC, P	High
Water regulation	High	M, AC, RC, H, P, CV	Medium
Soil retention (erosion)	Medium	AC, RC, H	Medium
Waste regulation	High	RC, AC, CV	Medium a High

Environmental service	Suitability for economic valuation	Most appropriate method used in the valuation	Transferability between sites
Nutrient cycling	Medium	AC, CV	Medium
Water supply	High	AC, RC, M, TC	Medium
Food	High	M, P	High
Raw materials	High	M, P	High
Genetic resources	Low	M, AC	Low
Medicinal resources	High	AC, RC, P	High
Ornamental resources	High	AC, RC, H	Medium
Recreation	High	TC, CV, ranking	Low
Aesthetic	High	H, CV, TC, ranking	Low
Science and education	Low	Ranking	High
Spiritual and historic	Low	CV, ranking	Low

AC, avoided cost (defensive); CV, contingent valuation; H, hedonic prices; M, market prices; P, productivity effects; RC, replacement cost; TC, travel cost.

The Ramsar Convention has adopted the developed framework, practically as a whole, for the valuation of wetlands. The following section briefly describes that adoption.

3. Application of the aforementioned framework to wetlands: Recommendations of the Ramsar Convention

The Ramsar Convention has published two documents on the application of monetary valuation methods to wetlands. The first document was published in 1997 as a guide for policy makers and planners. It justifies the effort with the fact that monetary valuation serves to measure and compare the different benefits of wetlands. Thus, it can be an efficient instrument to aid and improve the use and rational management of global wetland resources. The authors indicate that until then wetlands had been undervalued because many of the ecological services, biological resources and amenity values they provide are not bought or sold, which makes them difficult to price (Barbier, Acreman, & Knowler, 1997).

It indicates that a key concept underlying the principles of the Ramsar Convention is that wetlands have great value. Conservation can only be achieved if wetlands can be shown to be of value and, in some cases, of greater value than proposed alternative uses of the wetland site itself or of the water feeding the wetland. In line with this, Contracting Parties are asked to provide physical and social values of wetlands as part of the information for designation on the List of Wetlands of International Importance, as is the case of HCN. Contracting Parties are also committed to making environmental impact assessments, before initiating schemes that might affect wetlands, which should pay particular attention to maintaining the values of wetlands (Barbier, Acreman, & Knowler, 1997).

Regarding the recommended monetary valuation framework, the guide establishes that for researchers to value the uses of wetlands and for decision-makers to take them into account when making policies

that affect wetlands, a framework is necessary to distinguish and group these values. It indicates that the concept of total economic value (TEV) provides such a framework and there is an increasing consensus that it is the most appropriate one to use (Barbier, Acreman, & Knowler, 1997).

Regarding its application, Barbier et al. (1997) indicate that ideally any assessment ought to lead to an economic valuation of all benefits and costs associated with each wetland use option that is to be evaluated. It recommends the application of the cost-benefit analysis technique. However, given that data limitations often constrain the analyst's ability to value many environmental functions and resources, it will be necessary to adapt the assessment methodology in such circumstances to provide the best information possible to aid decision-making. This is due to the importance of preventing stagnation of the potential decisions that affect the protection of such valuable ecosystems, which are at risk. Thus, the necessary application of the precautionary principle must be kept in perspective (Barbier, Acreman, & Knowler, 1997).

They demonstrate the application of the framework for the identification of the economic benefits with examples from Petexbatún wetlands, Department of Petén, Guatemala and the mangrove wetlands in the North Pacific Coast of Nicaragua.

To estimate the monetary value they agree with that indicated herein regarding the need to mix direct valuation methods with market information and indirect valuation methods. The report is complemented with a detailed examination of case studies of wetlands in Nigeria, United States, United Kingdom, Sweden and Indonesia. For reference regarding coastal wetlands, two case studies are presented, one in Southwest United States and another in the mangrove wetlands of Indonesia (Barbier, Acreman, & Knowler, 1997).

The second document is a compilation of guidelines for the valuation of wetland ecosystem services, published in 2007. It arises from that in the period from 2002 to 2005 the Convention's Scientific and Technical Review Panel reviewed the set of Ramsar guidance on wetland inventory, assessment and monitoring and recognized the need for guidance on wetland valuation to complement and update the work of Barbier, et al. (1997) prepared for the Ramsar Convention (De Groot, Stuio, Finlayson, & Davidson, 2007).

The document integrates in the guidelines a more comprehensive and structured view of the reasons why wetlands are undervalued and over-used. According to this report, the reasons include:

- Market failure: public goods. Many of the ecological services, biological resources and amenity values provided by wetlands have the qualities of a public good, i.e. many wetland services are seen as "free" and are thus not accounted for in the market (e.g. water purification or flood prevention).
- Market failures: externalities. Another type of market failure occurs when markets do not reflect the full social costs or benefits of a change in the availability of a good or service (so-called externalities). For example, the price of agricultural products obtained from drained wetlands does not fully reflect the costs, in terms of pollution and lost wetland services, which are imposed upon society by the production process.

- Perverse incentives (e.g., taxes/subsidies stimulating wetland over-use). Many policies and government decisions provide incentives for economic activity that often unintentionally work against the wise use of wetlands, leading to resource degradation and destruction rather than sustainable management. An example might be subsidies for shrimp farmers leading to mangrove destruction.
- Unequal distribution of costs and benefits. Usually, those stakeholders who benefit from an ecosystem service, or its over-use, are not the same as the stakeholders who bear the cost. For example, when a wetland is affected by pollution of the upper catchment by runoff from agricultural land, the people living downstream of the wetland could suffer from this. The resulting loss of value (e.g., health, income) is not accounted for and the downstream stakeholders are generally not compensated for the damage they suffer.
- No clear ownership. Ownership of wetlands can be difficult to establish. Wetland ecosystems often do not have clear natural boundaries and, even when natural boundaries can be defined, they may not correspond with an administrative boundary. Therefore, the bounds of responsibility of a government organization cannot be easily allocated and user values are not immediately apparent to decision-makers.
- Devolution of decision-making away from local users and managers. Failure of decision-makers and planners to recognize the importance of wetlands to those who rely on them, either directly or indirectly (De Groot, Stuio, Finlayson, & Davidson, 2007).

The report highlights the need to have participatory instances in the design and assessment of policies and, consequently, the valuation processes. Similarly, within a comprehensive proposal, it introduces the need to identify and create an inventory of the ecosystem functions and services.

It adopts the model of the Millennium Ecosystem Assessment to identify these services. Table 5, adapted from that report, shows a comparison of the relative size (by surface unit) of each ecosystem service provided by diverse types of wetland according to the opinion of international experts (De Groot, Stuio, Finlayson, & Davidson, 2007).

Table 5- Services provided by selected coastal wetlands and relative magnitude of each service. Source: Adapted from De Groot, et. al. (2007).

Services	Estuaries and marshes	Mangroves (Tidal tropical forested wetlands)
Provisioning		
Food	High	High
Fresh water	Low	None
Fibre and fuel and other raw materials	Medium	Medium
Biochemical products and medicinal resources	Low	Low
Genetic materials	Low	Low
Ornamental resources	Low	Low
Regulating		
Air quality regulation	Low	Medium
Climate regulation	Medium	Medium

Hydrological regimes (recharge and discharge)	Low	None
Pollution control and detoxification	Medium	Medium
Erosion protection	Medium	High
Natural hazards mitigation	High	High
Biological regulation	Medium	High
Cultural and recreational		
Cultural heritage and identity	High	Low
Spiritual and artistic inspiration	High	Low
Recreational	High	Low
Aesthetic	High	Low
Educational	Low	Low
Supporting		
Biodiversity and places for breeding	Medium	Medium
Soil formation	Medium	Medium
Nutrient cycling	Medium	Medium

The original Table includes more types of continental and coastal wetlands. Here we include two systems which seem important to establish parameters for the goals of this study, estuaries and marshes and mangroves as a representation of tidal tropical forested wetlands.

Similarly, the report develops indicators to determine the sustainable use of the different wetland ecosystem services. Furthermore, it establishes parameters for ecological and sociocultural valuation. In economic terms, it also adopts the TEV framework for the monetary valuation of ecosystem services. Figure 7 shows us the application of the ecosystem services provided by wetlands, according to the authors.

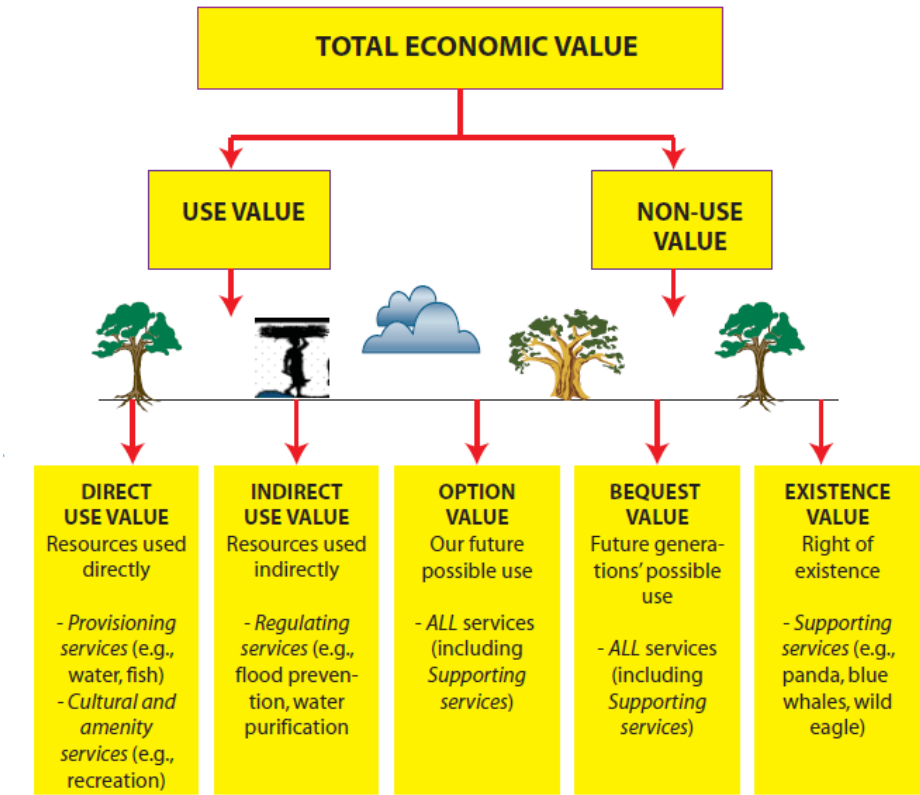


Figure 7- TEV elements and examples of ecosystem services corresponding to each element. Source: De Groot, et al. (2007)

Within this framework, the report also focuses on the need for a variety of direct and indirect estimation methods, recognizing all methodologies set out in the TEEB report. This includes slow direct valuation methodologies, shadow prices, contingent valuation and the quick value transfer methodology. Regarding the latter, when there is no time to perform an original investigation, or there is no available data, benefits transfer may be used, but with caution (De Groot, Stuio, Finlayson, & Davidson, 2007).

Having developed the TEV valuation framework for the valuation of ecosystem services and its application to wetlands, we now focus on the methodology applied by that framework to the valuation of environmental damage.

4. Framework for the valuation of environmental damage

The application of this framework to the monetary valuation of environmental damage has found, as recognized by Moreno (2005), one of its prevalent expressions in the biophysical and social costs method of the *Instituto de Políticas para la Sostenibilidad* (Institute on Sustainability Policies, IPS) from Costa Rica.

The base document for this methodology is from 2001, and was developed by a multidisciplinary team from that non-profit organization, whose goal of analysing and formulating policies for development and conservation. Its main activities are research and training. The document was developed for SINAC (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001).

As a starting point, environmental damage is defined as an action or activity that causes an unfavourable disturbance in the natural environment. This action causes a change in the condition of the affected resources; therefore, it is necessary to know the state of conservation of the resource before and after the disturbance. Thus, it considers this change as that considered in the analysis of the terms of the expression, effects, causes and agents involved, which serves as basis for the methodology proposed in the estimation of the restoration cost and the social cost (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001).

To define the environmental damage, the study starts by determining the state before and after the action that causes the damage (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001). It is expressed by the equation:

$$(4) DAj = \int_{t0}^{x} [f1(t) - f2(t)]dt$$

where

DA: is the damage caused to the natural resource, *j,*

$f_1(t)$: explains the behaviour of the natural resource (or environmental factor) *before* the damage,

$f_2(t)$: explains the behaviour of the natural resource (or environmental factor) *after* the damage,

t: time,

x: duration of the effect on factor *j.*

It graphically represents the change condition according to Figure 8.

The Total Cost is expressed by three components:

$$(5) TC = RC + SC + EC$$

where

TC: is the total monetary cost associated to the environmental damage,

RC: is the restoration cost (used as indicator of the value of the biophysical damage) of the natural environment affected to its initial state of conservation,

SC: is the social cost, which depends on the loss of generated benefits due to the effects on the state of conservation of the natural environment, and the quality and quantity of flows provided by the natural capital,

EC: is the value of the total extracted production, in the case of extractions (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001).

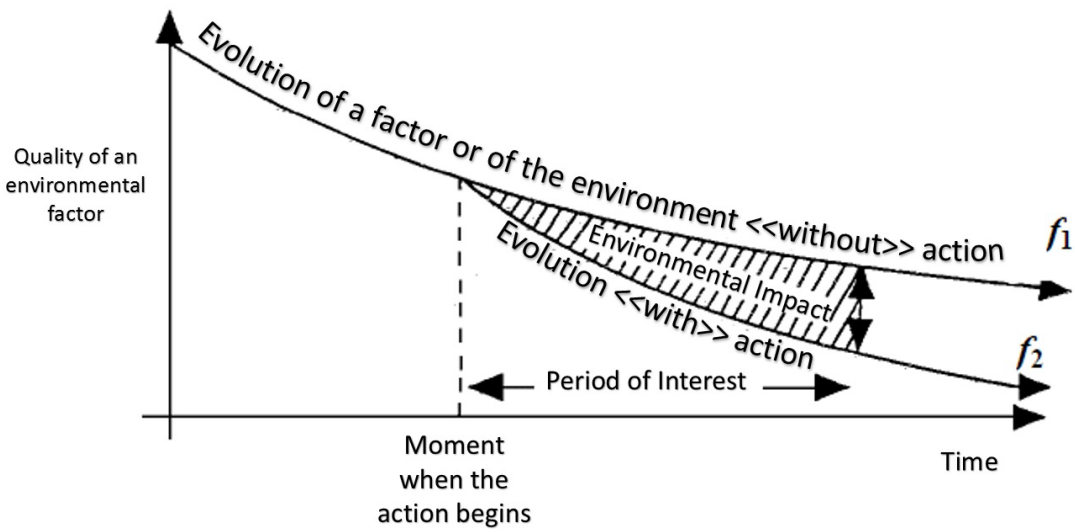


Figure 8- Graph representation of the environmental damage. Source: Barrantes and Di Mare (2001)

Thus, Barrantes and Di Mare (2001) indicate that for purposes of estimating restoration costs it is necessary to identify the state of conservation of the natural resources affected and the degree of the effects thereon. Knowing the state of conservation prior to the disruption, it is possible to determine the estimated time for restoration of the resource, which shall result in a more correct approximation of the economic costs that it will entail. Specifically, the methodology developed to estimate the restoration cost is a function of the inputs required and time for restoration of the natural resources affected to the conditions before the disturbance. Since the action may affect one or more resources, the time for restoration must correspond to the resource with the longest recovery time (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001; Vega, Evaluación Económica del daño ambiental causado por los incendios forestales en Costa Rica, 2004).

The estimation of the social costs considers the benefits lost due to the environmental damage caused. Thus, it is necessary to determine the group of benefits provided by the natural environment affected and how these benefits have decreased due to the environmental disturbance. If the benefits are measurable, a direct method is proposed which depends on the available information on the benefits

lost and the means to compensate them. If, on the contrary, the benefits are not measurable, a method is proposed where the social cost is proportional to the restoration cost, where the proportionality constant is based on the change in the state of conservation (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001; Vega, Evaluación Económica del daño ambiental causado por los incendios forestales en Costa Rica, 2004).

Furthermore, the methodology proposes assessing the initial state of the natural resources involved by measuring the potential to provide the flows or environmental services that benefit society. The qualities proposed are 1) scale, 2) elasticity (resilience), 3) representativeness, 4) complexity and the fact of being or not a 5) key component. A weighing proposal is presented, as well as ranges. In addition, a series of possible indicators to determine the state of conservation of the natural resources is specified. Flexibility is recommended in the selection of indicators and weighing according to the factors of the specific contexts (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001; Vega, Evaluación Económica del daño ambiental causado por los incendios forestales en Costa Rica, 2004)

Although the environmental services framework defined by the methodology is not as broad and detailed as that developed above based on the MEA (e.g. it does not contemplate the systematization of provisioning, regulation, habitat and information services) it is quite comprehensive. The weighing of the state of conservation ideally depend on direct field verifications or, depending on that established by the study, the development of an updated, reliable, systematic, continuous and consistent database, which allows having statistics about the biophysical state of natural resources and the flows that benefit the population's welfare (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001; Vega, Evaluación Económica del daño ambiental causado por los incendios forestales en Costa Rica, 2004)

The valuation methods recommended are fundamentally direct and indirect valuation, of the slow methods established above. In addition, it must be noted that the study does not specifically adopt a governing framework of the estimation, such as the total value estimate, tool adopted here and previously in the application of this context to the Crucitas mining project by Aguilar et al. (2012).

The Crucitas mining conflict in Costa Rica also generated advances in the application of this valuation framework, as it introduced variants with the quick value transfer methodology in the studies requested by the National Comptroller's Office and the Contentious-Administrative Court that determined, in the execution of the judgment of first instance, the monetary value of the environmental damage caused by this project, declared illegal by that judicial forum (Aguilar, et al., 2012; Marozzi, Chacón, Alpizar, & Mata, 2012).

C. Applications of the described frameworks in Costa Rica and Latin America

1. Valuation of ecosystem services

The most comprehensive study is that of a researcher from Universidad Nacional, Mary Luz Moreno, which documents the trends in valuation literature in Costa Rica, both on ecosystem services and

environmental damage, up to the first decade of the XXI Century (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001; Vega, Evaluación Económica del daño ambiental causado por los incendios forestales en Costa Rica, 2004) This work identified seven types of studies, among the best known and influential studies. Table 6 summarizes the 36 studies examined by Dr. Moreno, by categories and methods identified. Furthermore, it indicates which have been influential in environmental decision-making in the country.

Some of the trends in this study are summarized as follows: First, the vast majority of literature is grey, mainly composed of studies published with reviewers regarding the study of protected wildlife areas and the water resource. Furthermore, the studies that have had an effect on environmental policies are mainly related to water resources and estimations of environmental damage. The studies using alternative methodologies with participatory elements or a multiple-criteria analysis do not seem to have much influence until this review. Finally, it can be noted from Moreno's study that in most cases no distinction is made between the implications of a valuation study from environmental economics and from ecological economy.

An important study not contemplated by Moreno (2005) is the study by the former Minister of the Environment, Energy and Telecommunications, René Castro, who performs a valuation of the environmental services generated by Costa Rican forests to offset climate change (Castro, 1999).

The trends identified by Moreno also appear in the review subsequently performed by Aguilar (2007) of 55 studies in Latin America. A notable difference is that the collective work found in that study clearly distinguishes for the first time the studies that can fall within the framework of environmental economics and those that fall under ecological economy. This study publishes several investigations listed by Moreno and other new ones. Three studies are included that are considered to be from ecological economics (one with the cluster analysis methodology and two multiple-criteria analysis). Furthermore, 10 more studies from an environmental economics approach are included (Aguilar B. , Reflexiones y estudios de caso utilizando una Teoría Multidimensional del Valor: recomendaciones para Centroamérica, 2007).

Table 6-Summary or the review of the valuation literature by Moreno (2005). Source: Summarized from Moreno (2005)

Category	Study	Methods	Effect on Costa Rican Environmental Policies	Published with review / Grey literature
Valuations related to water resources	Barrantes, Vega and Maldonado (2003)	Direct valuation and revealed preference (shadow prices)	Executive Decree that stipulates the charging of a fee to water concessionaires in Costa Rica	G
	Corella (2001)	Direct valuation and revealed preference (shadow prices)		G
	Segura et. al. (2001)	Revealed preference (shadow prices)		G
	Reyes and Córdoba (2000)	Revealed preference (shadow prices)		G
	Barrantes and Castro (1999)	Revealed preference (shadow prices) and stated preference (contingent valuation)	Served as basis to develop a plan for the collection and payment of the water environmental services, environmentally adjusting the rate for the distribution of drinking water.	P
	Barton (1999)	Stated preference (contingent valuation)		G
	Merayo (1999)	Stated preference (contingent valuation)		G
	Barrantes and Castro (1998a)	Stated preference (contingent valuation)	The study served as basis for discussion of possible rates and income from the water part of the environmental area.	G
	Barrantes and Castro (1998b)	Direct valuation and revealed preference (shadow prices)		P
	Marozzi (1998)	Stated preference (contingent valuation)		G
	Valera (1998)	Stated preference (contingent valuation)		G
	Solórzano, et. al. (1995)	Direct valuation and revealed preference (shadow prices) and stated preference (contingent valuation)		G
Valuation of Forest Ecosystem Services	Hearne and Motte (2001)	Choice experiments		G
	Mejías, Alpízar and Watson (2000)	Direct valuation and revealed preference (shadow prices)		G
	Bolaños et al. (1996)	Direct valuation		G
	Carranza et al. (1996)	Revealed preference (shadow prices)	The first amount paid for PSA in Costa Rica was in 1997 and was based on this study.	G
	Menkhaus and Lober (1995)	Revealed preference (shadow prices)		P
Valuation of specific ecosystems	De Sena (1997)	Revealed preference (shadow prices) and stated preference (contingent valuation)		G
	Barton (1995)	Direct valuation		G
Valuation of conservation areas, national parks and biological reserves	Adamson (2001)	Stated preference (contingent valuation)		P
	Mejías (2001)	Direct valuation and stated preference (contingent valuation)		G
	Echeverría et al. (1997)	Direct valuation and revealed preference (shadow prices) and stated preference (contingent valuation)		G
	Shulz et al. (1994)	Stated preference (contingent valuation)		P

Category	Study	Methods	Effect on Costa Rican Environmental Policies	Published with review / Grey literature
	Gutic (1993)	Direct valuation		G
	Tobias and Mendelsohn (1991)	Revealed preference (shadow prices)		P
Valuations to measure environmental damage	Barrantes and Vega (2004)	IPS- Direct valuation and revealed preference (shadow prices)		G
	Barrantes et al. (2004)	IPS- Direct valuation and revealed preference (shadow prices)	Input for the Environmental Administrative Tribunal to punish the perpetrator and to carry out actions related to the recovery, compensation or mitigation of the damage.	G
	Vega et al. (2004)	IPS- Direct valuation and revealed preference (shadow prices)		G
	Vega, Vega and Barrantes (2004)	IPS- Direct valuation and revealed preference (shadow prices)		G
	Espinoza et al. (2001)	Direct valuation and revealed preference (shadow prices)	With this information SETENA determined that the company had to pay a penalty. Although it considered that the damage caused is not measurable, it estimated that the penalty would be fair to respond to the contamination of the river caused by wastewater of the accused company. The Environmental Administrative Tribunal issued a resolution on the case based on the valuation performed.	G
Valuation with alternative methodologies	Marozzi (2004)	Multiple criteria analysis		G
	Reyes et al. (2004a)	Multiple criteria analysis		G
	Reyes et al. (2004b)	Direct valuation and revealed preference (shadow prices) with focus groups		G
	Camacho et al. (2003)	Case study and multiple criteria analysis		G
	Hartley (2002)	Multiple criteria analysis		G
	ICE (1994)	Direct valuation and revealed preference (shadow prices) with focus groups		G

An aspect not contemplated in Moreno's study (2005) is the presence of biophysical valuations for Costa Rica. A more notable example is the work compiled by Hall (2000). This work includes an evaluation of implicit energy in the country's development model and a series of studies by production sector using various methodologies of this type (Hall, 2000). This trend has been followed by other studies such as *Informe del Estado de la Nación*, which in its last issues has reported the evolution of the country's ecological footprint (Programa del Estado de la Nación en Desarrollo Humano Sostenible, 2011).

It is important to note a study from 2007 which in the context of Costa Rica and Panama makes a combination of monetary and qualitative methodologies. A study by Marozzi and Solís (2007) expressly recognizes the value of combining the TEV techniques with the multiple criteria technique. This comprehensive methodology is applied to the problem of the conservation of the wetlands *Gandoca-Manzanillo* and *San San Pond Sak* in Panama (Marozzi & Solís, Valoración económica total de los humedales Gandoca-Manzanillo San San Pond Sak en el caribe fronterizo entre Costa Rica y Panamá, 2007).

Subsequent evolution has demonstrated the trend of performing valuations that measure the socioeconomic contribution of protected wildlife areas through a cluster analysis methodology (Moreno, Choden, Floquet, & Mongbo, 2011). Furthermore, it is important to mention the studies that have combined or promoted the combination of methodologies within a multi-dimensional framework for the valuation of environmental damage at Isla Portillos, *Humedal Caribe Noreste* or for the *Humedal Nacional Térraba-Sierpe* (Aguilar-González & Moulaert, 2011; Aguilar-González & Moulaert, 2013). The work compiled in the second of these studies has been pioneering with regard to the use of the multiple-criteria methodology and having an impact on the environmental policy, as it was instrumental to the approval of the Management Plan for that wildlife area.

2. Valuation of environmental damage

In an extensive compilation study, UNEP reported the state of art in terms of the recognition of methodologies for the valuation of environmental damage up to 2006, with strong emphasis on the European Community and Latin America (Castañón del Valle, 2006). A series of constants were extracted from the instruments examined.

First, it distinguishes between the systems based on a subjective understanding and those with an objective understanding of environmental damage. The Subjective System is where the originator of the damage is considered liable if there are subjective elements of guilt or negligence. It is the system that prevails in countries such as Italy, France, United Kingdom, New Zealand and Holland, among many others. According to this mechanism, in order to repair environmental damage the behaviour of the parties that cause such damage is taken into account. On the other hand, in the Objective System the originator of the damage is considered liable independently of proof of guilt or negligence, and can only be exempted from liability if it is proven that the damage was caused by force majeure, or was inevitable and unavoidable (Castañón del Valle, 2006). Castañón del Valle recognizes two central concepts as typical stages of the various systems examined: 1 -

identification and determination of the effects of the damage, and 2 - valuation of the damage. (Castañón del Valle, 2006; Barrantes, Metodología para la evaluación económica del daño ambiental, 2011).

Secondly, it can be verified from the examination that the theoretical framework of the total value equation is recognised within both of these legal environments as one of the guiding frameworks of common application. However, it is worth noting, perhaps because of the date of the source, that an organizing framework for environmental services, such as that of the MEA, is not documented as having being widely used. Furthermore, according to this source, the diversity of valuation methods, from slow direct and indirect methodologies to quick (value transfer) and multiple criteria methodologies are recognized by legal theory and by the instruments examined (Castañón del Valle, 2006).

After citing examples of instruments that require the valuation of environmental damage, such as Decree N° 233 of the General Environmental Law of El Salvador, from 1998, the General Environmental Law of Panama (41 of 1998), or that of Peru (28611 of 2005, it concludes generally that there are no standards in the assessed instruments that establish procedures for valuation or common criteria to put into practice their contents, which creates problems regarding the legal certainty of the offenders. Even when examining the situation in the European Union, it indicates that “the White Paper on Environmental Liability of the European Commission recommends that when restoration is technically not possible, the valuation of the natural resource has to be based on the costs of alternative solutions, aiming at the establishment of natural resources equivalent to the destroyed natural resources... Apart from that guideline, the European Union lacks, as is practically the case of the entire international community, specific guidelines for the valuation of environmental damage.” It recognizes that in the case of the European Union as well as in other areas there are cases that use: 1) the value of the environmental damage, irrespective of the restoration or cleaning costs, 2) the compensation of resources through primary restoration or compensation from another site, and 3) a mix of the two (Castañón del Valle, 2006).

Thus, it concludes that the process of valuation of the environmental damage cannot be as simple as applying previously defined valuation techniques, as it needs to be much more sequentially elaborate. First, a starting point needs to be established, to determine the initial conditions of the environmental damage caused, assessment of the damage caused, the number of affected parties, initial situation of the damaged environment, etc. This first phase is followed by the valuation per se, which shall estimate the loss suffered, and thirdly, using all of the foregoing information, decide on the reparation best suited for the fact under consideration. The whole process, in all phases, must adapt to the characteristics of each case (Castañón del Valle, 2006).

There are two additional points worth noting regarding this review. First, the existence of systems that define standardized values by amount or space of the environmental damage. This is the case of the United States with damage due to oil spills, where mitigation costs were standardized following the EXXON-Valdez spill in Alaska (1998). Second, there are systems where a standardized and unique value is defined by species (or damage to a species). This is the case of Decree 4/1986,

from 22 January, which extends the list of protected species and establishes rules for their protection in the territory of the Autonomous Community in Andalucía (Spain), where, for example, the value of a sea turtle is estimated at €3,005.10, the same as that for an imperial eagle and other marine mammals (Castañón del Valle, 2006).

To provide an example of recent cases in Latin America, we can cite here methodologies for the valuation of environmental damage recently applied in Ecuador and in Costa Rica, in compliance with their domestic environmental law in the administrative venue. These are summarised in Table 7. The countries seem to be moving toward the establishment of more advanced methodological frameworks.

Table 7 - Methodological backgrounds applied for the valuation of damage in Ecuador and Costa Rica. Source: Prepared by the authors based on the cited studies.

Reference area	Year	Economic value of the environmental damages	Hectares affected	Value per hectare	Method	Performed by
Tropical wetlands of Ecuador	2001 and 2008	$2,160.43	1	$2,160.43	Restoration cost, market and ecosystem weighing	Ministry Agreements 442 from 2001 and 178 from 2008 regarding restoration csots, based on Barrantes (2000)
Tropical wetlands of Ecuador	2001 and 2008	$1,357.76	1	$1,357.76	Restoration cost, market and ecosystem weighing	Ministry Agreements 442 from 2001 and 178 from 2008 regarding restoration csots, based on Barrantes (2000)
River protection area, Puriscal, Costa Rica	2010	$71,698	0.02	$71,698	Investment to cause the damage and ecosystem weighing	ACOPAC Technicians for the Environmental Court, based on Barrantes (2002)
Native primary forests and intervened forests in Ecuador	2012	$2,000 - $20,000	1	$2,000 - $20,000	Restoration cost by hectare and ecosystem weighing, between high and low	Ministry Agreement 1330 from 2012 on restoration costs
River protection area, Alajuela, Costa Rica	2012	$533.21	0.004	$143,220.52	Market and ecosystem weighing	Technicians from the ACCVC Grecia Office for the Environmental Court
Deforestation of the Crucitas Mining Project, Costa Rica	2012	$4,600,000.00	86.5	$53,179.19	Restoration cost and value transfer based on SIG for loss of environmental services	Multidisciplinary team of Fundación Neotrópica, at the request of MINAE
River protection area, Alajuela, Costa Rica	2014	$312.34	0.04	$8,008.72	Market and ecosystem weighing	Technicians from the ACCVC Grecia Office for the Environmental Court
Deforestation of the Crucitas Mining Project, Costa Rica	2015	$6,400,000.00	58	$110,344.83	Restoration cost and and cost of environmental services, estimated using a mix of techniques, based on fieldwork and weighing	Multidisciplinary team appointed by the Administrative Court at the request of the plaintiff

It can be observed that the records from Ecuador from the beginning of the 2000s show the establishment of a fixed price per hectare of primary forest and secondary forest, based on the methodology recommended by IPS, which was subsequently recommended for Paraguay (Barrantes & Cháves, Valoración Económica del Daño en Bosques Naturales. Estudio de Caso: Bosque Húmedo Tropical en Ecuador, 2000). The estimated values per hectare range from $1,357.76 to $2,160.43.

This situation persisted in that country until 2012, when the system for the application of the current law was modified, changing to a system that uses as elements the base value and an ecosystem weighing of four factors: water, timber and non-timber products, carbon storage and biodiversity, through Likert scales. This new methodology increases the values per hectare to a range of $2,000.00 to $20,000.00 depending on the degree of priority and valuation factors (Ministry Agreement 1330 from 2012, Ecuador).

In the case of Costa Rica there is a similar evolution, with interesting manifestations at the judicial level. During the first half of the first decade of this century there is concern regarding the development of these methodologies, which is addressed by the work of IPS. However, not all administrative entities adopt the methodology proposed. For example, in the case of National System of Conservation Areas (SINAC), each conservation area adopts independent valuation methods. This need is in part due to the creation of the Environmental Administrative Tribunal, which requires them due to its punitive function, pursuant to article 99 of the Organic Environmental Law of Costa Rica (Law 7554 of 1995).

Thus, in some areas valuations have been developed which seem disproportionate and do not correspond to the most common theoretical standards of the theory on the valuation of ecosystem services. This is the case of the valuation of environmental damage performed by the Central Pacific Conservation Area (Sequeira, 2010), in this case using the value of the investment to cause the damage, increased by a 1000% due to a weighing of indicators of the seriousness of the damage caused by a technical appraiser. The value of the damage by hectares recorded in Table 5 is evidently extreme in comparison to others included in the sample.

For 2012 and 2014, we find technical reports for the same purpose which are based on the quantification of the value of the environmental damage in the sum of the restoration cost (recovery, follow-up and monitoring) and of the social cost expressed in the loss of ecosystem services. The sum is deflated by weighing the degree of environmental damage done to the resources, and the degree of initial conservation of the damaged site (prior to the damage). This is used to determine the chargeable damage. These applications in the administrative sub-region of Grecia, part of the Central Volcanic Range Conservation Area, however, make the mistake of not looking for means or additional information that would allow them to transfer values in the absence of “social cost” primary estimates. They limit themselves to the use of IPS’s research, which repeats the restoration cost (Barrantes & Cháves, Valoración Económica del Daño en Bosques Naturales. Estudio de Caso: Bosque Húmedo Tropical en Ecuador, 2000). This means that the restoration cost is added twice, and deflated by the degree of the chargeable damage. Subsequently, the net present value is calculated for the period of time until recovery of the ecosystem (in this case 25 years) (Jiménez, Valoración del Daño Ambiental. Propiedad Kattia Vargas Arias Rodríguez de Valverde Vega-, 2014). In the case of the valuation from 2012, the difference is that recovery costs are not estimated because the area is small; rather, the costs of removal of the works that cause the damage are estimated (Jiménez, Valoración del Daño Ambiental Area de Protección Quebrada Pilas Propiedad de Digna Prendas Loría, Candelaria de Naranjo-Alajuela, 2012).

In the case of the administrative proceedings regarding the damage caused by the Crucitas mining project, the practice in Costa Rica introduces new elements. Having declared in this judicial venue the unlawfulness of the permits and decrees that facilitated the start-up of the strip mining project, the Attorney General's Office requested the Ministry of the Environment (MINAE) to perform a valuation of the environmental damage caused by the clearing of trees and vegetation and the restoration costs, in order to have an idea of the liability that could eventually correspond to the State, according to the ruling, given that the regulations establish joint liability with the originator of the damage. Minister Castro engaged Fundación Neotrópica as an independent third party to perform the task (Aguilar, et al., 2012).

Since the valuation was requested to be performed within a short period of time, and the infringing company denied entry to inspect the properties, as the execution of the judgment phase was about to begin, a transfer of value methodology was chosen. An interdisciplinary team was put together, comprised of three ecological economists, one expert in political ecology, a technician in natural resource management, a tropical biologist, a sociologist and a technician in sustainable tourism. Satellite photos and an overflight were used to measure the change in land use in the project's area of operation, thus estimating the costs of losses of environmental services, which are added to the restoration costs documented by reviewing the literature and consultation to technicians of the Huetar Norte Conservation Area. A range of values is estimated with respect to the loss of environmental services, using the value transfer methodology and various scenarios of the net present value (NPV), projecting the flow of loss of environmental services to 10 and 25 years, with discount rates of 1%, 4% and 10%. The highest NPV, 25 years, with a discount rate of 1%, is $11.86 million. Along with a restoration cost of $159,449.75 gives a NPV of $11.88 million. Prudently, through the use of the median of the estimates in the range, a valuation with a 4% discount and 25-year projection of the NPV to recover environmental services is suggested. It amounted to $4.6 million dollars (Aguilar, et al., 2012).

In the execution phase of the judgment, an interdisciplinary group of expert witnesses, appointed by the court, at the request and recommendation of the applicant, performs a valuation with verification of the state of the properties through field inspections. The valuation takes several months, and results in an estimate of damage to 58 hectares, plus restoration costs and loss of felled timber of $6.4 million. This estimate was made with a discount rate of 3% and a projection of flow of services for the NPV to 50 years. The technical team had suggested a higher estimate, using a 0% rate of $10.4 million (Marozzi, Chacón, Alpizar, & Mata, 2012). The Court prudentially accepted the first in its ruling. This decision was appealed.

In sum, this study is based on the environmental services framework defined by the Millennium Ecosystems Assessment. The monetary estimation falls within the framework of the theoretical tool of the Total Value Equation, comprised of direct and indirect values of environmental goods and services, widely recognised by the theory of natural resource/environmental economy and ecological economy. Consequently, this method is accepted by the influential TEEB report by UNEP. Furthermore, it is a reference in the application of the economic valuation of wetland

ecosystems, as evidenced in the technical recommendations reports issued by the RAMSAR Convention.

The value of the damage is estimated using a mix of the methodologies prescribed by IPS, modified through the recent experience in Costa Rica and Latin America. Specifically, the estimation uses the direct valuation and shadow price methodologies. Furthermore, slow and quick methodologies are mixed with the necessary prescriptions indicated in the literature.

V- Estimation of the monetary value of the environmental damage caused in Isla Portillos, according to the facts ascertained in the Judgment of 16 December 2015

This chapter presents the process for valuation of the damage caused by the construction of the three *caños* in the territory of Isla Portillos, HCN, Costa Rica. First, the process for selection of ecosystem goods and services to be assessed in the monetary valuation of damage is presented, followed by the data collection process from the technical and legal sources available. Subsequently, the methodological specifications of the estimation are presented, to conclude with the presentation of the results.

A- Preliminary determination of the ecosystem goods and services included

The government of Costa Rica has expressed its wish to act with the good faith that is suggested by Court in its judgment when it gave the parties a prudent time to agree on the reparation of the material damage caused by the actions of the Government of Nicaragua in Isla Portillos between 2010 and 2013. To this end, three meetings were held by the valuation team, the SINAC technical team and the technical team of the Ministry of Foreign Affairs [of Costa Rica]. The framework of the ecosystem goods and services defined in the MEA, with the adaptations made by the RAMSAR Convention regarding wetlands, were used as the guiding framework for the classification of the effects in the area of the three *caños*.

Furthermore, we used the evaluation table for valuations presented in Table 4, from Liu et al. (2010), published in the Annals of the New York Academy of Sciences, in order to assess the potential for valuation, according to the prevailing doctrine, of those goods and services to be adequately assessed. Furthermore, in order to provide an adequate basis for valuation through value transfer of some of these goods and services affected, if necessary, we used the assessment made by that scientific publication of the transferability of valuations of such services.

Thus, it was agreed that the country would concentrate the valuation of damage in Isla Portillos on the environmental goods and services which, apart from being affected, had the most developed and credible experience regarding their potential for valuation and the highest transferability. Those which were affected but had a lower potential for valuation or less transferability are only mentioned. The result of this process in presented in Table 8.

To strengthen the selection, the relative magnitude of the services in the coastal wetlands ecosystem presented in Table 5 is included. We only modified the relative magnitude of the regulation service of the hydrological regime in view of the specific technical considerations of the Ramsar technical missions, which indicate the importance/magnitude of the service in the HCN, referring to the specific weather and hydrological regime of that area (Ramsar Secretariat, 2010).

Regarding provisioning services, in conformity with the high presence and ecological value of biodiversity in the area (Ramsar Secretariat, 2010) it was recognized that the area has perceptible stock or reserves. However, since it is a protected wildlife area with regulations regarding the possibilities of use, it cannot be said that there is a flow of service with regard to hunting, fishing, or gathering of edible plants. Since the wetland has mangroves (Araya & Mena, Informe de Gira. ACTo-GMRN-EPMF-364-2013, 2013; Monge, Jiménez, & Bonila, 2013), the permitted uses restrict fishing that is not artisanal fishing for domestic use, the harvesting of crustaceans and molluscs, etc. Thus, the technical team prefers to not consider this service among the due and therefore, chargeable damage.

Similarly, standing timber and fibre-based raw materials, with proven losses, can be recorded as losses in reserves. Although commercial use is restricted, these are national reserves for which there would at least be an option value, given that as its sovereign right the country could decide to use these materials in various situations, including emergencies. Thus, it was decided to account for this aspect both from the perspective of the standing timber lost and the estimation of the raw materials (comprised of fibres, energy and ornamental resources). A qualitative description and monetary quantification are performed.

Regarding the provisioning services derived from biodiversity (biochemical, medicinal), Costa Rica's experience in sustainable use has been widely documented from the perspective of extraction of samples within the framework of the biodiversity law, for information uses. This is the case of the HCN (ACTO-SINAC-MINAET, 2009). However, information resources and the time available could limit the individual quantification of this service.

We deemed it reasonable to assess the possibility of quantifying the loss from a perspective of flows, along with habitat and nursery services (biological regulation) and information/cultural, science and education. If the valuation of at least one of these categories is possible, having available data or reference studies, we can obtain an idea of the whole. This conservative decision was made even though it might lead to an undervaluation of such services. For pest and disease control and pollination, despite evident flows in the area, we were unable to find support in the technical reports to evidence the loss of those flows as a result of the damage.

Table 8- Preliminary selection of ecosystem goods and services for monetary valuation by the valuation team and the technical team of SINAC and the Costa Rican Ministry of Foreign Affairs. Source: Prepared by the authors.

Ecosystem goods or services	Ease of valuation	Transferability of the monetary value	Magnitude in the ecosystem	Perceptible reserve in the area	Perceptible /legal flow in the area	Verifiable loss due to damage	Qualitative description	Monetary valuation
Provisioning								
1. Food	High	High	High	Yes	No	No	No	No
2. Freshwater	High	Medium	None	No	No	No	No	No
3. Timber, combustible fibre and other raw materials.	High	High	Medium	Yes	No	Yes	Yes	Yes
4. Biochemical and medicinal resources	High	High	Low	Yes	Yes	Yes	Yes	Yes
5. Genetic materials	Low	Low	Low	Yes	Yes	Yes	Yes	No
6. Ornamental resources	High	Medium	Low	Yes	No	Yes	Yes	Yes
Regulating and supporting								
7. Air quality and gas regulation	Medium	High	Medium	Yes	Yes	Yes	Yes	Yes
8. Climate regulation	Low	High	Medium	Yes	No	No	No	No
9. Hydrological regime - recharging and discharging	High	Medium	Medium*	Yes	Yes	Yes	Yes	No
10. Natural hazards mitigation	High	Medium	High	Yes	Yes	Yes	Yes	Yes
11. Pollution control	High	Medium to High	Medium	Yes	No	No	No	No
12. Regulation of other wastes	High	Medium to High	?	Yes	No	No	No	No

Ecosystem goods or services	Ease of valuation	Transferability of the monetary value	Magnitude in the ecosystem	Perceptible reserve in the area	Perceptible /legal flow in the area	Verifiable loss due to damage	Qualitative description	Monetary valuation
13. Erosion control	Medium	Medium	High	Yes	Yes	Yes	Yes	Yes
14. Soil formation	Medium	Medium	Medium	Yes	Yes	Yes	Yes	Yes
15. Nutrient cycling	Medium	Medium	Medium	Yes	Yes	Yes	Yes	Yes
16. Pest and disease control	Medium	High	High	Yes	Yes	No	No	No
17. Biological control (control, habitat and nursery)	Medium	High	High	Yes	Yes	Yes	Yes	Yes
18. Pollination	Medium	High	High	Yes	Yes	No	No	No
Cultural and recreational								
19. Historic and spiritual	Low	Low	Low	Yes	No	No	No	No
20. Recreational	High	Low	Low	Yes	Yes	Yes	Yes	No
21. Aesthetic and artistic	High	Low	Low	Yes	Yes	Yes	Yes	No
22. Science and education	Low	High	Low	Yes	Yes	Yes	Yes	Yes

Similarly, although it is evident that the existence of a high biological diversity has a positive effect on the number of genetic resources of old-growth forests in complex ecosystems (Thorne, Assessment of the physical impact of works carried out by Nicaragua since October 2010 on the geomorphology, hydrology and sediment dynamics of the San Juan River and the environmental impacts on Costa Rican territory, 2011), the development and execution of techniques for their valuation and the low transferability of values from other sites would require a primary study with measurement of samples, which entails a high cost. Consequently, the team decided to not include this point in the valuation performed.

Drinking water is not quantified because there is no provision of public services in the affected area and because of the small number of houses in the nearest area, several of which were abandoned due to the border dispute conflict, which ended with the judgment of December 2015 (Monge, Jiménez, & Bonila, 2013).

Regarding regulating and supporting services, several groups of goods and services are assessed, due to the difficulty of performing a primary study for the valuation of services and stock considered affected and collectible. This is the case of the erosion control regulating services and soil formation and nutrient cycling supporting services.

Air quality and gas regulation services will be valued, as they are essential to the country's environmental goals. It was also determined that the natural hazards mitigation service is important to the area, the infrastructure and nearby towns, especially because these areas are highly vulnerable to the effects of climate change (ACTO-SINAC-MINAET, 2009; Monge, Jiménez, & Bonila, 2013). Thus, it was identified as a service that needs to be highlighted individually.

The remaining supporting, regulating and cultural goods and services will not be measured. Regarding the hydrological regime regulating service, the time and resources necessary for its valuation by means of slow methods, and the lack of recent studies in tropical coastal wetland areas led the valuation and the technical team to decide not to value it in spite of its importance. As in other cases, we opted for a qualitative description.

Regarding pollution control and other waste regulating services and the historical and spiritual cultural service, the team decided that the flows are not sufficiently perceptible in the area. This is not the case for aesthetic and recreational cultural services, which although not economically valued, were qualitatively described.

Since the damage was caused on separate dates, the estimations are segregated for each area affected. Thus, the estimations are separated for C2010 and CE2013. In each case, the name refers to the affected areas as a whole (deforested, cleared, physically opened *caño*, etc.). Regarding CO2013, as can be inferred from the technical tests its development was not significant (Secretaría de la Convención Ramsar, 2014), therefore Costa Rica decided not to file a pecuniary claim in this regard.

In sum, of the 22 categories of ecosystem goods and services considered, 10 were selected for preliminary consideration for their monetary valuation. A qualitative description of the damage will be provided for four other services, without monetary valuation. The remaining four will have neither. The

final assessment and selection is performed considering the availability of information necessary for the valuation of resources according to the methodologies most common in the literature, or, in its absence, adequate reference studies to apply the value transfer methodology. Damage is segregated according to the area affected in 2010 and in 2013, called C2010 and CE2013.

B- Evaluation of the availability of data and refinement of the estimation methodology

To adequately assess the balance between the required data and the need for valuation, the data requirements and direct and indirect monetary valuation methods that prevail in the literature were first determined. The results of this process are presented in Table 9. The most used methods are determined by complementing the information included in Table 4 with Ramsar's most recent guidance on the valuation of wetlands (De Groot, Stuio, Finlayson, & Davidson, 2007; Liu, Costanza, Farber, & Troy, 2010).

In view of the data requirements observed in Table 9, the goods and services that can be estimated with the data collected in the technical reports on the record are limited to the provision of timber and erosion control or soil formation. The time and resource requirements, and the difficult access to the area, make it impossible to estimate the value for the others.

Table 9- Methods most used in the literature and data required for the monetary valuation of the preselected ecosystem goods and services Source: Prepared by us.

Preselected goods or services	Most used method	Required data
Provisioning		
3. Timber	M, P	Volume, market prices, shadow prices
3. Fibres, fuels and other raw materials	M, P	Volume, market prices, shadow prices
4. Biochemical and medicinal resources	AC, RC, P	Medical costs or health costs
6. Ornamental resources	AC, RC, H	Cost of substitute decorative elements, effect on price of related goods (e.g. real estate) of the amenity created with the ornament.
Regulating and supporting		
7. Air quality and gas regulation	CV, AC, RC	Costa Rican's willingness to pay, cleaning costs, mitigation costs, greenhouse gas fixation rates, carbon pricing.
10. Natural hazards mitigation	AC	Avoided cost in the destruction of infrastructure and properties.
13. Erosion control	AC, RC, H	Volume of lost soil, costs of fertilization to replace nutrients, costs of recovery of the coastal erosion, market costs of land, costs of machinery to recover the lost soil, effect on the price of related goods (e.g. real estate) of the amenity created with uneroded soil.
14. Soil formation	AC	Volume of lost soil, market costs of land, costs of machinery to replace the lost soil.
15. Nutrient cycling	AC, CV	Volume of lost soil, costs of fertilization to replace nutrients, Costa Rican's willingness to pay.
17. Biological control	AC, M	Costs of application of agrochemicals or other methods to

Preselected goods or services	Most used method	Required data
(control, habitat and nursery)		regulate species that you wish to regulate, market value of selected species.
Cultural and recreational		
22. Science and education	RC, M	Expert opinions, information regarding scientific and educational revenue generated in the country and the region for the generated information.

AC, avoided cost (defensive); CV, contingent valuation; H, hedonic prices; M, market prices; P, productivity effects; RC, replacement cost; TC, travel cost.

In view of the circumstances, a search was conducted for potential reference studies for a value transfer exercise, complying with a number of requirements to prevent the risks and biases inherent to that methodology (Pascual, Muradian, Brander, Gómez-Baggethun, & Martín-López, 2010; Aguilar, et al., 2012). First, studies on similar ecosystems, i.e. tropical coastal wetlands (most of the literature is on mangroves) were looked for. Second, studies that are not prior to 2000. Studies which have used the most commonly used methods for the valuation of the good or service under discussion are selected (De Groot, Stuio, Finlayson, & Davidson, 2007; Liu, Costanza, Farber, & Troy, 2010). To the extent possible, only studies published in indexed journals with peer reviews are used. For grey literature, we use the review protocol followed by the NGO specialized in the valuation of ecosystem services, Earth Economics (http://www.eartheconomics.org/), to review the studies to be included in its global database of valuation studies. Furthermore, we only seek to transfer the value of goods or services with a high or medium ease of valuation, for which transferability of values is high or medium (Table 8). Also, when selecting the values and adjusting them to the site under consideration, this is performed according to the technical recommendations of the local valuation teams and technicians from SINAC and the Costa Rican Ministry of Foreign Affairs (Costanza, et al., 2014). The goods and services identified and the reference studies are presented in Table 10.

Table 10- Reference studies[1] for the value transfer that comply with the adopted specifications Source: Prepared by the authors.

Study	Good or service valued	Site of the study
Arguedas (2015)	Gas regulation	Gulf of Nicoya, Costa Rica
Barbier (2007)	Natural hazards mitigation	Thailand
Barbier, et. al. (2002)	Habitat and nursery Natural hazards mitigation	Thailand
Camacho-Valdez, et. al. (2014)	Fibre and energy raw materials Habitat and nursery Natural hazards mitigation	Gulf of Mexico, Mexico
Cooper, et. al. (2009)	Natural hazards mitigation	Belize
De la Peña, et. al. (2010)	Gas regulation	Ciénaga Grande Santa Marta, Colombia
Emerton (2005)	Soil retention	Coastal wetland ecosystems in Asia and Africa
Gómez (2001)	Gas regulation	Sabana Camagüey, Cuba

[1] The full list of the studies is presented in Appendix 1.

Study	Good or service valued	Site of the study
Mendoza-González, et. al. (2012)	Fibre and energy raw materials	Gulf of Mexico, Mexico
Samonte-Tan, et. al. (2007)	Habitat and nursery Soil retention	Bohol marine triangle, Philippines
White, et. al. (2000)	Fibre and energy raw materials	Olango island, Philippines

The existence of these studies enables the final selection of the various ecosystem services for purposes of the loss of ecosystem goods and services component of the environmental damage, according to the equation (5). The remaining goods and services for which a loss is evident in the technical reports but are not estimated will be included qualitatively, only as presented in Table 11.

In sum, of the 22 categories of ecosystem goods and services considered, the monetary valuation will be performed for six categories. Eight categories will be qualitatively described and eight will not be included in the losses accounting.

Table 11- Final selection of ecosystem goods and services for valuation and qualitative description, according to the data and resources available and the existence of reference studies Source: Prepared by the authors.

Ecosystem goods or services	Method to be used
Provisioning - to be valued	
Standing timber	Direct valuation and opportunity cost
Other raw materials (fibre and energy)	Value transfer
Regulating and supporting - to be valued	
Gas regulation	Value transfer
Natural hazards mitigation	Value transfer
Soil formation/erosion control	Replacement cost
Habitat and nursery (biodiversity)	Value transfer
Provisioning - to be described	
Biochemical and medicinal resources	Qualitative description of losses
Genetic materials	Qualitative description of losses
Ornamental resources	Qualitative description of losses
Regulating and supporting - to be described	
Hydrological regulation	Qualitative description of losses
Nutrient cycling	Qualitative description of losses
Cultural and recreational - to be described	
Recreational	Qualitative description of losses
Aesthetic and artistic	Qualitative description of losses
Science and education	Qualitative description of losses

Thus, equation 5 becomes:

$$(6) TC_t = RC_t + SC_t$$

where

TC: is the total monetary cost associated to the environmental damage in HCN due to the opening of artificial *caños*, clearing of trees and vegetation,

RC: is the restoration cost (used as indicator of the value of the biophysical damage) of the HCN area affected to its initial state of conservation, In this case, the method is recommended by the SINAC forestry technicians, with an intervention of at least three years.

SC: is the social cost, which depends on the loss of benefits from the six groups of ecosystem goods and services (selected as a representation of all of those provided by the ecosystem) generated by the effects on the state of conservation of the natural environment, and on the quality and quantity of flows of goods and services provided by the natural capital of the HCN area affected, to its initial state of conservation,

t: is the time that elapses until the HCN area affected returns to its initial state of conservation or, if not possible, to a state of recovery deemed sufficient.

Regarding the value of the flow of losses of the social cost over time, it is calculated in accordance with the standards of the net present value (NPV). Thus,

$$(7) SC_t = \sum_1^t BSE/(1+r)^t;$$

where

BSE: is the monetary value of the loss of benefits generated by the effects on the state of conservation of the natural environment and on the quality and quantity of flows of goods and services (selected as a representation of all of those provided by the ecosystem) provided by the natural capital of the HCN area affected, to its initial state of conservation,

r: is the discount rate used for the current value of the flow of ecosystem goods and services,

t: is the time that elapses until the HCN area affected returns to its initial state of conservation or, if not possible, to a state of recovery deemed sufficient.

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. This view has been opposed with the idea of a social discount rate that takes into account future social preferences. In environmental matters, the use of the discount has been accused of devaluating the future flows of environmental services. The ecological economist Clive Spash (1993) indicates that there is a correlation between the economic and epistemological perspectives. Using the discount rate entails a moral judgement. He indicates that a zero rate implicitly prevents environmental damage from being ignored in the future (Spash, 1993).

The TEEB report devotes a whole chapter to this topic. Summarizing the most important considerations, it is worth noting the difference between discount rates based on the perspective of an individual and discount rates based on a social preference where the responsibility toward future generations can be considered. Since a significant portion of the progress of current generations has been obtained by depleting natural capital reserves, the study calls for the use of low rates, including zero and negative

rates, depending on the time period involved, the degree of uncertainty, the ethical responsibility toward the world's poorest and the scope of the project or policy being evaluated. However, it calls for consideration of the macroeconomic implications of the rates chosen, apart from the microeconomic ones, given that a low discount rate for the entire economy in a development model such as the current one might favour more investment and growth and more environmental destruction. Due to the frequency of interdependent relationships between countries, this destruction can be transferred to poor areas in other countries, where the world's poorest are suffering disproportionately from the loss of ecosystems and biodiversity (Gowdy, Howarth, & Tisdell, 2010).

Costa Rican jurisprudence set a pioneering precedent in the execution phase of the judgment regarding the Crucitas environmental conflict. The independent appraisers' report established alternative discount rates of 4% and 0% in the valuation of the environmental damage caused in Crucitas de Cutris, northern Costa Rica, quite close to HCN (Marozzi, Chacón, Alpizar, & Mata, 2012). In its judgment, the Environmental Administrative Tribunal accepted a discount rate of 4% (Resolución 2015111438 de 24 de noviembre, 2015). We adopt the same approach in this study.

C- Compilation and methodological processing of the required data

Having selected the ecosystem goods and services, the data required for the monetary valuation was determined. This is identified in Table 12. It indicates the source used from the body of evidence.

As explained above, the estimation of the monetary value is fully based on the body of evidence described in Table 2. Similarly, the categories of goods and services to be presented qualitatively will be supported by the indicated sources.

Table 12- Location of the required data in the sources from the technical body of evidence on record to justify the monetary valuation or qualitative description Source: Prepared by the authors.

Ecosystem good or service affected	Required data	Source in the technical body of evidence
Provisioning - to be valued		
Standing timber	Inventory of trees felled, volume by area and measurement of the area of trees felled.	1, 2, 3, 5, 6, 7, 8, 11, 12, 13, 14.
Other raw materials (fibre and energy)	Area measurement and description of the elimination of vegetation in deforested and cleared areas.	1, 2, 5, 6, 7, 8, 9, 11, 12, 13, 14.
Regulating and supporting - to be valued		
Gas regulation	Area measurement and description of the elimination of vegetation in deforested and cleared areas.	1, 2, 5, 6, 7, 8, 9, 11, 12, 13, 14.
Natural hazards mitigation	Area measurement, description of the elimination of vegetation in deforested and cleared areas, total area intervened in *caños*, description of the hydrological impact on the area.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.

Ecosystem good or service affected	Required data	Source in the technical body of evidence
Soil formation/erosion control	Area measurement, description of the elimination of vegetation in deforested and cleared areas, total area intervened in *caños*, volume of soil removed.	1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.
Habitat and nursery (biodiversity)	Area measurement, description of the elimination of vegetation in deforested and cleared areas, information on species present in the area.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.

The estimate of the social cost component of the environmental damage requires two additional elements which are confirmed in the technically relevant facts presented in Table 2. First, the time period is required to calculate the net present value of the flow of ecosystem goods and services lost. In conformity with the methodological specifications of the framework for the valuation of environmental damage adopted, this time period is the time for recovery of the ecosystem to the state prior to the damage caused (Barrantes & Di Mare, Metodología para la evaluación económica de daños ambientales en Costa Rica, 2001). Based on the confirmed technical reports, that time is of 50 years, even though trees that were over 200 years old were cut down (Aguilar-Gonzalez, et al., 2011; MINAET, 2011; Thorne, Assessment of the physical impact of works carried out by Nicaragua since October 2010 on the geomorphology, hydrology and sediment dynamics of the San Juan River and the environmental impacts on Costa Rican territory, 2011). Supporting this judgment, the time period matches the time ruled as necessary in the report for valuation of environmental damage prepared by the expert witness team appointed by the Contentious Administrative Court for the Crucitas mining conflict that affected a tropical forest near the area in HCN subject to this case (Marozzi, Chacón, Alpizar, & Mata, 2012).

It is worth noting that the initial state of the areas affected corresponds to non-intervened areas with forests aged over 200 years, in a protected wildlife area in the case of C2010 and CE2013 and the cleared areas. This has been clearly established in the technical reports and in the judgment of the ICJ. In the case of CO2013 and other areas affected by sediments in Isla Portillos, the technical body of evidence established that there were areas with pastures managed by squatters or in non-consolidated possession (Thorne, Assessment of the physical impact of works carried out by Nicaragua since October 2010 on the geomorphology, hydrology and sediment dynamics of the San Juan River and the environmental impacts on Costa Rican territory, 2011; Monge, Jiménez, & Bonila, 2013).

Another important element to consider is the recommendation of restoration measures, which must be included as another element of the total value of the environmental damage. There are engineering restoration measures and direct and indirect restoration of the ecosystem in various sources of the technical documents mentioned (Ramsar Secretariat, 2010; Oreamuno & Villalobos, 2013; MINAE, 2014; Secretaría de la Convención Ramsar, 2014). It can be inferred from these recommendations that active restoration models would be advisable, not natural regeneration, due to the magnitude of the damage and the conditions of the area.

However, in Costa Rican forestry literature there are no specific cost models for the restoration of ecosystems in an area with the nature of the affected area and the type of damage caused (combining the clearing of trees and vegetation and the removal of significant amounts of soil). There are studies on the restoration costs of wetlands composed of different species, including yolillo *(Raphia taedigera)* and marillal, with a predominance of species such as cedro maría (*Callophylum brasiliense*), cerillo (*Symphonia globulifera*) and *Campnosperma panamense* where damage was caused by fire. This is the case of the Caño Negro Wildlife Refuge, located in northern Costa Rica, which is part of the complex of cross-border wetlands between Costa Rica and Nicaragua. The cost per hectare affected in this case was estimated at $929.21 including the repopulation of species, control, monitoring and infrastructure (Vega, Evaluación Económica del daño ambiental causado por los incendios forestales en Costa Rica, 2004; Montes de Oca Lugo, 2006). On the other hand there are models to establish the cost of forest plantations of native species with a maintenance model over 5 years developed for the northern area of Costa Rica. This model assumes fixed and variable costs per hectare of $2,169 (Ulate, 2010). Because of the amount of soil removed in the affected areas (9502.72 m^3), the replacement cost of soil lost due to the effects of dredging of the *caños* must be added to the model selected. The valuation team favours a conservative selection of the restoration cost taken from the *Caño Negro* Wildlife Refuge study, adding the soil restoration costs.

The processing of data was complemented by an overflight by the leader of the valuation team with two members of the SINAC technical team (Miguel Araya) and the Ministry of Foreign Affairs (Arnoldo Brenes) on May 31, 2016. They flew over the areas with clearing of trees, clearing of undergrowth vegetation and the *caños*. This exercise contributed to refining the criteria for compilation and processing of data for the valuation.

Data on the affected goods and services is processed according to the selected methodologies. To determine the monetary value of standing timber, the loss is quantified from the perspective of the eliminated stock and the growth potential of that stock from the moment of the damage to the preparation of this study. Thus, a value is presented for damage due to the loss of standing timber, national stock, resulting from the volume per hectare estimated in the technical studies and the area affected in C2010 and CE2013 (Araya, Appraisal al maximum average age of trees felled in primary forest areas in the Punta Castilla, Colorado, Pococí and Limón sectors of Costa Rica, as a result of the Nicaraguan Army´s occupation for the apparent restoration of an existing canal, 2010; Araya, Age approximation of trees cut in the Area under Costa Rica´s Environmental Management located on the causeway of the artificial channel built on a portion of territory of Calero Island to connect the San Juan River with los Portillos Lagoon, 2011; MINAET, 2011; Thorne, Assessment of the physical impact of works carried out by Nicaragua since October 2010 on the geomorphology, hydrology and sediment dynamics of the San Juan River and the environmental impacts on Costa Rican territory, 2011; Araya, Estimación preliminar de impactos en el extremo norte de Isla Portillos por la apertura de dos nuevos canales artificiales entre junio y setiembre de 2013, 2013; MINAE, 2014; Secretaría de la Convención Ramsar, 2014; Thorne, Written Statement. Dispute Concerning Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua), 2015). To calculate this the average price of standing timber per cubic metre is used for the inventoried species, according to the applicable publications of the National

Forestry Office closest to the facts of the corresponding years, translated into U.S. dollars (Salazar & Salas, 2009; Oficina Nacional Forestal, 2013). For those species for which a price is not indicated in that publication, the lowest prices published for the identified species that do have them were used. Those prices are indicated in Appendix 2. This same information is used for the growth potential during the time elapsed from the damage to date, named opportunity cost of forest growth (Delgado, 2007). The volume of standing timber per hectare used is 211 cubic metres, with a harvesting rate of 50%. Similarly, a growth rate of volume per hectare of 6 cubic metres per year is used, with the same harvesting rate.

Regarding the ecosystem service of soil formation/erosion control, the replacement cost is used. It is calculated by multiplying the volume of soil removed (MINAET, 2011; Thorne, Assessment of the physical impact of works carried out by Nicaragua since October 2010 on the geomorphology, hydrology and sediment dynamics of the San Juan River and the environmental impacts on Costa Rican territory, 2011; Araya, Estimación preliminar de impactos en el extremo norte de Isla Portillos por la apertura de dos nuevos canales artificiales entre junio y setiembre de 2013, 2013; MINAE, 2014) by the costs or excavations and earth movements by cubic metre published by the Costa Rican Association of Engineers and Architects (Colegio Federado de Ingenieros y Arquitectos de Costa Rica, 2007). This price was used by the expert witness team and was accepted by the Administrative Court and Civil Court of Finance in the execution of the judgment for the Crucitas Mining Conflict in Costa Rica (Marozzi, Chacón, Alpizar, & Mata, 2012; Resolución 2015111438 de 24 de noviembre, 2015). The initial calculations of the volume were refined with the help of SIG tools by the ACTO technical team (Araya, Entrevista sobre los Daños Ocasionados por la Construcción de los Caños Artificiales en Isla Portillos en los Años 2010 y 2013, 2016).

The ecosystem goods and services in the raw materials, habitat and nursery categories (biodiversity) are estimated through value transfer, calculating the mean of the values per hectare provided by the ecosystems studies in the reference studies, as performed by renowned studies (Costanza, et al., 1997; Costanza, et al., 2014). This value is multiplied by the hectares affected in C2010 and CE2013. In the case of raw materials, affected areas cleared but without removal of the trees were also included.

Regarding the loss of the environmental services of natural hazards mitigation, the value transfer is qualified by selecting a low value from the range of selected studies. This is performed given that as recorded in the technical reports and confirmed in the field visit, it is an area with low density of population, with nearby towns 4 kilometres away, few houses on the river meadows, some SINAC infrastructure on the Costa Rican side, and an airstrip on the Nicaraguan side (ACTO-SINAC-MINAET, 2009; Monge, Jiménez, & Bonila, 2013).

The specific situation of the ecosystem services of gas regulation and, consequently, air quality, deserve special mention. In spite of finding several reference studies, we chose to use as basis the calculations of the study concluded in 2015 by Maureen Arguedas at Centro Agrícola Tropical de Investigación y Enseñanza (CATIE) under the supervision of Dr. Miguel Cifuentes, main expert in Costa Rica on the estimation of carbon reserves in wetlands. This study has the advantage that it is based on the fixed carbon estimate of studies in Costa Rican wetlands, both in biomass and soils. Furthermore, it presents the stock by hectare and the annual fixation (flow) by hectare estimated for the mangrove areas of the Gulf of Nicoya (Arguedas, 2015). Because of the advantages of this level of specificity, and having

identified mangroves in the affected area (Araya & Mena, Informe de Gira. ACTo-GMRN-EPMF-364-2013, 2013), we opt to use these numbers to estimate both the lost stock and flows of this ecosystem service. Figure 9 shows us the mangrove area identified in the northern part of CE2013.

Having indicated the sources of the data used and how they were processed, the results are now presented. This exercise is divided into various sections, as explained below.

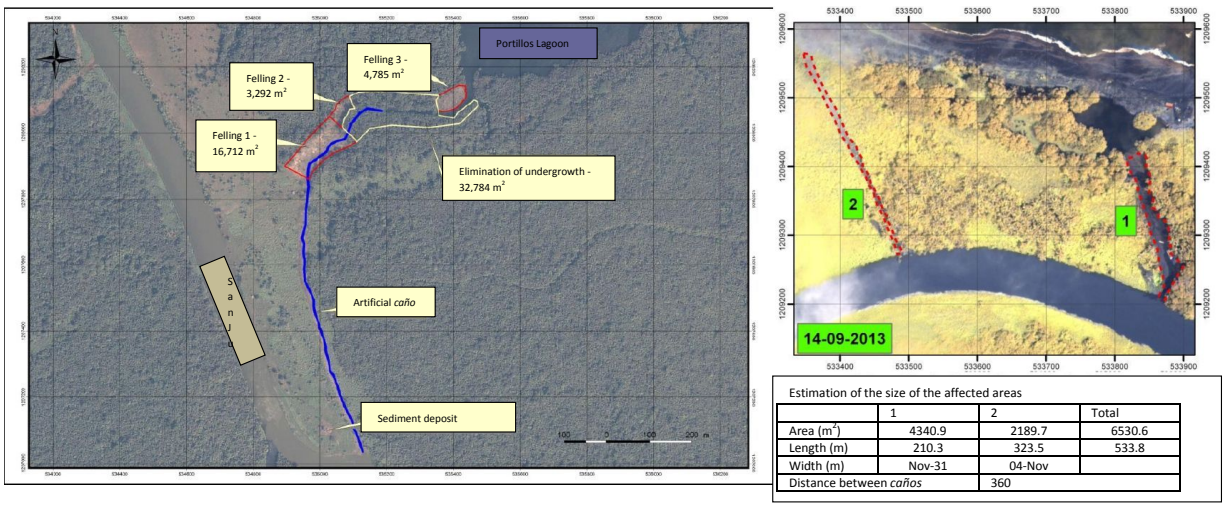
E- Results

The presentation of results is divided into two sections. The first presents the environmental damage due to the documented effects on ecosystem goods and services that cannot be valued monetarily. The second presents the monetary estimation of the environmental damage permitted by the available information.

The results are presented separately for C2010 and CE2013. The cleared area affected in 2010 is highlighted where appropriate. These are consolidated for the final sum of the monetary value of the environmental damage. As previously indicated, Costa Rica has chosen not claim the damage caused by the construction of CO2013, although they are documented in the body of evidence presented in Table 2.

Figure 9 – Photograph of the North End of CE2013, in which you can observe the presence of mangrove trees. Source: Araya & Mena (2013)

Figure 10 shows us the areas affected by the environmental damage in C2010, CO2013 and CE2013. The total area felled in C2010 is 2.48 hectares.



Estimation of the size of the affected areas

	1	2	Total
Area (m^2)	4340.9	2189.7	6530.6
Length (m)	210.3	323.5	533.8
Width (m)	Nov-31	04-Nov	
Distance between *caños*	360		

Figure 10- Areas affected by environmental damage in C2010 (left panel), CO2013 and CE2013 (right panel). Source: MINAET (2011) and Araya (2013).

The area of clearing of undergrowth, or cleared area, is 3.28 hectares in 2010. The area in CE2013 is 0.43 hectares. The total area affected is 6.19 hectares. In both areas a total of 9502.72 m^3 of soil were removed.

1- Environmental damage to ecosystem goods and services documented but not valued

As previously mentioned, a number of environmental goods and services categories have been identified for which losses can be confirmed through the existing technical reports, but for which the data is insufficient for a monetary valuation of the damage.

Table 13 provides the qualitative descriptions of the impacts identified on those ecosystem goods and services. It also includes the sources from the technical reports on record and additional bibliographical sources. This description shows that the monetary estimation is a relatively conservative and partial amount, based on the substantial value that can be perceived from such descriptions for the neighbouring communities, the country and the world. Subsequently, we present the estimation of the monetary value of the damage caused to the goods and services for which the available data allows quantification.

Table 13- Qualitative description of the ecosystem goods or services for which damage can be confirmed in the technical evidence on record but that cannot be valued. Source: Prepared by us.

Ecosystem goods or services	Description of the environmental and source
Provisioning	
Biochemical and medicinal	Documented impact of the loss of vegetation in large areas of wetland and primary forest (Ramsar Secretariat, 2010; Thorne, 2011; Secretaría de la Convención Ramsar, 2014; Thorne, 2015). The documented species present in the undergrowth vegetation of Isla Portillos include *Passiflora sp.*, known as passion flower (Monge, Jiménez, & Bonila, 2013). *Passiflora quadrangularis* has been documented by the *Herbario Nacional de Costa Rica* (Costa Rican National Herbarium) as having anti-diarrheic, decongestant and other uses (Quesada, 2008).
Genetic materials	Documented impact on fauna of the possible decrease in the successful breeding of marine species in the area's wetlands. This fauna is the most important in the area. In the ichthyic province of San Juan there are records of eight families, 25 genus and 54 species of freshwater fish, and at least 84 species of marine fish. Furthermore, it is worth noting the presence of regulated or endangered species, such as the manatee *(Tricherus manatus)* or hammerhead shark *(Sphyrna lewini)* (Ramsar Secretariat, 2010; Thorne, 2011; Monge, et al., 2013; Thorne, 2015).
Ornamental resources	Documented impact of the loss of vegetation in large areas of wetland and primary forest (Ramsar Secretariat, 2010; Thorne, 2011; Secretaría de la Convención Ramsar, 2014; Thorne, 2015). The documented species present in the undergrowth vegetation of Isla Portillos include ferns, orchids and bromeliads, widely used for ornamental purposes (Monge, et al., 2013).
Regulating and supporting	
Hydrological regulation	Reported impacts on the following elements of the physical and hydrological systems: surface water hydrology, surface water drainage network, changes in the surface and ground water, aquifers, alteration of the freshwater-saltwater interface, etc. (Ramsar Secretariat, 2010; Thorne, 2011; Secretaría de la Convención Ramsar, 2014; Thorne, 2015).
Nutrient cycling	Reported effects on the wetland's sediment balance. The increase in the sediment flow to certain areas alters the nutrient balance, affecting the trophic state of the lagoons. This type of disturbance can cause an unbalance in the food chain, thus considerably affecting the food sources of the inhabitants. (Ramsar Secretariat, 2010; Thorne, 2011; Secretaría de la Convención Ramsar, 2014; Thorne, 2015).
Cultural and recreational	
Recreational	Reported effects on the area's tourism potential (Aguilar-Gonzalez, et al., 2011; Thorne, 2011). Tourism activity is reported in the area, though emerging and irregular, of national tourists who camp in the freshwater areas, for fishing and recreational purposes. The inhabitants of the area have cabins where they receive them and also provide water transport (Monge, et al., 2013).
Aesthetic and artistic	Documented effect on the aesthetic value of the area due to the fragmentation of habitats and the blocking of biological corridors in the wetland, as it results in a loss of spatial continuity previously observed in the vegetation formations in the area (Ramsar Secretariat, 2010; Thorne, 2011; Secretaría de la Convención Ramsar, 2014; Thorne, 2015).
Science and education	Losses and changes in the ecosystem affect the possibility of usage of this value in areas where it is occurring in the country. For example, there is a

Ecosystem goods or services	Description of the environmental and source
	growing interest in the study and documentation of the uses of the predominant species in the area, such as yolillo *(Raphia taedigera)* (Calvo-Gutiérrez, et al., 2013). Similarly, the *Instituto Nacional de Biodiversidad* (National Biodiversity Institute) has fed its databases with data on scientific knowledge of species from the area (Monge, et al., 2013).

2- Estimated monetary value of the environmental damage

Table 14 presents the estimate of the monetary value component of the social cost (loss of ecosystem goods and services) of the environmental damage caused in the affected areas of C2010 and C2013, due to the clearing of trees and vegetation and removal of soil, including areas where only vegetation was removed, for the first year of alteration of the ecosystem. Furthermore, the net present value calculation is made for the social cost to 50 years, with a discount rate of 4%.

The estimation data shows that the highest monetary values for damage in C2010 and CE2013 correspond to the loss of the greenhouse gas fixation service, loss of the soil formation and erosion control service, and the stock of standing timber and opportunity cost of forest growth. This is the result of the process of clearing of trees and excavation of *caños* that took place in that area (confirmed in images such as those presented in Figure 11) and the great capacity of wetlands in coastal areas for carbon fixation not only in the biomass but also in its soils (Cifuentes, 2012; Sepúlveda-Machado & Aguilar-González, 2015; Arguedas, 2015).

Figure 11 shows us the consequences of the clearing of trees and vegetation and excavation of *caños* that led to the values established. This helps us to understand the relationship between the monetary value and the magnitude of the damage caused.

Figure 11- Image comprising several photos included in the records which evidence the damage caused by the clearing of trees and vegetation and dredging of C2010 and CE2013. Source: Technical reports included in Table 2.

Figure 12 shows the SC over time for C2010 and CE2013 from the first year up to 50 years, documented term for minimum recovery of the ecosystem's ability to provide the ecosystem services lost. Apart from the economic-financial requirement, this estimate illustrates the possibility of a progressive decrease in the value of the monetary loss as the ecosystem services are gradually recovered.

Table 14- Monetary value of the social cost (loss of ecosystem goods and services) of the environmental damage caused in the affected areas of C2010 and CE2013. Source: Prepared by the authors.

Ecosystem good or service	Affected area	Amount and reference unit of the loss	Monetary value by unit[2]	• Estimated total of the loss in U.S. dollars (2016)
Provisioning				
Standing timber (Includes the opportunity cost of forests, OCF)	C2010	211 m^3/ha for standing timber with a 50% harvesting rate and OCF of 6 m^3/ha per year of growth with a 50% harvesting rate in 2.48 ha	$64.65	$19,558.64
	CE2013	211 m^3/ha for standing timber with a 50% harvesting rate and OCF of 6 m^3/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
Regulating and supporting				
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	$1,280.19
Soil formation/erosion control	C2010	Replacement cost of 5,815 m^3 of removed soil (collection and transport)	$5.87	$33,610.69
	CE2013	Replacement cost of 3687.72 m^3 of removed soil (collection and transport)	$5.87	$21,315.00
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
Total SC First year	C2010			$100,028.04
	CE2013			$31,388.38
Total SC 50 years	C2010			$2,148,820.82
	CE2013			$674,290.92

[2] The different values weighted are included in Appendix 3.

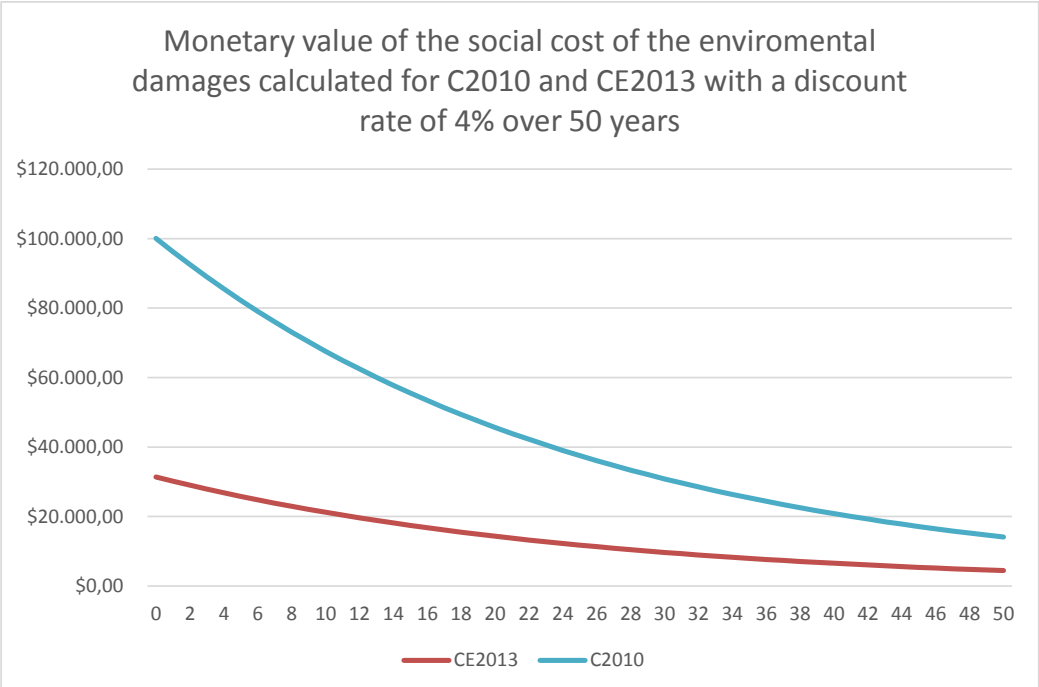


Figure 12- Monetary value of the social cost of the environmental damage calculated for C2010 and CE2013 with a discount rate of 4% over 50 years. Source: Prepared by the authors.

The value for restoration of the wetland, according to the previously stated assumptions (cost of $929.79 per ha for restoration cost of a wetland in the Costa Rica-Nicaragua cross-border wetland area) is $2,304.86 for C2010 and $403.53 for CE2013, for a total of $2,708.39. The total value of the replacement of the dredged soil is, in conformity with the above estimates, $33,610.69 for C2010 (due to the removal of 5,815 m3 of soil) and $21,315.00 (due to the removal of 3,867.72 m3 of soil) for CE2013. This adds up to a grand total restoration cost for the affected area of $57,634.08.

Thus, the monetary calculation of the environmental damage according the assumptions, the ecosystem goods and services in the affected area that can be valued and the methodologies presented is as follows:

$$(7) TC_t = \$57{,}634.08 + \$2{,}823{,}111.74 = \$2{,}880{,}745.82.$$

As previously indicated, this estimate is conservative since the inventory of ecosystem goods and services used is partial. We provide our conclusion below.

VI- Summary and conclusion

This report has performed a monetary valuation of the environmental damage caused by the actions confirmed by the International Court of Justice in its final and definitive judgment on the activities ordered by the Government of Nicaragua in the *Humedal Caribe Noreste*, through the opening of three *caños* and clearing trees and vegetation in 2010 and 2013. To perform this estimation the facts ascertained by the Court and the technical reports available for purposes of the valuation were first examined.

The methodological framework for the valuation was defined by developing three elements accepted in the most recent literature. First, the use of the ecosystem services framework recognized by the Millennium Ecosystems Assessment was defined. This framework organizes ecosystem services into four groups: provisioning, regulating, supporting and cultural/information services. This allows organizing and systematically choosing the ecosystem goods and services to be valued.

As a second element for the theoretical framework we adopt the Total Economic Value (TEV) accepted by the state of art as adequate to combine the direct and indirect values of ecosystem goods and services arising from consumptive, sale, and non-consumptive use values and option values. This part of the framework established the most appropriate and most used methods for the valuation of the elements that constitute the TEV, from a direct valuation perspective (using market prices) and indirect valuation (using shadow prices, surveys, etc.). It also introduced the option of using quick value transfer valuation methods when the conditions require it or with the methodological precautions indicated by the most recent literature.

The application of these instruments within the prevailing framework for the estimation of environmental damage in Costa Rica, with applications in other countries in Latin America, was discussed. This method, initially developed by Barrantes and Di Mare (2001), includes elements of environmental damage such as restoration costs, reparation for biophysical damage and the social costs of losses in the flow of ecosystem goods and services. This flow must be estimated until the full recovery of the ecosystem element which takes the longest. Several applications of the selected methods in Latin America which show its evolution and prevalence for purposes of this technical report were presented.

Ecosystem goods and services whose impact due to the damage can be quantified monetarily according to the technical information available were selected. The provisioning services of standing timber and other raw materials were included. The regulating and supporting services of gas regulation/air quality, natural hazards mitigation, soil formation and soil retention, and habitat and nursery services were also included. Furthermore, we selected those services for which losses can be documented qualitatively based on the technical information available. This selection included several categories of provisioning, regulating, supporting and cultural/information services. The full selection made was conservative and this is how the results should be interpreted, given that with more available resources several groups of ecosystem goods and services could have been selected and their loss quantitatively measured.

The monetary value of environmental damage was estimated through a mix of direct valuation, replacement cost and value transfer methodologies. A term of 50 years for the recovery of the damage to the ecosystem, as defined by the technical reports on record, was determined.

The areas of the damage included were also confirmed in the technical reports as 2.48 hectares of clearing of trees and 3.28 hectares of clearing of undergrowth in the area of the *caño* built in 2010, denominated *Caño Pastora* (C2010). In this area the soil removed due to dredging was 5,815 cubic metres. Regarding the area affected in 2013, only the damage caused in one of the two *caños* was taken into account, the one named *Caño Este* (CE2013). The affected area of that *caño* measures 0.43 hectares, and 3,687.72 cubic metres of soil were removed. The area of *Caño Oeste* (CO2013) is 0.22 hectares.

The restoration costs were estimated based on an estimation model applied in the *Refugio de Vida Silvestre Caño Negro* (Caño Negro Wildlife Refuge), which is part of the complex of cross-border wetlands between Nicaragua and Costa Rica. To the value per hectare estimated in that model we added collection and transport costs as an approximation of the replacement cost of the amount of soil removed in the affected areas.

Thus an estimate of the monetary value of environmental damage of $2,880,745.82 was obtained. This estimate is composed of restoration costs in the amount of $57,634.08 and a social cost of $2,823,111.74 related to the loss of stock and flows of ecosystem services, estimated with a recovery term of 50 years, with an environmental discount rate of 4%.

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Appendix 1: List of the studies used for the estimations based on the value transfer methodology

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Appendix 2: Standing timber prices used

Table 15- Species present in *Caño Pastora* and compiled prices. Source: Prepared by the authors with data from the National Forestry Office as of 2009

Species		Vernacular	Price pmt-p colones ONF 2009	Price m3-p colones
Caesarea	*Sp*	Cesarea	₡90.00	₡32,580.00
Ceiba	*pentandra*	Ceiba	₡90.00	₡32,580.00
Unknown	*Unknown*		₡90.00	₡32,580.00
Grias	*cauliflora*	Tabacón	₡90.00	₡32,580.00
Inga	*Sp*	Guabilla	₡90.00	₡32,580.00
Lonchocarpus	*Sp*	Chaperno	₡90.00	₡32,580.00
Mimosaceae	*Mimosaceae*		₡90.00	₡32,580.00
Pachira	*aquatica*	Popenjoche	₡90.00	₡32,580.00
Pentaclethra	*macroloba*	Gavilán	₡93.00	₡33,666.00
Pterocarpus	*officinalis*	Sangrillo	₡90.00	₡32,580.00
Simira	*maxonii*	Guaitil Colorado	₡90.00	₡32,580.00
Spondias	*mombin*	Jobo	₡90.00	₡32,580.00
Symphonia	*globulifera*	Cerillo	₡90.00	₡32,580.00

Table 16- Species present in *Caño Pastora* and compiled prices. Source: Prepared by the authors with data from the National Forestry Office as of 2013

Species		Vernacular	Precio pmt-p colones ONF 2013	Precio m3-p colones
Caesarea	*sp*	Cesarea	₡50.00	₡18,100.00
Ceiba	*pentandra*	Ceiba	₡50.00	₡18,100.00
Unknown	*Unknown*		₡50.00	₡18,100.00
Grias	*cauliflora*	Tabacón	₡50.00	₡18,100.00
Inga	*sp*	Guabilla	₡50.00	₡18,100.00
Lonchocarpus	*sp*	Chaperno	₡50.00	₡18,100.00
Mimosaceae	*Mimosaceae*		₡50.00	₡18,100.00
Pachira	*aquatica*	Popenjoche	₡50.00	₡18,100.00
Pentaclethra	*macroloba*	Gavilán	₡105.00	₡38,010.00
Pterocarpus	*officinalis*	Sangrillo	₡50.00	₡18,100.00
Simira	*maxonii*	Guaitil Colorado	₡50.00	₡18,100.00
Spondias	*mombin*	Jobo	₡60.00	₡21,720.00
Symphonia	*globulifera*	Cerillo	₡50.00	₡18,100.00

Appendix 3: Weighted monetary values for the value transfer

Ecosystem good or service	Study	Value per hectare	Area of the study
Raw materials (fibre and energy)	Camacho-Valdez, V. et al. (2014)	$467.94	Gulf of Mexico, Mexico
	Mendoza-Gonzalez, G. et al. (2012)	$2.02	Gulf of Mexico, Mexico
	White, Ross & Flores (2000)	$57.31	Olango Island, Philippines
Habitat and nursery	Camacho-Valdez, V. et al. (2014)	$2.02	Gulf of Mexico, Mexico
	Samonte-Tan, et. al. (2007)	$292.45	Bohol Marine Triangle, Philippines
	Barbier, et. al. (2002)	$109.66- $4,432.19	Thailand
Gas and climate regulation	Arguedas (2015)	$14,955.23 (stock) $15.56- $38.10 (flow)	Gulf of Nicoya, Costa Rica
	Gómez (2001)	$105.11- $512.41	Sabana Camagüey
	De la Peña, et. al. (2010)	$116.04- $3,367.07	Cienaga Grande Santa Marta, Colombia
Natural hazards mitigation	Camacho-Valdez, V. et al. (2014)	$3,731.38	Gulf of Mexico, Mexico
	Cooper, et. al. (2009)	$7,282.72	Belize
	Barbier (2007)	$11,615.69	Thailand
	Barbier, et. al. (2002)	$2,949.74	Thailand

Annex 2

Fundación Neotrópica,

"Explanatory addenda to the Report '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

8 December 2016

English translation

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CRECIENDO COMO LA NATURALEZA

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

I - Clarification regarding the process of monetary valuation of the ecological or ecosystem services

The process for selection of the ecosystem services to be accounted for as losses in the monetary valuation of the environmental damages was meticulously performed, within the available timeframe and in conformity with the technical information on record that confirmed the damages. To this end the report describes the technical environmental background that supports the valuation, specifically citing the documents and relevant inputs with their specific location (as summarized in Table 2). We highlight the technically-relevant facts that support the documented losses. The ascertained facts and technical evidence on record provide the causal link of the claimed damages.

These technical facts, ascertained by the Judgment of the Court, are supported by professionals in biology, forestry, hydrogeology and specifically wetlands, as included in the case records: Professor Colin Thorne (U. of Nottingham, United Kingdom), SINAC technicians (Costa Rica), technical personnel of the RAMSAR Secretariat, technical personnel from CIEDES (UCR, Costa Rica), etc.

They were also discussed and assessed by the technical team that worked on the report, which includes three professionals in environmental sciences, part of the team of Fundación Neotrópica, an organization with over thirty years of experience in fieldwork in Costa Rican protected areas and ecosystems. This discussion and assessment included continuous feedback from the technical personnel of the Tortuguero Conservation Area, the bio-geographical conservation unit in charge of Humedal Caribe Noreste, where Isla Portillos is located. The process of verification of the current status included an aerial inspection by means of an overflight with personnel from the Ministry of Foreign Affairs, the Conservation Area and Fundación Neotrópica.

Furthermore, we structured both the claimed services and the available methodologies according to the international state of the art on the monetary valuation of ecosystem services and environmental damages, not only to have clarity regarding the methods used but also in order for the assessment of the ecosystem functions involved to be comprehensive, avoid redundancy and maintain proportionality with the ascertained damages. This process included the key component of reviewing the application on coastal wetland ecosystems commissioned by the RAMSAR Convention itself, to have a perspective on the specific application to those ecosystems and its challenges. Furthermore, we documented the applications made in Latin America and specifically in Costa Rica, which, as confirmed by the Court's ruling, has sovereignty over the territory where the damages occurred. In this process the technical preparation of the professional who led the report includes education and extensive experience in environmental law, environmental economy and ecological economy, both nationally and internationally.

Based on this body of evidence, and with a highly selective spirit, we performed a preliminary selection of ecosystem goods and services for which losses were ascertained in the Judgment, to be considered for the valuation (Table 8). We took into consideration the parameters established in international literature regarding the ease of performing the valuation of those goods and services, the transferability of the estimated monetary values from similar ecosystems located in other sites, the magnitude of the presence in the area of the damages, the perceptible reserves and flows therein, and the extent to which it is possible to verify the loss due to the damages caused and

ascertained in the judgment according to the opinion of the environmental technicians and legal experts consulted. We thus arrived at a list of 11 categories of preselected goods and services.

This preliminary determination was subjected to a thorough examination of the data available to perform the valuation according to the most accepted methodologies and their reliability. In accordance with the good faith of the Government of Costa Rica, only six (6) categories were selected for valuation of the attributable damage and eight (8) categories to be presented as a qualitative description. Of these services, the valuation of standing timber and soil formation/erosion control was performed through direct valuation, opportunity cost and replacement cost. These constitute approximately 60% of the base estimate. It is worth noting here an error in the original report; however, it does not affect the calculations. Table 16 was named "Species present in *Caño Pastora* and compiled prices". The correct name should have been "Species present in *Caño Este* 2013 and compiled prices". The species are the same and the table tries to show the price levels used for the calculation of the monetary value in 2013 when CE 2013 was excavated, which are different from those used in 2010 when *Caño Pastora* was excavated.

The three other categories (raw materials, gas regulation, natural hazard mitigation, habitat and nursery) were estimated using the value transfer methodology, from similar sites. Rigorous parameters were used in the selection process to comply with that recommended in the technical literature, so that the base studies used the most recognized studies and for the transferability of the service to be medium or high (Table 8). Furthermore, as established in page 46 of the report[1]:

> "… First, studies on similar ecosystems, i.e. tropical coastal wetlands (most of the literature is on mangroves) were looked for... To the extent possible, only studies published in indexed journals with peer reviews are used. For grey literature, we use the review protocol followed by the NGO specialized in the valuation of ecosystem services, Earth Economics (http://www.eartheconomics.org/), to review the studies to be included in its global database of valuation studies... Also, when selecting the values and adjusting them to the site under consideration, this is performed according to the technical

[1] Translator's note: This page number refers to the English translation. It corresponds to page 48 of the original Spanish.

recommendations of the local valuation teams and technicians from SINAC and the Costa Rican Ministry of Foreign Affairs (Costanza, et al., 2014)."

Consequently, the studies selected and presented in Table 10 comply with that indicated by UNEP in its study "The Economics of Ecosystems and Biodiversity", which defines the state of the art on this matter.

It is also worth noting that for each of the categories of goods and services included in the valuation, in Table 10, its grounds and causal link to the facts ascertained by the Court are confirmed in conformity with the sources listed in the column "Source in the technical body of evidence" in reference Table 2.

II - Clarification regarding the accuracy of the value transfer methodology and the adequacy of the transferred values

The value transfer method is used to estimate the lowest percentage of the selected categories, and it is performed with all due thoroughness, reviewing the base studies (their methodology, whether they are current and their location) and the transferability of the values in the specific category of ecosystem goods and services. Specifically, the base studies given preference are mainly from coastal wetlands in Costa Rica, Central America and the Caribbean, with exceptions justified in that we sought to obtain a more conservative and accurate valuation.

We quote page 52 of the report[2] and expand on this. "The ecosystem goods and services in the raw materials, habitat and nursery categories (biodiversity) are estimated through value transfer, calculating the mean of the values per hectare provided by the ecosystems studies in the reference studies, as performed by renowned studies (Costanza, et al., 1997; Costanza, et al., 2014). This value is multiplied by the hectares affected in C2010 and CE2013. In the case of raw materials, affected areas cleared but without removal of the trees were also included.

[2] Translator's note: This page number refers to the English translation. It corresponds to page 55 of the original Spanish.

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Regarding the loss of the environmental services of natural hazards mitigation, the value transfer is qualified by selecting a low value from the range of selected studies. This is performed given that as recorded in the technical reports and confirmed in the field visit, it is an area with low density of population, with nearby towns 4 kilometres away, few houses on the river meadows, some SINAC infrastructure on the Costa Rican side, and an airstrip on the Nicaraguan side (ACTO-SINAC-MINAET, 2009; Monge, et al., 2013).

The specific situation of the ecosystem services of gas regulation and, consequently, air quality, deserve special mention. In spite of finding several reference studies, we chose to use as basis the calculations of the study concluded in 2015 by Maureen Arguedas at Centro Agrícola Tropical de Investigación y Enseñanza (CATIE) under the supervision of Dr. Miguel Cifuentes, main expert in Costa Rica on the estimation of carbon reserves in wetlands. This study has the advantage that it is based on the fixed carbon estimate of studies in Costa Rican wetlands, both in biomass and soils. Furthermore, it presents the stock by hectare and the annual fixation (flow) by hectare estimated for the mangrove areas of the Gulf of Nicoya (Arguedas, 2015). Because of the advantages of this level of specificity, and having identified mangroves in the affected area (Araya & Mena, 2013), we opt to use these numbers to estimate both the lost stock and flows of this ecosystem service. Figure 9 shows the mangrove area identified in the northern part of CE2013.

Thus, Table 14 presents the values transferred in the categories of other raw materials, gas regulation/air quality, natural hazards mitigation, habitat and nursery (biodiversity). The monetary value of the service lost per hectare per year is presented in the table. The transferred values are included in appendix 3, as stated in note 2. The complete references of the studies are included in appendix 1.

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The other raw materials are estimated from the average values of studies in the Mexican Pacific and Caribbean and in the Philippines. All of the values are from coastal tropical wetlands with presence of mangroves. It includes three published studies with peer reviews. Note that this is an environmental service that is highly adequate for economic valuation and has a high transferability of values (Tables 4 and 8).

Another unintended error that does not affect the results should be noted here. In Appendix 3, the area of the study of Camacho-Valdez should read "Gulf of California, Mexico".

For gas regulation and climate regulation we used the study by Arguedas in the coastal wetlands of the Gulf of Nicoya in the Costa Rican Pacific. The monetary value considers adding the value of the stock and the average value of the flow by hectare. Note that this is an environmental service with a high transferability of values (Tables 4 and 8).

For natural hazards regulation we chose a more conservative approach, as mentioned in the text, given that the area of Isla Portillos has a low density of population. Thus, we used the lowest value identified in the studies that qualified within the desired time range and performed in coastal wetland ecosystems with the presence of mangroves: Barbier et. al., 2002 from Thailand. Note that this is an environmental service with a medium transferability of values (Tables 4 and 8).

The values of the habitat and nursery services are estimated from the average of the studies indicated in Appendix 3 of coastal wetlands with the presence of mangroves in Mexico, Philippines and Thailand. Note that this is an environmental service with a high transferability of values as well (Tables 4 and 8).

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III - Clarification regarding the 50-year projection adopted (instead of another duration)

As indicated in page 50 of the report[3]:

> The estimate of the social cost component of the environmental damage requires two additional elements which are confirmed in the technically relevant facts presented in Table 2. First, a time period is required to calculate the net present value of the flow of ecosystem goods and services lost. In conformity with the methodological specifications of the framework for the valuation of environmental damages adopted, this time period is the time for recovery of the ecosystem to the state prior to the damage caused (Barrantes & Di Mare, 2001). Based on the confirmed technical reports, that time is of 50 years, even though trees that were over 200 years old were cut down (Aguilar-Gonzalez, et al., 2011; MINAET, 2011; Thorne, 2011). Supporting this judgment, the time period matches the time ruled as necessary in the report for valuation of environmental damages prepared by the expert witness team appointed by the Administrative Environmental Court for the Crucitas mining conflict that affected a tropical forest near the area in HCN subject to this case (Marozzi, et al., 2012) It is worth noting that the initial state of the areas affected corresponds to non-intervened areas with forests aged over 200 years, in a protected wildlife area in the case of C2010 and CE2013 and the cleared areas. This has been clearly established in the technical reports and in the judgment of the ICJ.

It can be seen that the Costa Rican claim, although it could have justified a longer time since damages were ascertained to trees over 200 years old, in good faith adopts a reasonable term for the recovery of the ecosystem flows affected, in conformity with the causal link established on record.

[3] Translator's note: This page number refers to the English translation. It corresponds to page 53 of the original Spanish

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We expand on that specific reasoning below. Our report states on p. 31[4]:

> …for purposes of estimating restoration costs it is necessary to identify the state of conservation of the natural resources affected and the degree of the effects thereon. Knowing the state of conservation prior to the disruption, it is possible to determine the estimated time for restoration of the resource, which shall result in a more correct approximation of the economic costs that it will entail. Specifically, the methodology developed to estimate the restoration cost is a function of the inputs required and time for restoration of the natural resources affected to the conditions before the disturbance. Since the action may affect one or more resources, the time for restoration must correspond to the resource with the longest recovery time (Barrantes & Di Mare, 2001; Vega, 2004).

According to the reports presented by Costa Rica, the longest time could have been over 200 years, since there were trees in the areas affected that went beyond this age. This would have defined a much longer time for the projection and, therefore, a much larger amount to claim. However, the estimate here also adopted a very conservative approach, in good faith.

Therefore, our estimate sought a time frame that would guarantee that the growth of the trees in the area would be enough so as to ensure that all ecosystem services valued would be restored. We resorted to two sources/criteria to justify this.

1- The valuation reports that were accepted in the Crucitas court case in forested areas that have some similar characteristics in terms of the climate conditions and other ecosystem features and is roughly 70 km away, almost on a straight horizontal line to the site of Isla Portillos. Specifically, we looked at the method suggested by the report *"Evaluación del daño al bosque afectado por la empresa Industrias Infinito en Crucitas de Pocosol, Alajuela"* (Evaluation of the damages to the forest affected by the company Industrias Infinito in Crucitas de Pocosol, Alajuela) written by a multidisciplinary team of natural scientists.

[4] Translator's note: This page number refers to the English translation. It corresponds to pages 32-33 of the original Spanish.

They suggest determining the time needed for the recovery in the deforested area by estimating the average age of the trees in the plot. They estimated this average age and the percentage of trees that were beyond certain ages. Their averages (for the areas measured) were 112 and 83 years. Of the trees in one area, 50% were over 45 years old and in the other over 55 years old. Based on these age estimates, they recommend an estimate of the recovery time for ecosystem services to be no less than 50 years which may be the age needed for the forest to recover the structure, richness and species composition at the time of the damage. (Chacón, et al., 2012). This report was accepted by the Costa Rican court that has made the first instance decision on the Crucitas conflict and was the basis for the monetary valuation of damages that was accepted by that same court in 2015.

In our case, the average age of the trees in the deforested area, as measured for Caño Pastora by SINAC and confirmed by Dr. Colin Thorne, was 115 years. Of the trees in the deforested area, 66% were over 50 years old, 55% over 75 years old, and 46% over 100 years old. It is worth noting that, as indicated on record, the tree estimate for CO2013 and CE2013 accepted by the International Court of Justice was based on the inventory for Caño Pastora.

2- Dr. Colin Thorne had already stated in the records of the proceedings that tree diameters are a good estimate for tree age (Memorial of Costa Rica, Vol. 1 pp. 365). In his report he estimated the growth rate to be between 4 and 6 mm per year in diameter. If we assume a mean growth rate of 5 mm, a minimum of 50 years would mean that the trees in the area would have approximately 25 cm in diameter and heights above 20 meters. We consulted with the natural scientists in our team and SINAC's technical team if this seemed a reasonable minimum parameter for the forest in the wetland to continue providing the ecosystem services claimed in the monetary estimation presented.

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IV - Clarification regarding the selection of a discount rate of 4%

We clarify that already indicated in the report. Costa Rican jurisprudence set a pioneering precedent in the execution phase of the judgment regarding the Crucitas environmental conflict. The independent appraisers' report established alternative discount rates of 3% and 0% in the valuation of the environmental damage caused in Crucitas de Cutris, northern Costa Rica, quite close to HCN (Marozzi, et al., 2012). In its judgment, the Administrative Court accepted a discount rate of 3% (Resolution No. 2015111438 of 24 November 2015). In this same conflict, the valuation report of Fundación Neotrópica adopted a slightly more conservative rate, in close range of 4% for a report prepared for the Ministry of the Environment at request of the Attorney General's Office (Aguilar, et al., 2012). We adopt this approach in this study.

This decision is based on recent literature regarding the specific rates to use. The TEEB report states that different social rates of discount should be used for different scenarios, using a zero discount rate in cases of investments for environmental sustainability and other rates for other cases of public investment (Vardakoulias, 2013).

A lead economist in Synapse Economics, Dr. Liz Stanton, summarised in 2010 the situation regarding the discount rates used, stating that current conventional wisdom calls for a discount rate that is somewhat like the short-term "risk-free" interest rate (3 to 5%) for calculating the worth today of values that will exist sometime within the next 20 or 30 years and slightly lower for longer term horizons (Stanton, 2010). More conservatively, the Obama administration recommended of a 2.5-3 and a 5% discount rate to determine the social cost of carbon for an analysis that stretches hundreds of years into the future (Interagency Working Group on Social Cost of Carbon, United States Government, 2010).

Goulder and Williams (2012) report the implicit discount rates in three influential studies on climate change policies to be in a range between 1.4% and 4.3%. These studies include Nicholas Stern's influential 2007 work "The Economics of Climate Change: The Stern Review". This study recognizes the need to distinguish between financial performance rates and rates used in situations where what matters is the effect over social wellbeing, as is the case of this study. The study reaffirms the difficulties of addressing the subjectivity implied in the definition of social welfare functions. Further, it considers the effect of uncertainty in these estimates, suggesting declining rates in long-term horizons (Goulder & Williams, 2012). This last proposal is used in other reports which restate the lack of consensus on specific rates and suggest the use of declining as a pragmatic approach, citing studies that propose rates of 4% for the first 5 years, 3% from year 6 to year 25, 2% from year 26 to 75, 1% between years 76 and 300 and 0% for the longer term horizons (Cunninghmam, 2009).

England uses a somewhat similar approach for discounting the costs and benefits of social projects, where in the first 30 years they apply a rate of 3.5% and for longer periods a lower rate (Vardakoulias, 2013).

In view of these international parameters on the difficulty of defining inflection points where differential rates could be used and of the ongoing international discussion, this study adopts a conservative approach through a slightly higher rate amid the ranges found in the literature and the studies for Crucitas in Costa Rica: 4%. It represents the average of the ranges presented by Stanton (2010) and suggested by the Obama administration for the social cost of carbon. It is also the most conservative rate suggested by Goulder & Williams (2012). We use this rate in this study to discount the flow of values that allow the determination of the net present monetary value of the ecological damage assessed in the chosen time horizon of 50 years.

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Annex 3

Costa Rican Ministry of Foreign Affairs

New Works in The Northeast Caribbean Wetland, Report for the Executive Secretariat of the Ramsar Convention on Wetlands

July 2013

English translation

Ministry of Foreign Affairs
Republic of Costa Rica

NEW WORKS IN THE NORTHEAST CARIBBEAN WETLAND

Report for the Executive Secretariat of the Ramsar Convention on Wetlands

July 2013

Table of Contents

1. Background

As a result of the occupation and use of the Costa Rican territory in the area of Finca Aragón, Isla Portillos, carried out illegally by Nicaragua in October 2010, which also included environmental damages to the area, on November 18 of that year Costa Rica filed an application before the International Court of Justice (ICJ) accompanied by a request for provisional measures. The Costa Rican territory that was occupied and damaged by Nicaragua is part of the Northeast Caribbean Wetland (*Humedal Caribe Noreste*, hereinafter "HCN") which is a Ramsar site, registered in the list of wetlands of international importance of the Ramsar Convention since March 20, 1996. Due to this circumstance and in compliance with the provisions in paragraph 3 of the Convention on Wetlands of International Importance, especially as a waterfowl habitat, known as the Ramsar Convention, Costa Rica informed the Ramsar Secretariat of the facts, on the grounds that they were altering the ecological balance of the wetlands. The Ramsar Convention entered into force on 21 December 1975, and it was signed by Costa Rica and adopted as a law of the Republic through Act No. 7224, published in the Gazette N ° 86 of 8 May 1991

In the Order of Provisional Measures issued by the ICJ on 8 March 2011, the following provision was included:

> *"86. For these reasons,*
> *THE COURT,*
> *Indicates the following provisional measures:*
>
> *(1) Unanimously,*
> *Each Party shall refrain from sending to, or maintaining in the disputed territory, including the caño, any personnel, whether civilian, police or security;*
>
> *(2) By thirteen votes to four,*
> *Notwithstanding point (1) above, Costa Rica may dispatch civilian personnel charged with the protection of the environment to the disputed territory, including the caño, but only in so far as it is necessary to avoid irreparable prejudice being caused to the part of the wetland where that territory is situated; Costa Rica shall consult with the Secretariat of the Ramsar Convention in regard to these actions…"*

In accordance with the provisions of the ICJ in this paragraph, the Ministry of the Environment, Energy and Telecommunications (*Ministerio del Ambiente, Energía y Telecomunicaciones,* MINAET) of Costa Rica created a group of national experts so that along with three experts appointed by the Ramsar Secretariat a Joint Mission would be integrated to perform an environmental assessment on the status of the resources in the area indicated by the ICJ to determine the actions necessary to prevent further irreparable damage to that part of the wetland. Said visit was conducted on 5 and 6 April 2011. The conclusions of the visit and the corresponding work plan were presented to the Ramsar Secretariat in October 2011 in the document "First Technical Report for the Initial Evaluation and

Assessment of the Environmental Situation in the Northeast Caribbean Wetland within the framework of the Order of the International Court of Justice".

On the other hand, the Order of Provisional Measures of 8 March 2011 included the following considerations paragraph:

> *"78. Whereas, in order to prevent the development of criminal activity in the disputed territory in the absence of any police or security forces of either Party, each Party has the responsibility to monitor that territory from the territory over which it unquestionably holds sovereignty, i.e., in Costa Rica's case, the part of Isla Portillos lying east of the right bank of the caño, excluding the caño; and, in Nicaragua's case, the San Juan river and Harbour Head lagoon, excluding the caño; and whereas it shall be for the Parties' police or security forces to co-operate with each other in a spirit of good neighbourliness, in particular to combat any criminal activity which may develop in the disputed territory;"*

This paragraph requires both countries to provide security to the area from their corresponding territories which are not in dispute. In the case of Costa Rica, since their police cannot navigate the San Juan River to reach the area, this provision meant having to establish new police posts, as well as infrastructure to enable effective monitoring, such as towers and surveillance cameras.

Moreover, the occupation and use of Costa Rican territory and environmental destruction carried out by Nicaragua in the area of Isla Portillos in October 2010 was later accompanied by other hostile acts by that country, which evidenced Nicaragua's intention to entirely ignore the border regime. For example, in November 2010 President Daniel Ortega announced Nicaragua's intention to claim from Costa Rica a right to free navigation on Colorado River, which international instruments do not grant. Additionally, during the oral hearings relating to the request for provisional measures submitted by Costa Rica against Nicaragua before the International Court of Justice, the Nicaraguan Agent announced his country's position to ignore the regime of condominium in the bays of Salinas and San Juan del Norte. In addition, Nicaragua's representatives defended the -incorrect- legal position that according to the instruments that govern the border regime, Nicaragua has right to occupy Costa Rican territory and Costa Rica only would only be entitled to compensation. Subsequently, President Ortega threatened to reclaim the Costa Rican province of Guanacaste, and the Chief of the Nicaraguan Army announced his intention to stop Costa Ricans who visit the area indicated by the International Court of Justice in compliance with the Order of Provisional Measures of 8 March 2011.

In view of the threats to national security and territorial integrity from the Nicaraguan actions, Costa Rica, as a sovereign country and pursuant to the right to defend itself, has the power within the framework of international law of having the appropriate infrastructure that will allow its public authorities and inhabitants to transit easily along the border, as well as providing access to the border communities from other points in the interior of the country, if necessary, and to perform any act of defence of its territorial integrity. This is particularly important in the sector of Costa Rican territory where there was no other means of

communication apart from the San Juan River, on which navigation has been systematically restricted by the Nicaraguan authorities, despite Costa Rica's perpetual right to free navigation, established in the respective instruments and ratified in 2009 by the International Court of Justice.

As a first measure, the Government of Costa Rica initiated actions in December 2010 in order to allow access by land to the police post located at the Delta where the San Juan River forks and the Colorado River is born, site known as Delta 7 (see **Figure 1**). Thus, an existing route was rehabilitated between the Delta and the town of Fatima, which is located in the Northeast Caribbean Wetland. Later these works were extended to the West, along the border that runs along San Juan River, in order to allow not only the police and other Costa Rican institutions to have land access to different points of the national border area, but also to allow the inhabitants to move if necessary. Therefore, this road also has the function of reducing the dependence of the inhabitants of the border communities, and of the State institutions that provide basic health and education services, on the use of the San Juan River as the only way of communication that has traditionally existed in that area, given the restrictions imposed by Nicaragua to Costa Rican navigation on the San Juan River.

Within this context, the Government of Costa Rica issued Executive Decree No. 36440-MP published in The Gazette No. 46 of 7 March 2011, *Publication* no. 14 (see **Annex 1**), which ordered a "State of emergency situation and the process triggered by the violation of Costa Rican sovereignty by Nicaragua." Considering clause 5 of the Decree reads as follows:

> *"5. That Article 1 of Executive Decree No. 36440-MP, declares a State of Emergency in the cantons of La Cruz, Upala, Los Chiles, Sarapiquí, San Carlos and Pococí as these border with Nicaragua, a country that performs illegal actions on Costa Rican territory which threaten the life, physical integrity and property of its inhabitants, as well as against the national sovereignty and the environment".*

This Decree also allowed protecting the works that have been performed in the Northeast Caribbean Wetland.

The foregoing background and context explain the reasons why the Government of Costa Rica saw the need to perform new works in the Northeast Caribbean Wetland. Below these works will be explained in greater detail.

2. The works

The works that are being built at the HCN consist of the installation of 2 new police posts (one at the entrance of the fresh water lagoon and the other at Punta Castilla) and the expansion of the one that already existed at Delta del Colorado; a biological station at Punta Castilla; four surveillance towers (two at Colorado Delta, one at the mouth of Agua Dulce Lagoon and one in Punta Castilla; and electrical connection and computer infrastructure named Isla Calero technological project. There is also a portion of Ruta 1856 located within the boundaries of the HCN,

therefore it is included in this report. Figure 1 shows the location of each of these works, which are described below. The exception is made that the area of the mouth of Agua Dulce Lagoon is located outside the limits of the HCN, but it has been included in this report due to its relationship with the other works.

2.1. New posts for the Public Forces and expansion of the existing post at Delta Colorado

On 26 December 2010 a police post was installed at the mouth of Agua Dulce Lagoon, using a house that already existed in the area of approximately 100 square meters (see **Figure 6.** In addition, it has a tower for video surveillance and protection of the sector, 60 metres high. Electricity was brought to this station with a line of approximately 10 km (see **Figure 7**), for which the corresponding permits were processed before the National Emergencies Commission (see **Annex 3**) and the National System of Conservation Areas, SINAC (see **Annex 4**).

On 15 January 2012 the improvements to the physical plant of the so-called Delta Costa Rica post (Delta 7) began, which already existed from the end of the 1970s of approximately 80 square metres. In addition, three containers were placed at this post, which serve as a sleeping area for the policemen posted to the area, and one which operates as an office (See **Figure 2)**. These works are temporary, while the permanent works are built. In addition to the improvements to the physical structure***,*** two towers were installed to perform video surveillance and protection of the sector, the first 60 metres high, on the south bank of the Colorado River and the second tower on the north bank of the Colorado River with a height of 30 metres (see **Figure 3**). Electricity was brought to this station with a line of approximately 25 km starting from La Aldea (see **Figure 4**), for which the corresponding permits were processed before the National Technical Environmental Secretariat (see **Annex 2**).

It has been planned to build in the future a new police station on the southwestern point of Isla Calero, on the left bank of the Colorado River, in front of the Delta 7 post.

On 25 January 2012 a police post was installed in the sector of Punta Castilla, with a ***physical structure*** of approximately 160 square meters. In addition, it has a tower that is 60 metres high. The power supply is based on solar panels. (See **Figures 8-14**)

2.2. Isla Calero Technological Project, Tower Infrastructure for Control and Surveillance

This project consists of the construction of four surveillance towers, located at the following sites: two in the Delta sector, one at post at the mouth of Agua Dulce Lagoon and the other at the post at Punta Castilla. **Figure 1** shows the four towers identified with letters A (post at Delta 7), B (Isla Calero, opposite the Delta 7 post on the opposite bank of the Colorado River), C (mouth of Agua Dulce Lagoon) and D (Punta Castilla). At the time of the visit of the Ramsar Technical Mission the towers were under construction, as shown in the photographic record included, but were subsequently concluded.

Initially the project contemplated the construction of 6 towers, but it was then adjusted to 4 in the areas defined as priority and shown in the figures included in this section of the report. The towers will have long range cameras (15 kms) to serve as a support for the national security strategy in the border area. While the process of acquisition of long-range cameras is completed, others with a smaller range have been installed temporarily.

The camera at Punta Castilla (D) receives electricity from photovoltaic cells, while the other three receive electricity through cables.

To provide electricity to the police station located at Delta 7 and to the surveillance towers and cameras (A and B), as well as for the benefit of the inhabitants of the area, a power distribution line was traced on the existing public street, 24.6 kilometres long, between the villages of Aldea and Delta, which also entails the installation of approximately 255 concrete posts, 11m high (see **Figure 4**). Furthermore, subsequently a submarine cable was installed under the bed of the Colorado River to provide electricity to tower B, located on the southwest point of Isla Calero (See **Figure 5**).

In the case of the police post, the tower and the camera at the mouth of Agua Dulce Lagoon (C), an electric distribution line was traced from the village of Barra del Colorado, with a distance of 10.9 km long (see **Figure 7**).

The Ministry of Public Security, with the technical support of the *Instituto Costarricense de Electricidad* (ICE), was responsible for the construction of these works. MINAET issued the corresponding guidelines, specifically for the Delta Costa Rica sector, so that the power line after the Delta was a submarine line.

ICE called this activity "Isla Calero Technological Project" and said Institute processed all of the environmental permits required under the Administrative File # D1-5901-2011-SETENA, obtaining the environmental feasibility of the project, approving the stage of Environmental Management stage subject to compliance with the environmental commitment clause.

The work was planned based on Executive Decree N° 36440, published in The Gazette No. 48 of 7 March 2011 and Agreement N° 330-2011 of 24 August 2011, as well as Agreement N° 363-2011 on 21 September 2011, both of the Board of Directors of the National Emergency Commission.

On the website of the Presidential House the work performed in the North area is explained in the following terms:

"In addition, thanks to a 24-km power line built by the Instituto Costarricense de Electricidad (ICE), more than 100 families of Fatima, San Antonio and Delta-Costa Rica, in the canton of Sarapiquí, Heredia and the border area with Nicaragua, benefited with electricity for the first time. This work -which represents an investment of ¢250 million colones- allows for the improvement of socio-economic, educational and safety conditions of the inhabitants of this region."

ICE filed before SETENA an application for approval of the environmental viability for the works of two power lines, one from Aldea to Delta Costa Rica and the other from Barra del Colorado to Agua Dulce. MINAET issued in administrative file N° TO01 - PCE-SU-00341-2012, the resolution ACTO-GWRN-OFAU-116-12 whereby

it grants permission to cut 324 trees and 183 coconut palms necessary for the project. The authorization was provided by ICE's "*Área de Desarrollo de Guápiles*" (Guápiles Development Area), which is responsible for the works on site.

In both projects ICE had the support of the Offices of the Tortuguero Conservation Area (ACTo). This conservation area analysed and reviewed the routes and made environmental recommendations.

The electric network of Aldea-Delta was already built and is in operation, while the electrification from Barra del Colorado to Agua Dulce is in process.

2.3. Biological Station

The Tortuguero Conservation Area, supported by the Emergency Plan approved by the CNE in attention to Executive Decree No 36440-MP, began the construction of a biological station at Punta Castilla, which measures approximately 162 m2 (see **Figures 11** and **12**). This work was tendered through Institutional Purchases (*Proveeduría Institucional*), following the procedures established by CNE, and the blueprints were duly approved by the Costa Rican Association of Engineers and Architects, and the CNE conducted the corresponding monitoring of the work, as well as an external supervision performed by a company of specialists and consultants on this topic.

The creation of a biological station in the area of Isla Calero-Isla Portillos of the Northeast Caribbean Wetland area obeys the following objectives:

-Consolidate the management of the Northeast Caribbean Wetland through a research program that allows generating scientific information that will permit updating the management of the HCN and the management plans of the Barra del Colorado National Refuge and Tortuguero National Park.

-Create an appropriate programme for biological monitoring of the status of existing resources, mainly on Isla Calero, allowing management to take the necessary preventive and corrective measures.

-Consolidate a prevention and control programme to prevent the alteration of the existing natural resources.

MINAET hopes to achieve these goals through a research programme specializing on the subject, with the participation of national and foreign researchers, as well as a biological monitoring programme to measure the status of existing ecosystems, and finally a programme for prevention and control of natural resources to protect the biological diversity existing on Isla Calero-Isla Portillos and neighbouring sites.

It has been estimated that for the adequate functioning of the Biological Station 21 MINAET employees are required.

At the time of the visit of the Ramsar Technical Mission, the construction of the biological station had been completed in a satisfactory manner, and already had the accommodation equipment for lodging. Sanitation, adequate disposal and wastewater treatment works were finished in February 2013. **Figure 13** shows the waste treatment plant, while **Figure 14** shows the batteries that provide power from photovoltaic energy to the station. This aspect is particularly sensitive due to

the high groundwater levels existing on the site. Furthermore, as part of the research project, a utility vehicle for four people was acquired. It is expected that the Station will have a laboratory to handle the samples.

2.4. Ruta1856

As indicated in the background section, a portion of Ruta 1856 is located within the limits of the HCN, between Delta 7 and the town of Fátima. This section can be seen in Figure 1, and it measures 14.9 kilometres. It has an average road width of 5.14 metres, and an average right of way of 21.42 metres. This was the first sector of Route 1856 that was built, and it consisted in the rehabilitation of an existing rustic road, so its construction did not alter at all the use of the existing soil prior to the work, given that it had already existed for many years, since it was the only way of communication, very limited, between Fátima and the Delta. Enabling this passage for vehicles originated in the need to allow land access to the Delta 7 police station, in order to facilitate their work in national defence.

The Government of Costa Rica is currently in process of creating the bid for the final plans of the entire Ruta 1856, for which the work was divided into five sections. The stretch from Delta7-Boca Sarapiquí, which includes the sector of the route which passes through HCN, was opened to a bidding process through an abbreviated tender, so it is expected that the final plans will be available in the medium term.

NEW WORKS AT THE NORTHEAST CARIBBEAN WETLAND

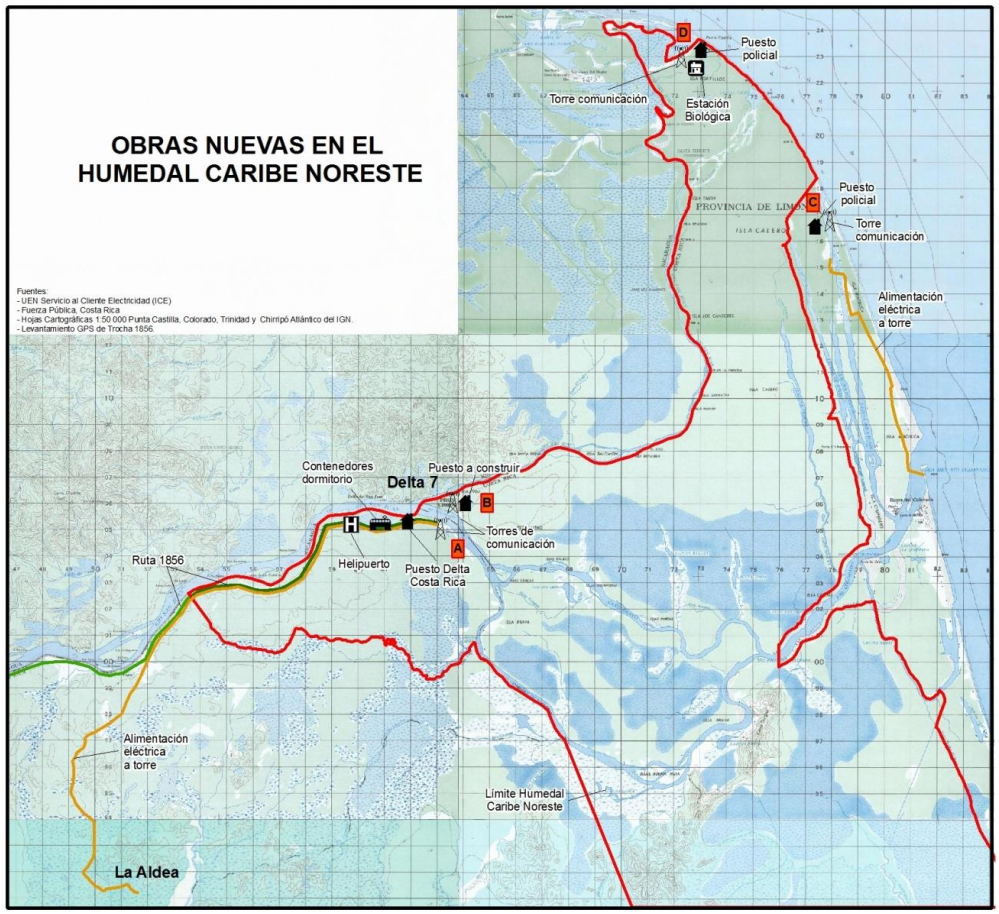

Figure 1: Illustrative map of the new works at the HCN

Figure 2: Containers and construction of Tower A at Delta Post 7

Figure 3: Tower B at Isla Calero

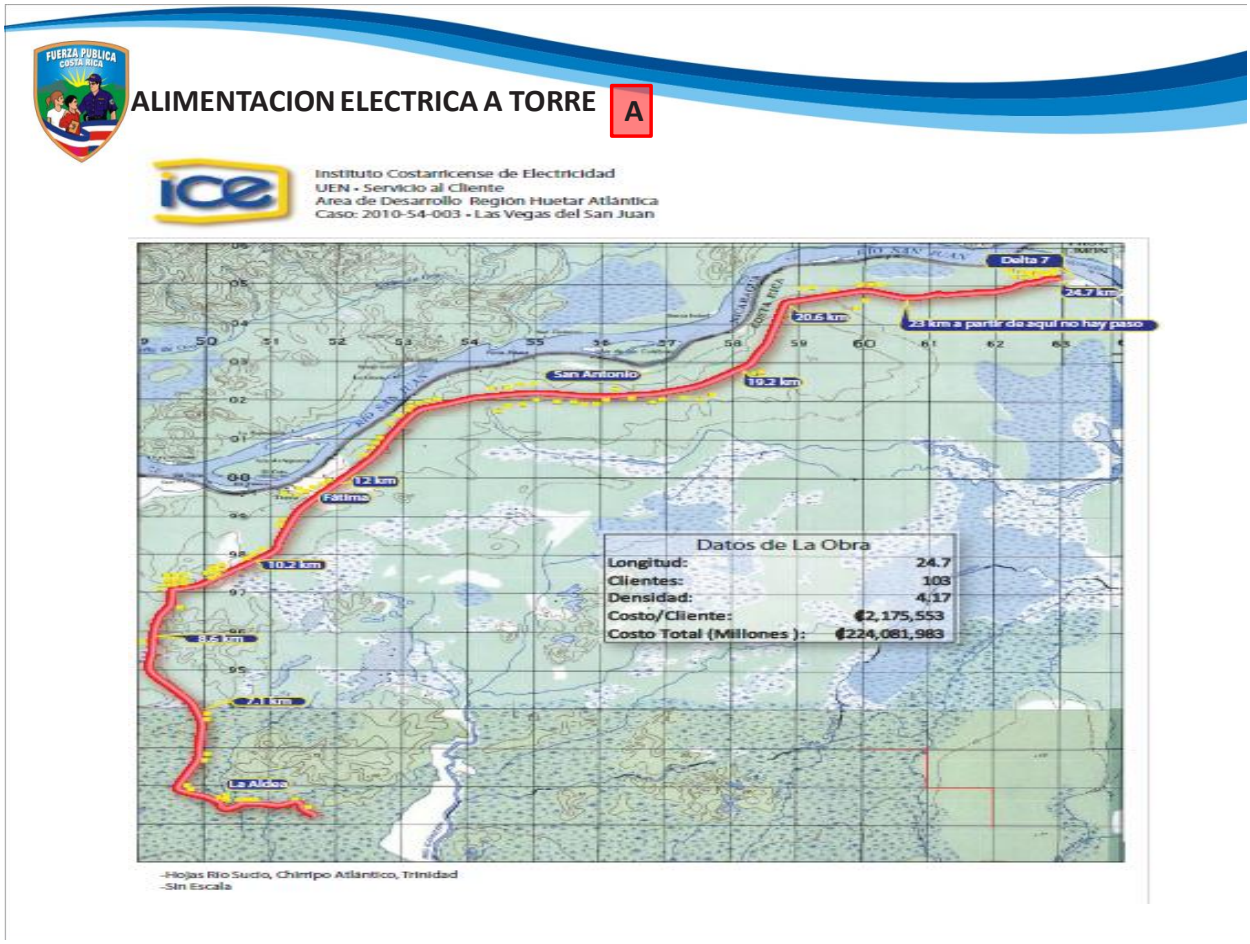

Figure 4: Power line for police post and Tower at Delta 7

Figure 5: Wiring for electrical connection of Tower B

Figure 6: Police post and Tower C at the mouth of Agua Dulce Lagoon

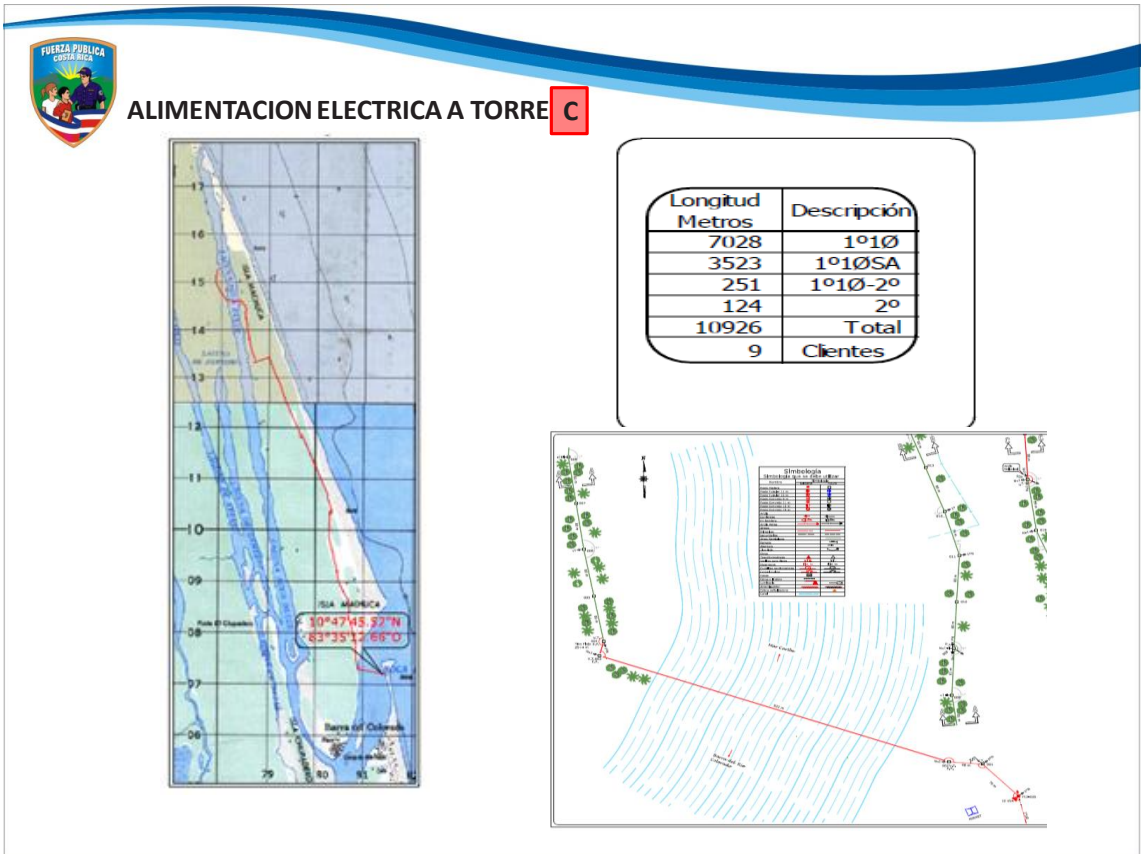

Figure 7: Power supply for police post and Tower C at the mouth of Agua Dulce Lagoon

Figure 8: Access to police post and Tower D at Punta Castilla

Figure 9: Police post at Punta Castilla

Figure 10: Tower D at Punta Castilla

Figure 11: Photograph of the side of the MINAET biological station

Figure 12: Bases of the MINAET Biological Station

Figure 13: Sewage treatment plant of the MINAET biological station

Figure 14: Photovoltaic electric system of the MINAET biological station

Annex 4

Costa Rican Ministry of Environment and Energy (MINAE)

Report of works carried out from 26 March to 10 April 2015

16 April 2015

English translation

SISTEMA NACIONAL DE ÁREAS DE CONSERVACIÓN
ÁREA DE CONSERVACIÓN TORTUGUERO
GERENCIA DE MANEJO DE LOS RECURSOS NATURALES

16 April 2015
ACTo-GMRN-O-093-2015

Eng. Laura Rivera Quintanilla
ACTo Address

Matter: Report of works carried out from 26 March to 10 April 2015 within the framework of the implementation of the VI Investment Plan pursuant to Decree N° 36440-MP named "Mitigation measures in artificial *caños* built by the Government of Nicaragua in Isla Portillos, disputed territory, according to the resolution of the International Court of Justice in The Hague."

1_BACKGROUND

In September 2013, Costa Rica informed the International Court of Justice of "new and serious activities by Nicaragua in the disputed territory" by means of satellite images of the area where they are located. Specifically, it was indicated that Nicaragua had begun the construction of two new artificial *caños* in the disputed territory. Both *caños* were located in the northern part of the disputed territory, the larger one toward the East (hereinafter "East *caño*").

As a result of the provisional measures requested by Costa Rica, the International Court of Justice issued an Order of Provisional Measures on 22 November 2013. In this Order the Court took into consideration that the *caños* are located in the disputed territory, within the "Humedal Caribe Noreste" (Northeast Caribbean wetland), which is under Costa Rica's responsibility pursuant to the Ramsar Convention.

Consequently, dispositive paragraph (E) of the Order of the Court of 22 November 2013 established that "following consultation with the Secretariat of the Ramsar Convention and after giving Nicaragua prior notice, Costa Rica may take appropriate measures related to the two new *caños*, to the extent necessary to prevent irreparable prejudice to the environment of the disputed territory; in taking these measures, Costa Rica shall avoid any adverse effects on the San Juan River."

In conformity with the ruling of the Court, in August 2014, after a visit to the site by a Ramsar Advisory Mission, it was determined that there is in fact a risk of irreparable prejudice to the area, if a combination of factors cause the San Juan River to continue all the way to the sea by creating a new mouth through the *caño* excavated by Nicaragua. In this regard the Ramsar Secretariat indicated that:

"Regarding the analysis of the possible scenarios, the Ramsar Advisory Mission recommended, following the principle of precaution and looking to improve the quantitative analysis of the area of study, the implementation of scenario 1 [measures for closing of the *caño*] accompanied by the rigorous implementation of a monitoring programme." It is important to clarify that the other proposed scenario was named scenario 0 and consisted of not implementing any measures to close the *caño*.

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Based on that recommended in the report Ramsar Advisory Mission No. 77, it is in Costa Rica's best interest to prevent this effect from occurring and to act as quickly as possible due to the following reasons:

a. The breaking of the sandbar would change the course of the San Juan River irreversibly, resulting in loss of land for Costa Rica, to the detriment of the country's territorial integrity.

b. The closing works must be performed before the end of the decrease in rains typical of October, given that it is immediately followed by the season of very heavy rains in the area, during which the risk of breakage of the sandbar that separates the *caño* from the Caribbean sea increases.

c. Delays in carrying out the works will increase the costs of implementation, due to the increase in operating costs (fuels, materials, labour) necessary to perform the works.

d. The Order of the Court was issued in November 2013 and the coordination with the Ramsar Secretariat recommended the closing works for August 2014.

By November 2014 the National Emergency Commission, pursuant to Executive Decree No. 36440-MP, had approved the V Investment Plan for the project named "Construction of dykes as mitigation measure where the artificial *caños* are located, built in Isla Portillos, disputed territory, according to the resolution of the International Court of Justice in The Hague". This investment plan, in sum, contemplated the construction of two dykes to close the "East *caño*" by carrying sandbags through the San Juan River.

On 12 November 2014, 5 December 2014 and 17 December 2014, specifically, the environmental authorities of the Tortuguero Conservation Area travelled from Delta Costa Rica to the site of the "East *caño*" to begin the construction of dykes in that *caño.* However, the military authorities located at Delta Nicaragua prevented their navigation on the San Juan River, claiming, among other, that they needed an authorization from the Ministry of Foreign Affairs of Nicaragua or that Costa Rica had to comply with the requirements of Nicaraguan law in order to use the San Juan River. This last aspect was not contemplated in the Order of the Court of 22 November 2013.

Due to the aforementioned impediment, since January 2015 Costa Rica began the coordination necessary to rethink the actions to comply with the order of the Court and recommendations of the Ramsar Advisory Mission No. 77.

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Thus, toward the end of March 2015 final approval was given for the VI Investment Plan, pursuant to Executive Decree No. 36440-MP, for execution of the project "Construction of a dyke as mitigation measure where the artificial *caños* are located, built in Isla Portillos, disputed territory, according to the resolution of the International Court of Justice in The Hague". Unlike the previous investment plan, this initiative centres on the construction of a single dyke, carrying the materials by air, specifically a helicopter, as it is the only means available due to the Nicaraguan refusal to allow navigation on the San Juan River.

Subsequently, dated 30 March 2015 and through diplomatic note No. DM-AM-166-2015, before beginning the works and in conformity with that established by the Court, Costa Rica informed Nicaragua of the operation to close the "East *caño*".

On that same day, through diplomatic note No. DM-AM-165-2015, Costa Rica also informed the Ramsar Convention on Wetlands of the beginning of works, following the recommendations provided in the report of the Ramsar Advisory Mission No. 77.

Finally, for 31 March 2015, through note ACTo-GMRN-O-092-2015, the company hired through bid No. SINAC-CDE-001-2015 was notified that the beginning of works for the "East *caño*" would be 1 April 2015.

1.1 Location of the new "East caño"

The "East *caño*" is located about 1600 metres downstream from the mouth of San Juan River into the sea. The *caño* is located in the narrowest stretch of land between the right bank and the beach on the coast. The approximate length between the river and a small lagoon into which the *caño* flows is 300 metres. Its location is shown in figure No. 1.

More specifically, the new *caño* is located at the beginning of a bend in the river, where it changes direction from northwest to west. The new caño continues approximately with the direction of the river before it enters the bend.

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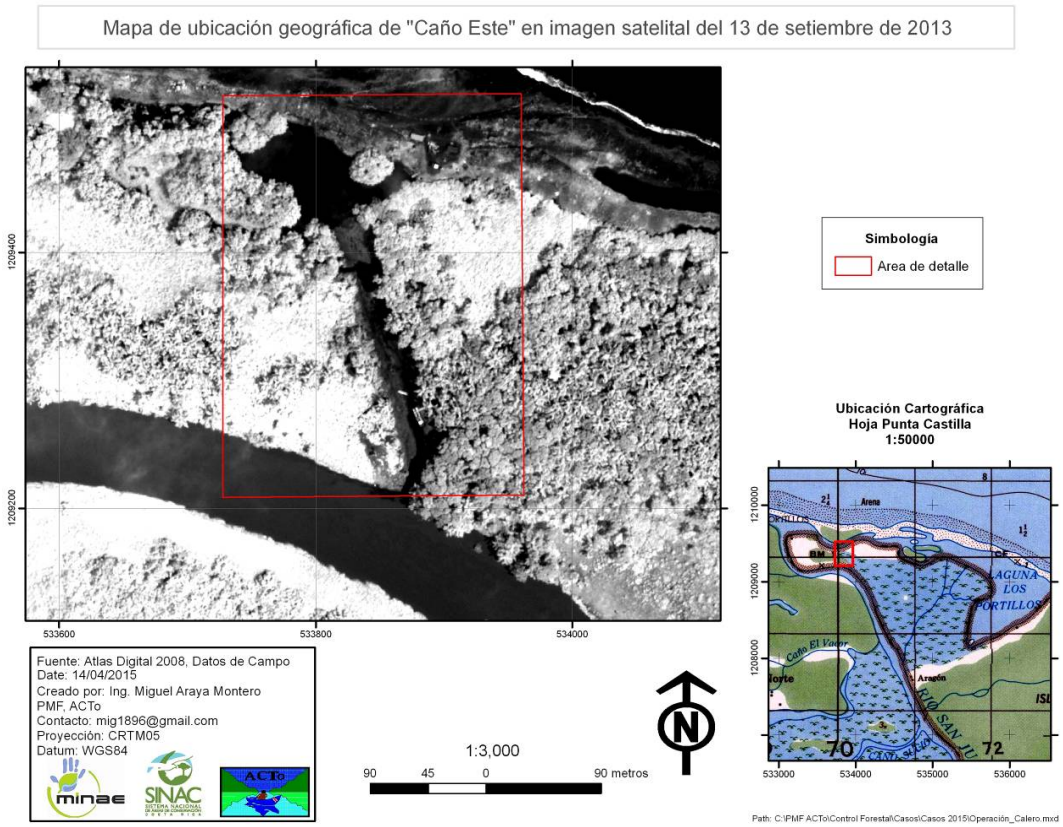

Figure 1. Geographic location of the "East *caño*" Miguel Araya, 2015.

1.2. Goal of the proposal:

As indicated, the initial goal of the proposed measures is to stop the environmental impact derived from the construction of this new artificial *caño*, in view of the existing threat of irreparable damage that the San Juan River could generate by consolidating a new exit to the sea during a season where its volume of flow increases. The subsequent goal is to promote restoration of the natural conditions of the wetland prior to the construction of the *caño*. These conditions refer to the following three topics:

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- closing of the artificial *caño,*
- regeneration of the vegetation that existed in the affected area,
- restoration of the natural conditions of water exchange between the river and the wetland.

The following measures are proposed to achieve the aforementioned goals.

1.3. Proposed theoretical model:

The construction solution proposed for the closing of the "East *caño*" was based on the following technical premises:

- Use of natural materials from the area, preferably.
- The transport and placement of these materials shall not produce impacts additional to the existing ones.
- The intermediate site proposed would be defined at the time of beginning the works, depending on the available access and transport of materials.
- The closing dyke would be built from the bottom of the *caño* to the height of the banks, which has been estimated at 1.6 metres high.
- The body of the dyke would be built with sacks, each filled with 30 sandbags weighing 30 Kg, forming a block of the following dimensions: 0.84 m x 0.84 m x 0.60 m high, with an approximate weight of 900 Kg. Along the width of the *caño*, the placement will be a staggered arrangement, as shown in Figure 2.
- The theoretical volume of each sack is 0.42 m^3.
- The typical cross section of the closing dykes can be seen in Figure 2 below. Arranged in three rows, varying from five sacks at the base to three on the crest, a slope is obtained with a theoretical incline of 1 vertical to 0.7 horizontal.
- The theoretical height of the sacks is indicated as 1.8 metres. In practice, due to the settling of the sacks and lowering of the foundation, the effective height would decrease to 1.5-1.6 metres.

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- A woven type of geotextile will be placed, 2 mm thick, as base for the sandbags in the sediment at the bottom of the *caño*. In addition, the top row of each dyke will include sediment from the deposits located on the banks in the first entrance of the artificial *caño*. These sediments contain organic matter that promote vegetation growth.

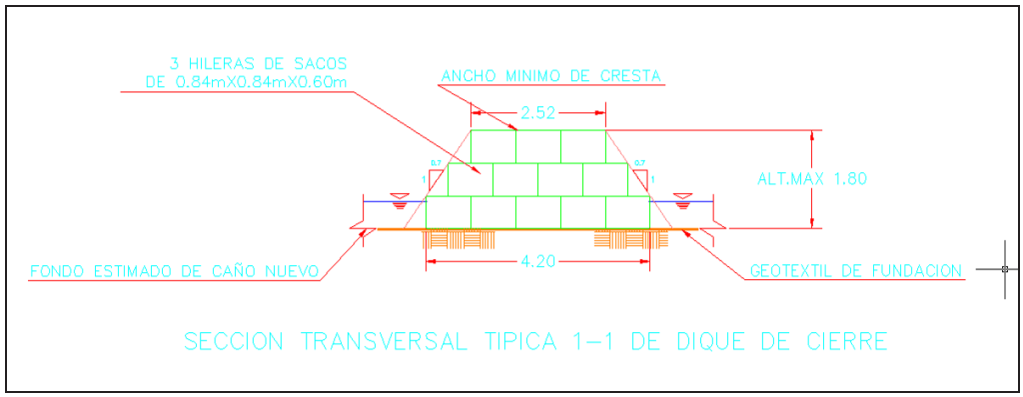

Figure 2 Typical cross-section of closing dykes
Source: Instituto Costarricense de Electricidad, 2015.

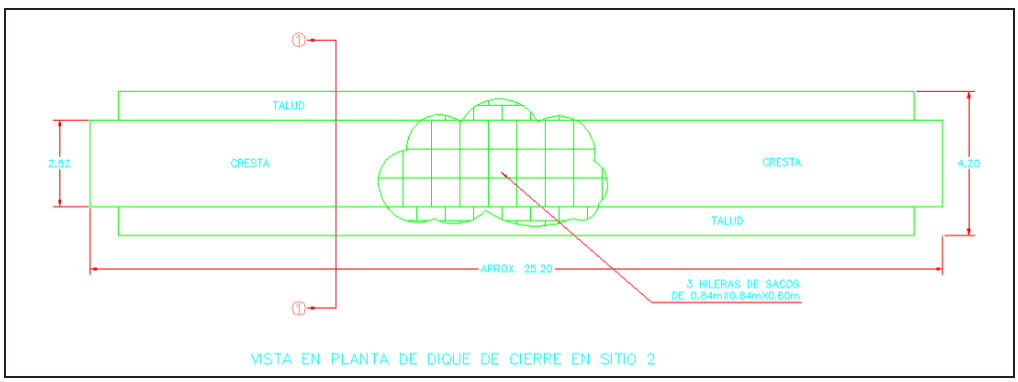

Figure 3. Plan view of closing dyke
Source: Instituto Costarricense de Electricidad, 2015.

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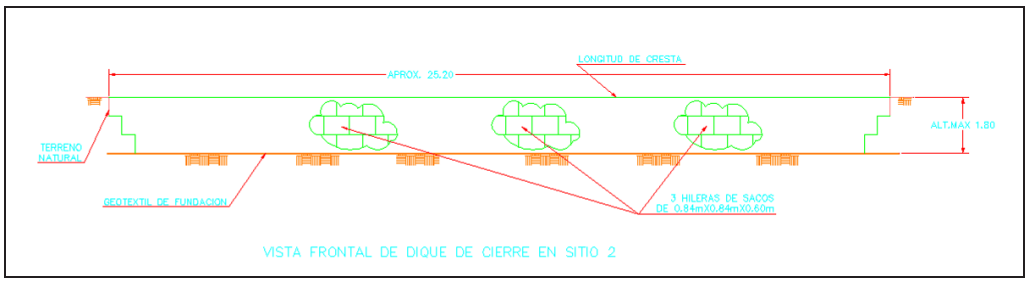

Figure 4. Front view of dam (looking northwest)
Source: Instituto Costarricense de Electricidad, 2015.

1.4 Selection of site to obtain material to fill the sacks:

Ideally, the filling material for the sandbags to be used for the construction of the dyke would be the same material that was removed during its excavation; however, this option was materially impossible due to the following:

- Most of the material extracted was scattered in the San Juan River and in the area adjacent to the site of the *caño*, which is a flooded grassland, causing it to sink: thus, only an insufficient fraction remained with optimal characteristics for collection.

- All of the land located in the dispute territory, including kilometres to the south, is very flat land with wetland characteristics, which prevented access to heavy loam material similar to that extracted to fill the sandbags.

- Carrying material of similar characteristics by land from the Delta Costa Rica for its subsequent transport by air to the "East *caño*" was ruled out because it multiplied the cost of the operation in an exaggerated manner.

Given the aforementioned limitations, the use of sand was selected. This material is not alien to the ecosystem, given that a few tens of metres from the location of the dyke on the "East *caño*" there is a lagoon with a sandy bottom.

In spite of the foregoing, it was not possible to access the sand on the beach near Punta Castilla given that Article 100 of Executive Decree No. 29300 MINAE, among other, establishes the prohibition of mining activity on the beaches adjacent to the territorial sea. Thus, the closest point to access sand was the Agua Dulce mouth, which is approximately 10 Km southeast (SE) from the location of the *caño* (see figure 5).

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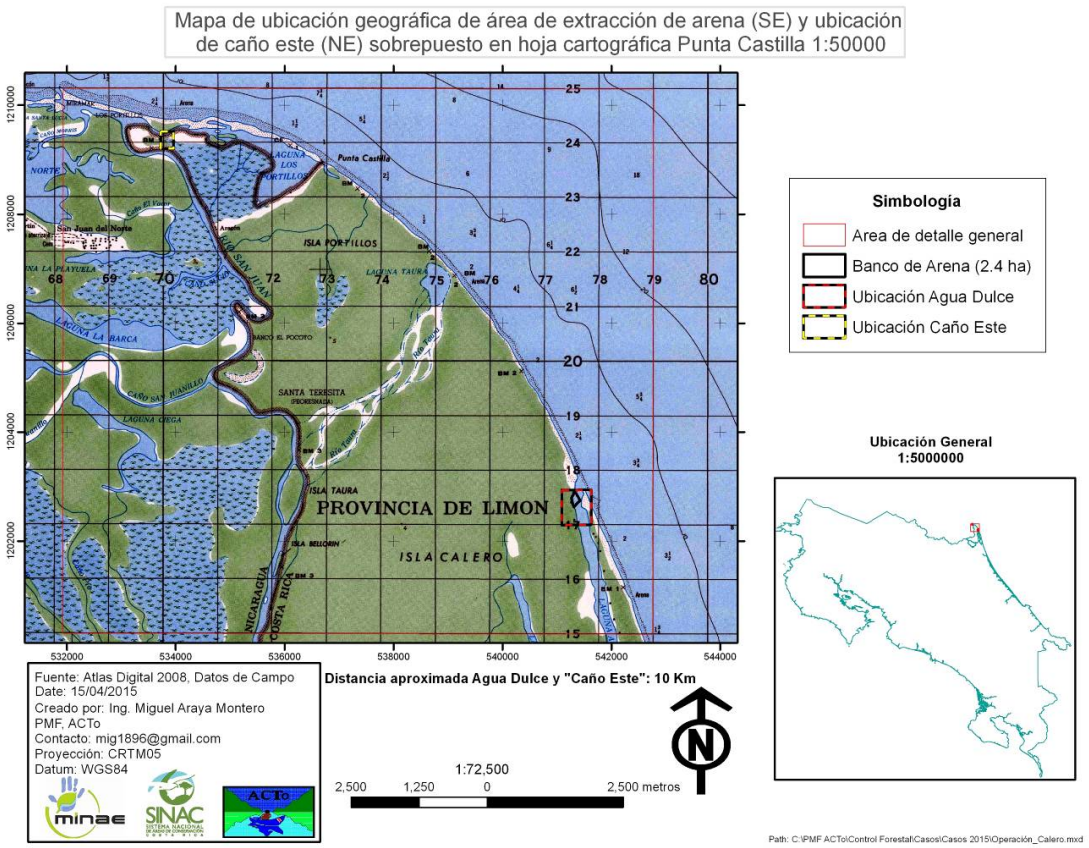

Figure 5. Map of the location of the "East caño" with regard to the Agua Dulce mouth.

In the area of the mouth of Agua Dulce lagoon an ample sand bank was identified, measuring approximately 2.4 ha, within which an area of 0.94 ha was selected as estimate to fill the sandbags. However, due to technical recommendations for the operation with an aircraft, only about 1265 m^2 (13.4%) of the area contemplated was used (See figure 6).

In the area contemplated to fill the sandbags approximately 6360 sandbags were filled (5460 synthetic fibre bags and 900 natural fibre bags), with an approximate 87.04 m^3 of sand as sole filling material. The impact of the filling of sandbags in the area contemplated for that purpose is minor, given that it entailed the removal of a layer of sand of slightly less than 7 cm.

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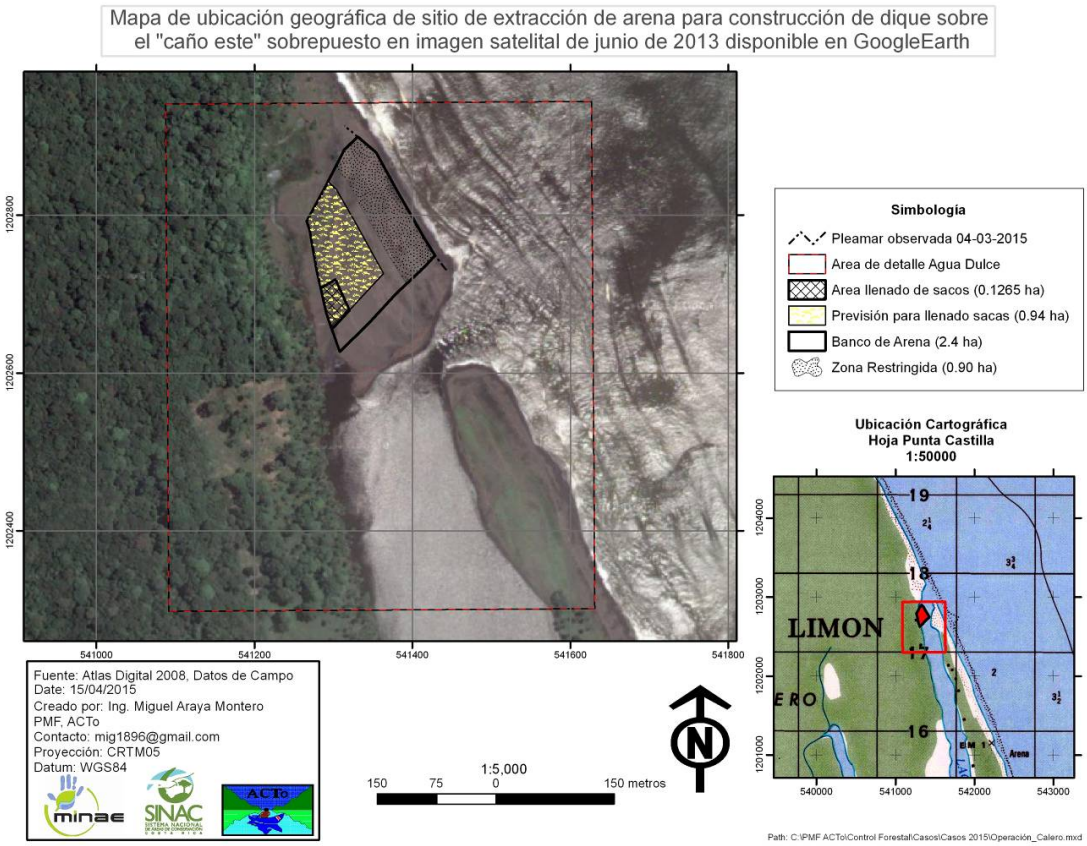

Figure 6. Map of the location of the area destined to fill the sandbags for the construction of the dyke. Miguel Araya, 2015.

2_FILLING OF THE BAGS WITH SAND

As indicated, this work was performed fully in the sector of the mouth of the Agua Dulce lagoon. Approximately 20 officers of the Public Forces participated in this work, in addition to the support on some days by 8 employees of the Tortuguero Conservation Area. The work of filling the sandbags began on 28 March 2015 and continued until 04 April 2015. During the first 6 days regular bags were filled and the larger sacks were created; on the last two days burlap sacks were filled, which would be part of the final materials to be placed in the dyke.

Each bag was filled with approximately 30 kg of beach sand. It was tied and placed inside a larger sack. Each of these sacks contained 30 small sandbags, to reach an approximate weight of 900 kilograms, with an approximate volume of 0.53 m³ each.

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Photo 1. Panoramic view of the site destined for the filling of sandbags during the first day. Photo by Miguel Araya. 29 April 2015

In total 212 sacks were filled. Based on the original design, it was initially planned that approximately 380 would be required; however, as the works progressed it was estimated that the amount would be lower, therefore the filling of sacks was suspended. The same happened with the filling of the burlap sacks; after 30 were filled it was determined that they were enough to conclude the works.

For the work to fill the sandbags shovels were used, as well as burlap sacks, sacks, black plastic to cover the material that was ready to prevent an increase in weight due to accumulation of humidity, string to tie each sack and weighing scales to control the weight of each sack filled.

The selection of synthetic fibre to structure the dyke was due to the need for that structure to remain stable for at least two years, while the natural succession processes allow the regeneration of the site until reaching conditions similar to those that existed prior to the opening of the "East *caño*". On the other hand, the natural fibre sacks (burlap sacks) selected for the top layer are intended to help secure the coconut fibre and, due to the short duration of the fibre, the colonizing vegetation will be able to have an underlying layer for its establishment.

3_TRANSPORTING OF SACKS

Prior to beginning the works a session was held by staff of the company responsible for the air transport in which they explained the procedure to hook and release the sacks from the device which the helicopter would use to perform the transport, as well as the security measures to be applied.

The work of transporting of sacks with the helicopter began on 31 March 2015, with the hooking of each sack in the Agua Dulce sector and its transfer to the *caño* where the dyke would be established. This work continued until 6 April, concluding on that date. The following table provides the details of the transport performed during the execution of the works.

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Photo 2. Session with the personnel in charge of collaborating with the transport of sacks. Photo by Miguel Araya, 30 March 2015.

Table 1. Details of the transport of sacks, weight and volume transported per day to the dyke constructed in an artificial caño, Isla Portillos, Colorado. April 2015

Day	Number of sacks transported	Volume of sand	Weight (tonnes)
31 March	2	1.06	1.8
1 April	18	9.53	16.2
2 April	17	9.00	15.3
3 April	22	11.64	19.8
4 April	14	7.41	12.6
5 April	24	12.70	21.6
6 April	14	7.41	12.6
Total	**111 sacks**	**58.75 m³**	**99.9 tonnes**

Source: Field data. Olman Mena, 2015.

It is worth noting that 5 of the sacks carried correspond to burlap sacks that were placed on the top part of the dyke, as planned. The burlap sacks contained in each sack were taken out and placed systematically on the surface of the dyke, placing approximately 110 burlap sacks. The rest of the large sacks (106) made up the body of the dyke.

During the execution of the works weather conditions and mechanical problems arose that interfered with the progress of the works, as it was necessary to pause while such issues were resolved. The details of what occurred are provided below.

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Table 2. Weather conditions and unexpected events that occurred during the work of transporting sacks to the artificial *caño*, Isla Portillos, Colorado. April 2015

Day	Weather conditions
30 March	Good. At around 2:00 there was a heavy rain in Agua Dulce, which delayed practice programmed with the aircraft.
31 March	Good
1 April	Good
2 April	Regular. At around 10:00 the transport had to be suspended because of strong winds and rain both at Agua Dulce and the *caño*. It was resumed at around 12:00 pm. Approximately at 2:00 work had to be stopped again because of problems with the fuel transfer pump that supplies the helicopter.
3 April	Regular From 8:30 to approximately 10:00 the transport had to suspended because due to rain in the Agua Dulce area.
4 April	Regular. At around 10:00 sack transport works had to be suspended due to strong winds in the *caño* area. The personnel present at the *caño* had to be evacuated at 15:30 due to a strong storm that was headed from Agua Dulce to the *caño* area.
5 April	Good. In spite of moderate winds, the pilots carried sacks.
6 April	Regular. There were only 14 sacks pending transport, and this concluded at 11:30. Due to problems with winds, the helicopter had to leave when it released the last load, and it had to return to evacuate the personnel.
7 April	Good

Source: Field data. Olman Mena, 2015.

To perform the process to hook the sacks, the personnel had the safety equipment necessary, as the wind generated by the helicopter caused sand to fly everywhere, possibly affecting the personnel. It is worth noting that on some occasions there was collaboration of the Public Forces to perform this manoeuvre.

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Photo 3. Partial view of the work of hooking the sacks for transport at the mouth of Agua Dulce Lagoon. Photo by Miguel Araya, 4 April 2015.

4_RESULTS IN THE CONSTRUCTION OF THE DYKE

Photo 4. Partial view of site selected for construction of the dyke. 30 March 2015 Photo by Christian Birkel.

4.1. Definition of the site where the dam would be established: In the company of Engineer Christian Birkel, who participated in directing the works, the current structure of the *caño* was analysed, and a site very close to that contemplated in the investment plan was selected. This point is located at the coordinates indicated in Figure 7.

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The site was mainly colonized by grasses, keeping water in an open riverbed 6.5 metres wide. The depth of the riverbed was 1.1 metres in the northeast bank and 1.5 metres in the southwest bank. On both sides there were mounds of material, the results of the dredging. After these mounds you could see the natural ground level (see photos 4 and 5).

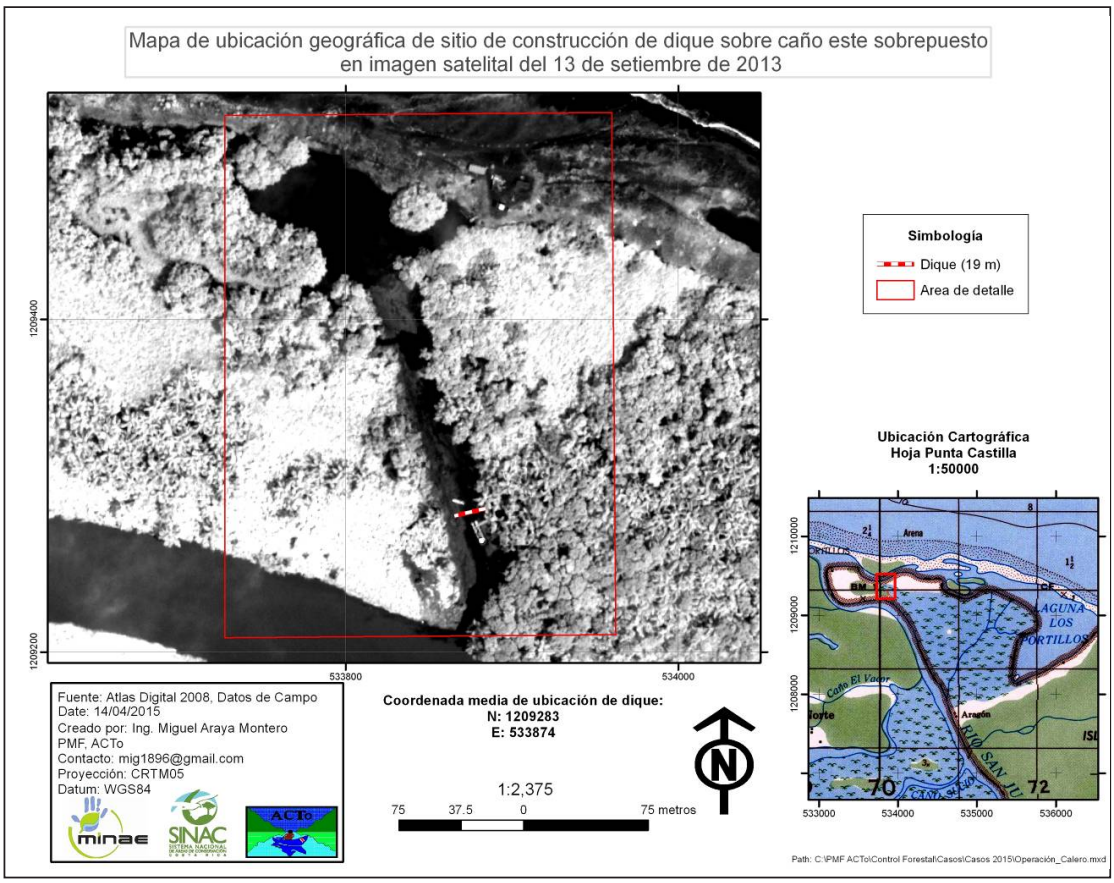

Figure 7. Geographic location of the site selected for the construction of the dyke in the east caño. Miguel Araya, 2015.

Toward the north of the *caño*, we observed that the sedimentation process had favoured the decrease in the depth of the riverbed, therefore this site was deemed inadequate to place the dyke. The place chosen agrees with pictures of the furthest entry of the dredger that built the caño in 2013.

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Photo 5. Approximate alignment of the dyke built in the "East *caño*" superimposed on the picture of the same site from September 2013. Photo by Miguel Araya. September 2013.

Photo 6. Panoramic view of site proposed in the project for establishment of dyke 2. Note visible sedimentation in the banks of the riverbed. 30 March 2015 Photo by Christian Birkel.

Once the place where the work would begin had been determined, the following tasks were performed.

4.2 Marking and placement of the geotextile: Once the point for construction of the works had been selected, the site was prepared to place the geotextile that would serve as the base of the dyke. It was defined on both sides until where it was necessary to place the sacks to reach the ground level and height required. Using an inflatable boat, personnel stood on both sides of the riverbed and laid out the geotextile.

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They tried to cover the entire work area, cutting off the excess material. Since the available material allowed it, two layers of textile were placed at the base, before placing the first row of sacks. Once the first row of sacks had been placed, another layer of fibre was laid out to improve the stability of the works.

4.3 Placement of marks for positioning of the sacks: In order to achieve the most accurate placement of the sacks and prevent incidents of the personnel, a system of ropes was used with a mark to reference the point where each hauled sack had to be placed. The system was mainly used for the first five trips, which corresponded to the first row of sacks that were submerged in the riverbed. Once this progress was achieved, other techniques were used to facilitate the accurate placement of the sacks.

4.4 Placement of the sacks: As previously mentioned, each sack was made up of 30 sandbags that weighed 30 kilograms each, meaning that each sack weighed approximately 900 kilograms. Due to the capacity of the helicopter, each haul permitted the transport of only one sack. This work began on 31 March 2015, and on that day two sacks were placed in the caño.

Photo 7. Release and placement of the sacks in the caño. Photo by Olman Mena. 3 April 2015

The sacks were placed from West to East, on the riverbed with water and ensuring that they covered the geotextile placed in advance. A first row was created, crossing the artificial bed, using 5 sacks that covered from one side to the other. Subsequently, a second row was placed, trying to make it form a triangle with regard to the sacks on the first row. At the site it was agreed with Engineer Birkel the direction in which the 4 rows would be placed as floor, waiting to see their behaviour to determine whether a fifth row would be required at the base of the dyke. This assessment included observing whether the sacks sank into the sediment existing at the bottom of the riverbed, as this could entail the need for a better base for the works. In total, 106 large sacks filled with sandbags were required to finish the body of the dyke.

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It is important to note that in theory approximately 380 sacks were needed to cover the area of the dyke. However, on site we found that the theoretical model was contemplated for a site with a width of 25 metres, and with an even riverbed. The site selected had different characteristics; the width was smaller (final measurement 17.4 metres, but the dyke ended up at 19 metres) and it had an irregularly shaped riverbed. The diagram below provides a description thereof:

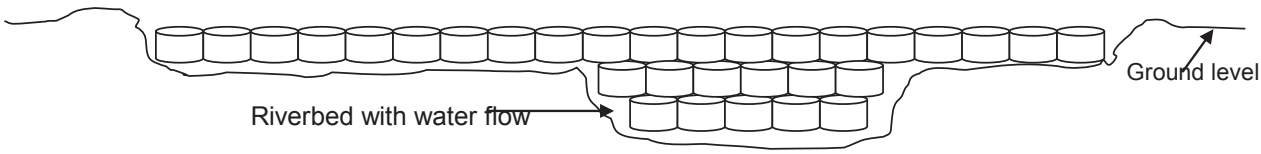

Figure 8. Diagram of front view of the dyke built Prepared by Olman Mena. April 2015

The proposed model agreed in the number of lines and rows (or levels) of sacks necessary to adequately perform the works, given that 5 lines of sacks were needed in the first row, 4 lines in the second row and 3 lines in the third row. As indicated, 111 sacks were used to complete the works, as well as geotextile and coconut fibre (see Figure 9).

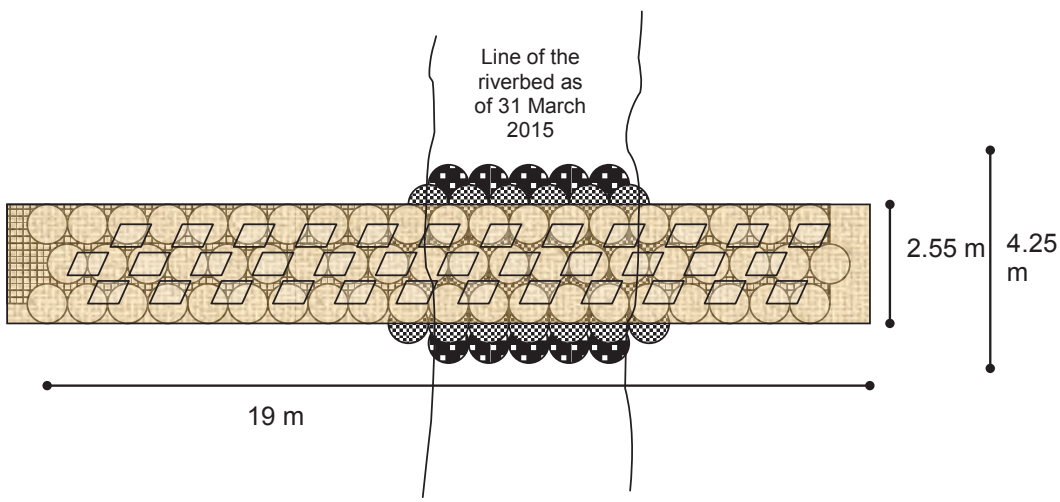

Figure 9. Diagram of front view of the dyke built Prepared by Olman Mena. April 2015

Some of the actions performed to improve the works included tying the sacks through the rings placed to hook them to the helicopter. This helped to improve its shape and to make the dyke more compact. This tying was both at the opening of the sack as well as between the lateral lines of sacks with regard to the middle lines.

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Photo 8. Arrangement and tying of sacks. Photo by Olman Mena, 2 April 2015.

4.5 Placement of woven coconut fibre, burlap sacks and cover of soil, seeds and some plants: Along with the progress in the placement of the sacks in the third row of the dyke, the final finishes began to be applied. This was conducted from the north-east end toward the south-west end of the dyke. After some empty spaces were filled with soil, the coconut fibre was laid out on top of the sacks.

Photo 9. Coconut fibre laid out over the sacks (A) and burlap sacks placed to set the coconut weaved textile. Photo by Miguel Araya, 6 April 2015.

This weave was set with burlap sacks, since it is very thin, to prevent it from being moved by a strong breeze. *Raphia taedigera* (Yolillo) seeds were found and spread all over the dyke, and they were covered with material from the edges of the *caño*.

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In addition, plants of the same species were planted, as well as *Brachiaria mutica* (Pará) which is a type of grass present at the site, and some *Pterocarpus officinalis* (Sangrillo) seedlings, a tree that is common in the area. All of these species are common in this sector, and grow in wetland conditions, which is typical of this sector.

Photo 10. Partial view of the coconut fibre setting process using natural fibre sacks, and placement of soil in surrounding areas. Photo by Miguel Araya, 6 April 2015.

Since there were mounds on the edges of the riverbed, result of the dredging process, this material was used to cover the dyke until the sediment was completely used up.

The works were completed on 6 April, 2015, seven days after the beginning of the transport of material to the *caño*.

Photo 11. Covering of the dyke with material present at the site, result of the dredging. Planting over the dyke. Photo by Miguel Araya, 6 April 2015.

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5_ EFFECTS OF THE DYKE CONSTRUCTION WORKS

The main tasks conducted at the construction of the dyke were: filling of the sandbags and sacks with sand, transportation of this material by helicopter, and the construction of the dyke over the artificial *caño*. Based on these works one can determine that the alterations to the environment were concentrated in two sites: first at the spot where the sacks were filled, meaning the beach at Agua Dulce; and the second site was the spot chosen specifically for the construction of the dyke, in the artificial *caño* at Isla Portillos.

5.1_Impact on Agua Dulce:

Since the filling of sacks was conducted manually, no machinery entered the area (except for the helicopter to transport the sacks). Therefore the estimated effects occurring at this area were: Therefore, the estimated effects produced in this area were:

5.1.1 Removal of 87.04 m³ of sand: This was conducted in an area of less than 1200 m², which helped to make sure that the affected area demonstrated fewer signs of the action. The layer of sand removed is calculated to be less than 7 cm deep. Since most of this material was loose, the effect was minor.

5.1.2 Generation of solid waste: The presence of employees and representatives during the sack filling activities led to the production of solid waste at the site. However, when the works were completed, these materials were removed for their adequate disposal. Only the extra sacks and sandbags from the works remained, and their final use or destination is yet to be determined.

Photo 12. Partial view of the sack filling area after the works were completed. Photo by Miguel Araya, April 08, 2015.

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5.1.3 Generation of wind by helicopter: The helicopter operation generated wind over the sack-filling area. However, since this area lacked vegetation or buildings, no tangible effects were produced at this area. The nearest plants were coconut palm trees, which appeared to be resistant to the winds, thus the impact there was minimal.

5.2 Impact at the dyke construction site:

5.2.1 Generation of noise by the helicopter: The helicopter operation produced loud noise over the site where the sacks were deposited. However, it is important to consider that this effect occurred during the approach, release of the sacks and evacuation of the site, which lasted 2 to 3 minutes per haul. It was brief and not continuous, which reduced the effect on the environment at that point. It is important to mention that the fauna around the dyke did not show evidence of being affected by the works and the noise produced at the site.

5.2.2 Generation of wind by helicopter: The main effect noticed was the crushing of plants at the edges of the *caño*, mainly grass at the site. This effect is reversible since the plants were not cut or altered directly. Another effect observed included broken branches of nearby trees, something that happened sporadically and without reducing the highest crown beyond approximately 10% of each tree.

5.2.3 Drying of plants caused by stepping on them: Drying of plants caused by stepping: Due to the constant passing of personnel on the edges of the dyke at the *caño*, certain *B. mutica* (Pará) plants dried out. Additionally, this was worsened by the strong sunshine during a portion of the time of the works.

Photo 13. Final condition of the area where the dyke was built. Photo by Miguel Araya, 6 April 2015.

It is important to take into account that after the works ended and the site returns to its normal activity, the stems that result from these plants and others in the surrounding areas will easily colonize the affected area, which is less than 30 m².

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5.2.4 Generation of solid waste: The presence of employees during the dyke construction works contributed to the generation of solid waste, which was removed at the end of the works and taken to Agua Dulce for disposal.

5.3_Other effects:

5.3.1 Generation of noise and gases by the helicopter: These were caused by the helicopter's travelling. However, based on its route, this effect was distributed throughout a very large area, thus the effects were reduced.

5.3.2 Fuel spills: Fuel was spilled during a transfer of fuel to fill the helicopter. It was not possible to determine how much was spilled. This happened on the mainland, at the Puerto Lindo area. As a preventive measure, sawdust and sand were kept at the site. The liquid was covered by these materials so that it could be absorbed and not contaminate water sources. The contaminated sawdust and sand were collected and taken to the site for adequate disposal.

6_RELEVANT OPERATION STATISTICS

6.1 Materials used for the construction of the dyke:

The following table shows the amount of materials used for the construction of the dyke:

Table 3. Materials used for the construction of the dyke at the artificial caño, Isla Portillos, Colorado. April 2015

Materials used	Measurement unit	Amount used at the dyke
Conventional sandbags	unit	3180
Burlap sandbags	unit	105
Sacks	unit	111
Geotextile	meters	80
Coconut fibre	rolls	2
String-based rope	rolls	3
Sand	tons	99.9
Volume of sacks hauled	cubic metres	58.75

Source: Field data. Olman Mena, 2015.

The placement of 111 sacks at the *caño* represents the use of over 52% of the total sacks filled for that purpose.

6.2 Number of personnel who participated in the operation:

Table 4 summarizes the number of supporting personnel who participated in the entire operation for construction of the East *caño*, for the different locations involved: construction site at the *caño*, mouth of the Agua Dulce lagoon, and Operating Station of Barra de Colorado at Refugio Nacional de Vida Silvestre Barra de Colorado.

During the days of the operation, there were 9-13 employees permanently located at the different strategic locations of the project at the Tortuguero Conservation Area, conducting a variety of duties, such as: filling of sandbags, construction of the dyke, hooking of sacks at Agua Dulce, water transportation of personnel, water transportation of fuel for helicopter, transportation of materials and equipment, legal advisory, follow-up of works and meal preparation.

Table 4. Number of personnel by institution and total time incurred at the operation sites from 26 March 2015 to 10 April 2015

Institution	Employees	Total time (hours)
Tortuguero Conservation Area (ACTo)/SINAC	19	1338
Border Police (MSP)	36	852
Physical Infrastructure Office / SINAC	1	4
Technical Management Office for the Project	2	12
Ministry of Foreign Affairs	1	11
General total	**59**	**2217**

Source: Field data. Miguel Araya, 2015.

Although a total of 19 employees are reported to be directly participating in the field works at the Tortuguero Conservation Area, it is important to clarify that the total amount of personnel was 24, since there was an additional team providing administrative support to the operation.

The collaboration of personnel supporting the Border Police was required as of 28 March 2015, and involved the filling of sandbags, the protection of the perimeter of the works at Agua Dulce, and patrolling directly related to the operation between Agua Dulce lagoon and the southern limit of the disputed territory, with a daily number of 10-15 employees.

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Furthermore, during the phase prior to the execution and during the development of the works, there was active involvement of the ministry authorities of MINAE and of the Executive Secretariat of SINAC, specifically from the Executive Director's Office, the Physical Infrastructure Office, Institutional Purchases Area and Legal Advisory. Employees of Instituto Costarricense de Electricidad also participated, supporting the design of the works.

Not taking into account the full number of persons who participated in the different planning and coordinating meetings prior to the execution of the works, nor the personnel from the contracted company (Aerodiva S.A.), it is estimated that the operation involved at least 77 persons from the aforementioned entities.

6.3 General summary of duties:

Table 5 summarizes the duties related to the construction of the dyke over the "East *caño*" from 26 March 2015 to 10 April 2015.

Table 5. General summary of the duties related to the construction of the dyke over the "East Caño" from 26 March 2015 to 10 April 2015.

Tasks	Amount
Land transportation of staff (# of trips)	**9**
Water transportation of staff (# of trips)	**18**
Land transportation of materials (# of trips)	**3**
Water transportation of materials (# of trips)	**13**
Water transportation of fuel for helicopter (# of trips)	**15**
Synthetic fibre sandbags filled (#)	**5460**
Natural fibre sandbags filled (#)	**900**
Sacks filled with sandbags (#)	**212**
Fuel consumed for motorboats (litres)	**2016**
Effective helicopter time (hours)	**51:05**
Flights Pavas-Barra de Colorado-Pavas (# of trips)	**2**
Flights Barra Colorado-Agua Dulce-Barra Colorado (# of trips)	**10**
Flights Agua Dulce-Caño-Agua Dulce (# of trips)	**121**
Air transport of sacks (# of trips)	**111**

Source: Field data: Miguel Araya, 2015.

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From the above table it is important to note that the duties related to the construction of the dyke occurred from 31 March 2015 to 06 April 2015. Another important aspect of the table above is that the total amount of flights from Agua Dulce to the construction site and vice versa was 121 trips. However, only 111 of those flights involved the hauling of sacks. This difference involves the transportation of staff at the start of each day, and other necessary flights related to the follow-up of the works.

6.4 Materials remaining from the operation:

Table 6 summarizes the amount of materials remaining from the construction of the dyke over the "East caño."

Table 6. Summary of the amount of materials remaining from the construction of the dyke over the "East *caño*." April 2015

Type	Amount (#)	Location	Observations
Filled sacks (regular)	79	Bocana Agua Dulce	
Filled sandbags (regular)	81	Bocana Agua Dulce	Outside of the sacks
Filled sacks (burlap)	25	Bocana Agua Dulce	
Filled sandbags (burlap)	14	Bocana Agua Dulce	Outside of the sacks
Packages of burlap sandbags	21	P.O Barra Colorado	Complete packages
Polyethylene packages of sandbags	10	P.O Barra Colorado	500 units each
Packs of sacks	15	P.O Barra Colorado	10 units each
Rolls of regular sandbags	9	P.O Barra Colorado	100 units each, plus 17 lose units
Shovels	16	P.O Barra Colorado	
Scales	2	P.O Barra Colorado	To be transported to Guapiles
Burlap sacks	38	P.O Barra Colorado	
Regular defective sandbags	68	P.O Barra Colorado	Inside an empty sack
Rolls of plastic	9	P.O Barra Colorado	Inside an empty sack
Empty sacks	3	P.O Barra Colorado	
Boxes of water, 10 litres	70	P.O Barra Colorado	Use prior to expiration
Bottles of water, 2 litres	50	P.O Barra Colorado	Use prior to expiration
Boxes of supplies	11	P.O Barra Colorado	To be transported to Guapiles Use prior to expiration
Incomplete rolls of string	9	P.O Barra Colorado	
Rolls of yellow string	1	P.O Barra Colorado	
Inflatable boat	4	P.O Barra Colorado	To be transported to Guapiles
Rolls of coconut fibre	2	P.O Barra Colorado	
1/4 roll of geotextile	1	P.O Barra Colorado	

Source: Field data: Miguel Araya, 2015.

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Leftover material included sandbags and sacks filled with sand at the delta of the Agua Dulce lagoon, with a total of 2451 synthetic sandbags mostly contained in 79 sacks, and 564 burlap sandbags contained in 25 sacks. If this material is not used at the site of the *caño* per the recommendations that could be issued by the project's technical management office, it could be used to contain erosion at the edge of Agua Dulce lagoon near its mouth. The legal feasibility of this action must be previously consulted with the National Emergency Commission. If it is not possible to use this material for the purposes recommended, the sandbags must be emptied and the materials must be warehoused at Agua Dulce.

CONCLUSIONS

- The dyke was constructed in conformity with the technical recommendations described in the original project, and the adjustments suggested by the Project's Technical Management, based on the current conditions at the site.
- The dyke's final length was 19 metres, with a width of 4.25 metres on the first row of sacks (base) and 2.55 meters on the third row of sacks. It had an approximate height of 1.6 metres.
- The construction required fewer materials than those planned in the original design.
- The environmental effects of the construction were minimal.

RECOMMENDATIONS

- It is necessary to guarantee monitoring at the site, in order to verify that the dyke behaves adequately and according to its intended purpose as an obstacle to prevent any type of artificial connection between the San Juan River and the Caribbean Sea.
- The monitoring would also allow verifying the progress of the restoration of the natural conditions of the affected wetland.
- It is advisable to perform inspection visits every two weeks, beginning on week 17, and then continuing on week 19; after that, they should be conducted each month, on weeks 23, 27, 31, 36, 40, 44, 49 in 2015, and weeks 02 and 06 in 2016.

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- For the abovementioned tasks, it is necessary to earmark a total of 45 hours of helicopter flight time for monitoring purposes from the existing authorized amount available in the VI Investment Plan Decree N° 36440-MP "Construction of a dyke as mitigation measure where the artificial *caños* are located, built in Isla Portillos, disputed territory, according to the resolution of the International Court of Justice in The Hague".

- If the sandbags and sacks located at Agua Dulce are not destined for any other use, they should be used at the edges of this lagoon as containment walls, specifically at the area near the Agua Dulce Border Patrol operating post, since there is noticeable impact at this site as a result of the water movement. This area is quite close to the location of the materials. The Border Police might be able to help with these tasks.

Miguel Araya Montero, Eng. Natural Resource Management Office	Olman Mena Valverde, Eng. Forestal Management Program

MAM/mam/Oficios/2015*16.04.2015

Appendix List of personnel that participated and supported the closing process of the artificial caño at Isla Portillos, disputed territory between Costa Rica and Nicaragua as per the resolution of the International Court of Justice.

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SISTEMA NACIONAL DE ÁREAS DE CONSERVACIÓN
ÁREA DE CONSERVACIÓN TORTUGUERO
GERENCIA DE MANEJO DE LOS RECURSOS NATURALES

Appendix 1. **: List of personnel that participated and supported the closing process of the artificial *caño* at Isla Portillos, disputed territory between Costa Rica and Nicaragua as per resolution of the Court. April 2015**

Full name	***Department***
Mariana Jiménez Arce	*ACTo/Refugio Nacional de Vida Silvestre Barra del Colorado*
Erick Herrera Quesada	*ACTo/Refugio Nacional de Vida Silvestre Barra del Colorado*
Manuel Arias Guzmán	*ACTo/Refugio Nacional de Vida Silvestre Barra del Colorado*
Jeffry Castillo Machado	*ACTo/Refugio Nacional de Vida Silvestre Barra del Colorado*
Miguel Aguilar Badilla	*ACTo/Refugio Nacional de Vida Silvestre Barra del Colorado*
Lisandro Zúñiga Marín	*ACTo/Refugio Nacional de Vida Silvestre Barra del Colorado*
Jesús Granados Araya	*ACTo/Parque Nacional Tortuguero*
Sara Zúñiga Calderón	*ACTo/Parque Nacional Tortuguero*
Eduardo Segura Fernández	*ACTo/Parque Nacional Tortuguero*
Jorge Cedeño Calderón	*ACTo/Parque Nacional Tortuguero*
Jorge Villalobos López	*ACTo/Parque Nacional Tortuguero*
Adolfo Bernard Padilla	*ACTo/Parque Nacional Tortuguero*
Miguel Araya Montero	*ACTo/Regional Office*
Olman Mena Valverde	*ACTo/Regional Office*
José Joaquín Vargas Mora	*ACTo/Regional Office*
Sebastián Bonilla Sánchez	*ACTo/Regional Office*
Carlos Calvo Gutiérrez	*ACTo/Regional Office*
Carlos Rodríguez Vega	*ACTo/Regional Office*
David Chavarría Morales	*ACTo/Regional Office*
Pablo Acuña Salazar	*ACTo/Regional Office*
Marvin Arias Zeledón	*ACTo/Regional Office*
José Miguel Sánchez Herrera	*ACTo/Regional Office*
Virgita Molina Sánchez	*ACTo/Regional Office*
Laura Rivera Quintanilla	*ACTo/Regional Office*
Julio Jurado Fernández	*SINAC Executive director*
Guido Chaves	*Advisor to the SINAC Executive director*
Fabio Rodríguez Ulloa	*SE SINAC/Physical infrastructure office*
Marietta Tencio Olivas	*SE SINAC/Institucional Purchases Area*
Jensy Rojas Araya	*SE SINAC/Institucional Purchases Area*
William Dalorzo	*SE SINAC/Institucional Purchases Area*
Roberto Quesada Quirós	*SE SINAC/Institucional Purchases Area*
Gidgett Ramírez Hernández	*SE SINAC/Legal advisory*
Óscar Romero Aguilar	*SE SINAC/Legal advisory*
Edgar Gutiérrez Espeleta	*MINAE Minister*
Patricia Madrigal Cordero	*Vice-Minister of the Environment*
Fernando Mora	*Vice-Minister of Waters*
Leonardo Chacón	*Director of the Office of the Minister of MINAE*

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(Continuation of Annex 1)

Arnoldo Brenes Castro	*Advisor to the Ministry of Foreign Affairs*
José Miguel Ramírez Vargas	*Border Police/MSP*
Odilio Campos Gonzáles	*Border Police/MSP*
Rafael Oporta Martínez	*Border Police/MSP*
Jorge Téllez García	*Border Police/MSP*
Cristian Mairena Pomares	*Border Police/MSP*
Jason Rojas Alpízar	*Border Police/MSP*
Adrián Barrantes Hernández	*Border Police/MSP*
Edwin Gutiérrez Hernández	*Border Police/MSP*
Antonio Ledezma Morales	*Border Police/MSP*
Jonnhy Castillo Bado	*Border Police/MSP*
Greivin Pereira Stewart	*Border Police/MSP*
Javier Esquivel Ramírez	*Border Police/MSP*
Alexander Carrillo Romero	*Border Police/MSP*
Pablo López Peterson	*Border Police/MSP*
Aníbal López Jiménez	*Border Police/MSP*
Jean Carlos Ortiz Figueroa	*Border Police/MSP*
Eddy Hernández Alemán	*Border Police/MSP*
Andrés Cordero Hurtado	*Border Police/MSP*
Roynis Palma Pineda	*Border Police/MSP*
Oldemar Potoy Navas	*Border Police/MSP*
Oscar Cambronero Porras	*Border Police/MSP*
Eder Ramírez Madrigal	*Border Police/MSP*
Andrey Cambronero	*Border Police/MSP*
Andrés Cárdenas Hurtado	*Border Police/MSP*
José Pablo Vargas González	*Border Police/MSP*
Eduardo Cantillo Jiménez	*Border Police/MSP*
Randall Carillo Jiménez	*Border Police/MSP*
Gabriel Sequeira Ugalde	*Border Police/MSP*
Roy Jiménez Calvo	*Border Police/MSP*
Carlos Aburto Muñoz	*Border Police/MSP*
Luis Ángel Fonseca Jiménez	*Border Police/MSP*
Jesús Herrera Dinarte	*Border Police/MSP*
David Quesada Corea	*Border Police/MSP*
Marcos Pérez Rodríguez	*Border Police/MSP*
Gerald Camacho Sánchez	*Border Police/MSP*
Allan Hernández Picado	*Border Police/MSP*

Source: Dirección ACTo, field data. April 2015

ACTo: Área de Conservación Tortuguero
SE SINAC: Secretaría Ejecutiva Sistema Nacional de Áreas de Conservación
MINAE: Ministerio de Ambiente y Energía
MSP: Ministerio de Seguridad Pública

Dirección: Estación Experimental Los Diamantes, Jiménez, Pococí, Limón
Tel. (506)27102929 • Fax: (506)27107673 •
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WITNESS STATEMENT

Annex 5

Witness Statement of Mr Mario Zamora Cordero, Former Minister of Public Security of Costa Rica

22 March 2017

English translation and Spanish original

English Translation

NUMBER ONE HUNDRED AND NINE-TEN: Before me, **GUSTAVO ARGUELLO HIDALGO,** Notary Public with office in San José, San Pedro de Montes de Oca, Barrio Dent fifty metres south of Consejo Monetario Centroamericano, at the Boulevard, appears Mr. MARIO ZAMORA CORDERO, Costa Rican national, of legal age, twice divorced, attorney at law, resident of San Jose, bearer of ID number TWO – CERO FOUR HUNDRED AND FORTY-NINE – CERO ONE HUNDRED AND FIFTY. **AND INDICATES THAT:** Having knowledge of the penalties imposed by law for perjury and false testimony, he declares under oath that: **FIRST:** I was appointed Deputy Minister of Police and Governance of Costa Rica from eight May two thousand tend to thirty April two thousand eleven, and then Minister of Public Security of Costa Rica from first May two thousand eleven, until eight May two thousand fourteen. **SECOND:** In my position as Minister of Public Security, I undertook the general control and direction of the Police Force. The Costa Rican police is a civic institution, the aim of which is to provide for the security and preservation of public order according to the Constitution. Its main task is to prevent, attend and pursue against the commission of criminal offenses by individuals or syndicated crime. In carrying out this task, given the human and material resources limitations faced by a small country like Costa Rica, the police carry out their duties mostly in urban areas, and as such, their equipment and training is focused on the fighting of crime in towns and cities, in order to provide security and protection to law abiding citizens and communities. While members of the police are also present in rural areas, their presence there is limited. **THIRD:** First, as a result of the territorial occupation of approximately three square kilometers of Costa Rican territory at the northern sector of Isla Portillos by the Military Forces of Nicaragua, that took place in October-November two thousand ten; and thereafter, as a result of an Order of Provisional Measures indicated by the International Court of Justice on eight March two thousand eleven, the police was faced with a drastic operational change, as we were forced to relocate staff from many of its urban units in order to provide the necessary personnel to establish a presence in the area of Isla Portillos. Many of the relocated police were moved from units in the Central Valley, more specifically from San José, Cartago, Heredia and Alajuela, but more generally resources were relocated almost from all police units across the country. Establishing and maintaining the police presence in the area of Isla

Portillos, which resulted from Nicaraguan actions there, required extensive operational and logistical efforts. First, at the height of the conflict, immediately after Nicaragua invaded Costa Rican territory, Costa Rica placed police personnel in the vicinity of Isla Portillos in order to provide security and assistance to communities in that area, and, where possible, to protect Costa Rican territory from further advances of Nicaraguan military forces. In those circumstances, and in particular given the heightened concern among the inhabitants of the vicinity of Isla Portillos, I had to establish a significant police presence in that area. After the Court indicated Provisional Measures on eight March two thousand eleven, I gave instructions for the planning of a long term police presence, in order to provide security to what was then termed "the disputed territory". This presence was particularly challenging because, as a consequence of Nicaragua's actions, Costa Rica did not have a choice of the adequate location where it could best place a police permanent presence. It had to establish a basic encampment on the right bank of the Los Portillos Lagoon, a location with enormous complexity, as the entire place is a wetland, and therefore there is no hard soil to build proper shelter. Aside from the location of the encampment, the biggest challenge was presented by the relocation of police personnel in that area. Not having readily available police forces for that kind of challenge, the Ministry under my command was forced to reassign police personnel from units in towns and cities serving communities and individuals, and relocate them to Isla Portillos. Moving these police into the area was not a simple task either. They would first be transported to a post called Agua Dulce, where they would be acclimatized and prepared for the task that represented being stationed in the Post of Isla Portillos. From there, they would be transported to this latter post. The Post of Isla Portillos was of extreme operational difficulty, given its inhospitable conditions. Having no running water, no sewage, no electricity, and no proper installations, the personnel suffered from the severe climate conditions, rampant illnesses, and the permanent hostility of the Nicaraguan armed forces. A police unit would be stationed for about ten days at a time there, but once they finish their stay, it did not mean that they would go back immediately to their urban units. They would need rest, and many instances they would go on sick leave, or leave the force altogether. This represented a serious problem for the police overall, as we struggled to secure new recruitments, affecting overall police operations nationally. Being forced to attend to this situation imposed to Costa Rica not only decimated the police's financial resources, but the police units were constantly understaffed, which meant that the Costa Rican communities were not receiving the proper services and protection that they would have otherwise received,

should the police had not faced this situation. As a matter of fact, and not having a specialized unit to address these challenges, I undertook the necessary actions so that a special border police unit be formed. For sake of clarity, this border police unit was formed by taking human and financial resources from other operational structures of the police. It must also be stated that human and financial resources that I was forced to employ to deal with the situation that resulted from the Nicaraguan activities in Isla Portillos mainly included those from the general police force, the Coast Guard, and the Aerial Vigilance Section. **FOURTH:** I am aware that the true financial cost of Costa Rica's mobilization of its police forces in the area of Isla Portillos resulting from Nicaragua's illegal conduct will not be recovered fully, because, beyond the payment of salaries and the tabulation of certain expenses related to that mobilization, the request for compensation does not reflect other internal operational costs, nor does it include the time taken up by administrative units, and most importantly, it does not reflect the overall loss suffered by the Costa Rican communities that were directly impacted by the decline of the police presence in towns and cities, and therefore, Costa Rica's compensation claim that seeks the payment of police salaries employed to deal with the Nicaraguan actions is conservative. As a matter of fact, the relocation of police resources greatly impacted the planning of police activity, as many of those plans to fight crime, particularly syndicated crime, were disrupted or altogether abandoned, as a result of Nicaragua's illegal activity in that Costa Rican territory. That is all I wish to testify. I advised the deponent of the legal value and transcendence of what he stated. I hereby issue a first testimony thereof. This document was read out loud, accepted by the deponent and signed in San Jose, at fourteen hours, on twenty two March two thousand and seventeen. **********

***********MARIO ZAMORA CORDERO *********** GUSTAVO ARGUELLO HIDALGO*************

THE FOREGOING IS AN EXACT COPY OF DEED NUMBER ONE HUNDRED AND NINE - TEN, VISIBLE AT THE BACK OF PAGE ONE HUNDRED AND THREE OF BOOK TEM OF THIS NOTARY'S PROTOCOL. CHECKED AGAINST THE ORIGINAL, IT IS FOUND CORRECT, AND I ISSUE IT AS A FIRST TESTIMONY THEREOF IN THE SAME ACT OF GRANTING OF THE ORIGINAL.

(Signature)

(Stamps)

NÚMERO CIENTO NUEVE-DIEZ: Ante mí **GUSTAVO ARGUELLO HIDALGO,** Notario Público con oficina en San José, San Pedro de Montes de Oca, Boulevard Dent, cincuenta metros al sur del Consejo Monetario Centroamericano, comparece el señor **Mario Zamora Cordero**, de nacionalidad costarricense, mayor, divorciado dos veces, abogado, vecino de San José, portador de la cédula de identidad: dos – cero cuatrocientos cuarenta y nueve – cero ciento cincuenta, **Y DICE:** Que apercibido debidamente de las penas con que la ley castiga el perjurio y el falso testimonio, se presenta a declarar bajo fe de juramento lo siguiente: **PRIMERO:** Que fui nombrado Vicemínistro de Gobernación y Policía del ocho de mayo de dos mil diez al treinta de abril de dos mil once, y luego Ministro de Seguridad Pública del primero de mayo de dos mil once al ocho de mayo de dos mil catorce. **SEGUNDO:** Que en mi condición como Ministro de Seguridad Pública, me correspondió la dirección y el control general de la Fuerza Pública. La policía de Costa Rica es una institución civilista, y su propósito es proveer la seguridad y la preservación del orden público de conformidad con la Constitución. Su objetivo principal es prevenir, atender y aprehender a individuos y el crimen organizado por la comisión de delitos. En el desarrollo de esta tarea, dadas las limitaciones de recursos humanos y financieros que tiene un país pequeño como Costa Rica, la policía realiza sus tareas principalmente en zonas urbanas, en ese sentido, su equipo y entrenamiento es enfocado en la lucha contra el crimen en pueblos y ciudades, de forma tal que se le brinde seguridad y protección a las comunidades y ciudadanos de bien. También hay presencia de la policía en zonas rurales, pero su presencia ahí es más limitada. **TERCERO:** Primeramente, como resultado de la ocupación territorial de aproximadamente tres kilómetros cuadrados de territorio costarricense por parte de las fuerza militares de Nicaragua, que tuvo lugar entre octubre y noviembre de dos mil diez, y luego, como resultado de la orden emitida por la Corte Internacional de Justicia indicando medidas provisionales el ocho de marzo de dos mil once, la policía enfrentó un drástico cambio operacional, pues nos vimos forzados a reubicar personal de muchas de sus unidades urbanas con el fin de proveer el personal necesario para establecer una presencia en la zona de Isla Portillos. Muchos de los policías reubicados fueron seleccionados de sus unidades en el Valle

Central, más específicamente de San José, Cartago, Heredia y Alajuela, pero también generalmente esos recursos fueron reubicados de casi todas delegaciones policiales del país. El establecimiento y mantenimiento de la presencia policial en la zona de Isla Portillos, debido a las acciones de Nicaragua ahí, requirieron de un esfuerzo operacional y logístico complejo. Primero, en lo más álgido del conflicto, inmediatamente después de la invasión de Nicaragua a territorio costarricense, Costa Rica emplazó personal policial en los alrededores de Isla Portillos con el objeto de proveer seguridad y asistencia a las comunidades en esa zona, y, donde fuera posible, proteger el territorio de Costa Rica de mayores avances de las fuerzas militares nicaragüenses. En esas circunstancias, y en particular dado el alto grado de temor por parte de los habitantes en las cercanías a Isla Portillos, tuve que establecer una significativa presencia policial en esa zona. Luego de que la Corte indicara medidas provisionales el ocho de marzo de dos mil once, instruí para que se realizara la planificación para una presencia policial de largo plazo, con el fin de dar seguridad a lo que se llamó "el territorio en disputa". Esa presencia fue particularmente difícil porque, a raíz de las acciones de Nicaragua, Costa Rica no tenía opciones de encontrar una ubicación adecuada para instalar una presencia permanente. Así, tuvo que instalarse un campamento básico en el lado derecho de la Laguna Los Portillos, una zona con mucha complejidad pues toda el área es un humedal, y por lo tanto no hay terreno sólido para construir instalaciones apropiadas. Además de la ubicación del campamento, el mayor desafío fue la reubicación de personal policial a esa zona. No teniendo fuerzas policiales preparadas para ese tipo de operación, el Ministerio bajo mi dirección se vio forzado a reasignar personal policial de delegaciones en pueblos y ciudades que atienden comunidades y personas, y reubicarlos a Isla Portillos. Trasladar esa policía a la zona no fue sencillo. Primero eran transportados al puesto de Agua Dulce, donde eran climatizados y preparados para la tarea que representaba ser ubicados en el puesto de Isla Portillos. De allí, entonces, eran transportados a este último puesto. El puesto de Isla Portillos era de una dificultad operacional extrema, dadas sus condiciones inhospitables. No había agua potable, no había alcantarillado, no había electricidad, y no había instalaciones apropiadas, lo que hizo que el personal

sufriera por el clima implacable, las enfermedades rampantes, y la hostilidad permanente del ejército de Nicaragua. Una unidad policial estaría destacada ahí por unos diez días cada vez, pero una vez que finalizaban su estadía no significaba que volvían inmediatamente a sus delegaciones urbanas. Primero debían descansar, y en muchos casos se incapacitaban o se iban definitivamente. Esto significó un problema serio para la policía en general, pues teníamos problemas para asegurar nuevos reclutamientos, afectando la operación policial a nivel nacional. Siendo forzados a atender esta situación impuesta a Costa Rica no sólo erosionó los recursos financieros de la policía, sino que además las delegaciones policiales estaban constantemente sin personal suficiente, lo cual a su vez significaba que las comunidades costarricenses no estaban recibiendo los servicios adecuados y la protección que de otra forma hubieran recibido si la policía no hubiera confrontado esta situación. De hecho por no existir una unidad especializada para atender este tipo de desafíos es que realicé las acciones necesarias para que una unidad especial de policía de fronteras fuera creada. Para aclarar, esta policía de fronteras fue creada al reubicar recursos humanos y financieros de otras estructuras operacionales de la policía. Debe también decirse que los recursos humanos y financieros que me obligado a emplear para atender la situación generada por las actividades de Nicaragua en Isla Portillos, incluyeron principalmente los recursos de la fuerza pública como tal, el Guardacostas, y la sección de Vigilancia Aérea. **CUARTO:** Me consta que el verdadero costo financiero para Costa Rica de la movilización de su fuerza de policía en la zona de Isla Portillos, resultado de la ilegal conducta de Nicaragua, no podrá ser recobrado totalmente porque, más allá del pago de salarios y la tabulación de ciertos gastos relacionados con esa movilización, la solicitud de compensación no refleja otros costos operativos internos, como tampoco incluye el tiempo empleado por las unidades administrativas, y más importante aún, no refleja la totalidad de la pérdida sufrida por las comunidades costarricenses que fueron directamente impactadas por la reducción de la presencia policial en poblaciones y ciudades, y por lo tanto, la solicitud de compensación que Costa Rica está haciendo para el pago de los salarios de los policías que participaron para enfrentar las acciones de Nicaragua es moderado. De hecho, la reubicación de los recursos policiales, como

resultado de las actividades ilegales de Nicaragua en el territorio de Costa Rica, impactó de manera significativa el planeamiento de operaciones policiales, dado que muchos de esos planes para combatir criminalidad, particularmente relacionada con el crimen organizado, fueros afectados o desechados del todo. Es todo lo que desea declarar. Advertí al declarante del valor y trascendencia legales de sus manifestaciones. Emito un primer testimonio. Siendo leída la presente en voz alta, resulto conforme y firmamos en San José, al ser las catorce horas del veintidós de marzo de dos mil diecisiete.**********

**********MARIO ZAMORA CORDERO********* GUSTAVO ARGUELLO HIDALDO *****

LO ANTERIOR ES COPIA EXACTA DE LA ESCRITURA NÚMERO CIENTO NUEVE-DIEZ, VISIBLE AL FOLIO CIENTO TRES VUELTO FRENTE DEL TOMO DECIMO DEL PROTOCOLO DEL SUSCRITO NOTARIO. CONFRONTADA CON SU ORIGINAL RESULTO CONFORME Y LA EXPIDO COMO UN PRIMER TESTIMONIO EN EL MISMO ACTO DEL OTORGAMIENTO DE LA MATRIZ. ********