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CLIMATE CHANGE

IMPLEMENTATION AND LEVEL OF COMPLIANCE WITH THE PARIS AGREEMENT. TOWARD A CLIMATE CHANGE RESILIENCE PORT: A CASE STUDY OF PORT CORINTO, NICARAGUA.

JORGE ALFONSO GÓMEZ PRADO

A dissertation submitted to the World Maritime University in partial fulfilment
of the requirements for the award of the degree of Master of Science in
Maritime Affairs

2023

Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature):

(Date):

Supervised by: **Professor María Carolina Romero**

Supervisor's affiliation:

Acknowledgements

I dedicate this dissertation to the efforts of all those who have contributed to the development of my nation.

This dissertation would not have been possible without the guidance of all faculty members of the foundation module, who provided the tools needed to prepare it. To the staff members, who guided me during my stay in Sweden, to the staff members of the library who were always willing to aid me when I needed it, and to the faculty members of the MLP specialization, especially Professor Carolina Romero, thank you professor for your thoroughness; your professionalism is an example to follow. I am deeply grateful to Dr. Yohei Sasakawa and the Sasakawa Peace Foundation, for granting me the opportunity to study at WMU, this was a once in a lifetime experience, thank Dr. Sasakawa for giving me the opportunity to improve for the sake of others and mine as well.

For their support and infinite trust, thank you Nicaragua, my home country, I thank the government of Nicaragua, the Nicaraguan Navy, thanks for appointing me to conduct this mission, especially to Commander-in-Chief of Ejercito de Nicaragua General de Ejercito Julio Cesar Aviles, Castillo, al J'EMG EN Mayor General Bayardo Ramón Rodríguez Ruíz, to Inspector General EN Mayor General Marvin Elias Corrales Rodríguez, to Jefe P y C EN General de Brigada Bayardo de Jesús Pulido Ortíz, to Jefe Fuerza Naval Contralmirante Angel Eugenio Fonseca Donaire, to Jefe EM FN Captain Gerardo Fornos Mendoza, to Captain Omar Hernandez, to Captain Mario Berrios Madrigal, to Lieutenant Colonel Mercado, to my brothers from Distrito Naval Pacífico, my great crew and my Ship BL – 408 “NACASCOLO”.

For your understanding, infinite sacrifice and patience, I thank my family, my mother, my sisters and my son who I love and miss so much.

Abstract

Title of Dissertation: **Climate Change. Implementation and Level of Compliance with the Paris Agreement. Toward a Climate Change Resilience Port: A Case Study of Port Corinto, Nicaragua**

Degree: **Master of Science**

This dissertation is a study of the Paris Agreement's implementation within the domestic legislation of the Republic of Nicaragua and the level of compliance to its commitments. The objective of this research is to reveal if Nicaragua has developed the policies to combat climate change by determining the level of compliance of the Republic of Nicaragua with the Paris Agreement, and if the country (having coastlines on the Caribbean Sea and on the Pacific Ocean) has considered the seaports, especially the Port of Corinto which the most important commercial seaport of the country.

Taking into consideration that climate change is here to stay, seaports are the most vulnerable structures to its impacts, and at the same time, they are one of the most important structures for national, regional, and international trade. Climate change resilient ports are needed. This research will identify the institutions responsible for the implementation of the policies as well as identify challenges in establishing standards to determine the adaptation and mitigation measures in order to achieve resilience.

Empirical legal research was adopted in order to be able to determine the level of compliance of Nicaragua with the Paris Agreement. In order to determine if there are adaptation and mitigation measures that suit the necessities of the port of Corinto, and to determine the vulnerabilities, statistical data, and vulnerability studies performed by Nicaraguan agencies were reviewed. The results show that the Republic of Nicaragua has a legal and policy framework to combat climate change, and is in compliance with the Paris Agreement's commitments. However, a limitation of this research was the lack of up-to-date information on some official websites, where all relevant information should be presented and accessible to the general public.

KEYWORDS: Climate change, resilience, adaptation, ports, Nicaragua, implementation, Paris Agreement, policy, identifying, compliance.

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List of Abbreviations

4-NCCC	Fourth National Communication About Climate Change
AKA	Also Known As
ASN	Asamblea Nacional de la República de Nicaragua (National Parliament of the Republic of Nicaragua)
CA	Central America
CABEI	Central America Bank for Economic Integration
CAI	Central America Isthmus
CC	Climate Change
CEMP	Climate Change Environmental Measures Plan
CH ₄	Methane
CO ₂	Carbon dioxide
CP	Contingency Plan
COP21	Conference of Parties of the 21 st Century
CPN	Constitución Política de la República de Nicaragua (Political Constitution of the Republic of Nicaragua)
CS	Caribbean Sea
COVID-19	Coronavirus Disease, caused by the SARS-Co V-2 Virus
DGTA	Dirección General de Transporte Acuático (General Directorate of Maritime Transport)
EMP	Environmental Manage Plan
ENSCC-AP	Environmental National Strategy on Climate Change and Action Plan 2010-2015 (Estrategia Nacional Ambiental y del Cambio Climático. Plan de Acción 2010-215)
EPN	Empresa Portuaria Nacional (National Port Company)
ERN-CAPRA	Evaluación de Riesgos Naturales (Natural Risk Evaluation) Comprehensive Approach for Probabilistic Risk Assessment
GDP	Gross Domestic Product
GHG	Greenhouse gasses
GW	Global Warming
INETER	Instituto Nicaraguense de Estudios Territoriales (Nicaraguan Institute of Territorial Studies)
IPCC	Intergovernmental Panel on Climate Change
H ₂ O	Water vapor
IPCC	Intergovernmental Panel on Climate Change
INETER	Instituto Nicaraguense de Estudios Territoriales (Nicaraguan Institute of Territorial Studies)
MARENA	Ministerio del Ambiente y los Recursos Naturales (Ministry of the Environment and Natural Resources)
MTI	Ministerio de Transporte e Infraestructura (Ministry of Infrastructure and Transport)
N ₂ O	Nitrous oxide
NASA	(US) National Aeronautics and Space Administration
NCACC	National Communication About Climate Change

NDCs	Nationally Determined Contributions
NMTRP	National Multi-Threat Response Plan 2020
NNRR	Natural Resources
NSREDDF	National Strategy to Reduce Emissions from Deforestation and Degradation of Forests
NPFAP-HD	National Plan for Fight Against Poverty and for Human Development 2022-2026
O ₃	Ozone
PA	Paris Agreement
PNLCP-DH Humano	Plan Nacional de Lucha Contra la Pobreza y Desarrollo Humano
PO	Pacific Ocean
REDD+	Reducing emissions from deforestation and forest and degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RMIT	Royal Melbourne Institute of Technology
RNRP	Reforestation and Natural Regeneration Plan
SDGs	Sustainable Development Goals
SINAPRED	Sistema Nacional para la Prevención, Mitigación y Atención de Desastres (National System for Disaster Prevention, Mitigation and Response)
SLR	Sea Level Rise
SNGCC	Sistema Nacional de Gestión del Cambio Climático (National System of Climate Change Management)
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework of Climate Change Convention
VNR	Voluntary National Review

Chapter 1 Introduction

1.1 Background

The Republic of Nicaragua is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and has ratified the legal tools of this Convention to reach the goal of the Paris Agreement, which is to limit global warming to well below 2° Celsius (United Nations Climate Change, n.d.a). Nicaragua is the largest country in the Central America Isthmus with 129,494 km² of land mass and two coastlines, one along the Caribbean Sea that extends up to 450 km and another along the Pacific Ocean with 305 km (Jameson et al., 2019). Being a country with coastlines on both the Caribbean Sea and the Pacific Ocean, shipping is a critical activity that significantly contributes to the country's economy. Figure 1 shows the official map of Nicaragua.

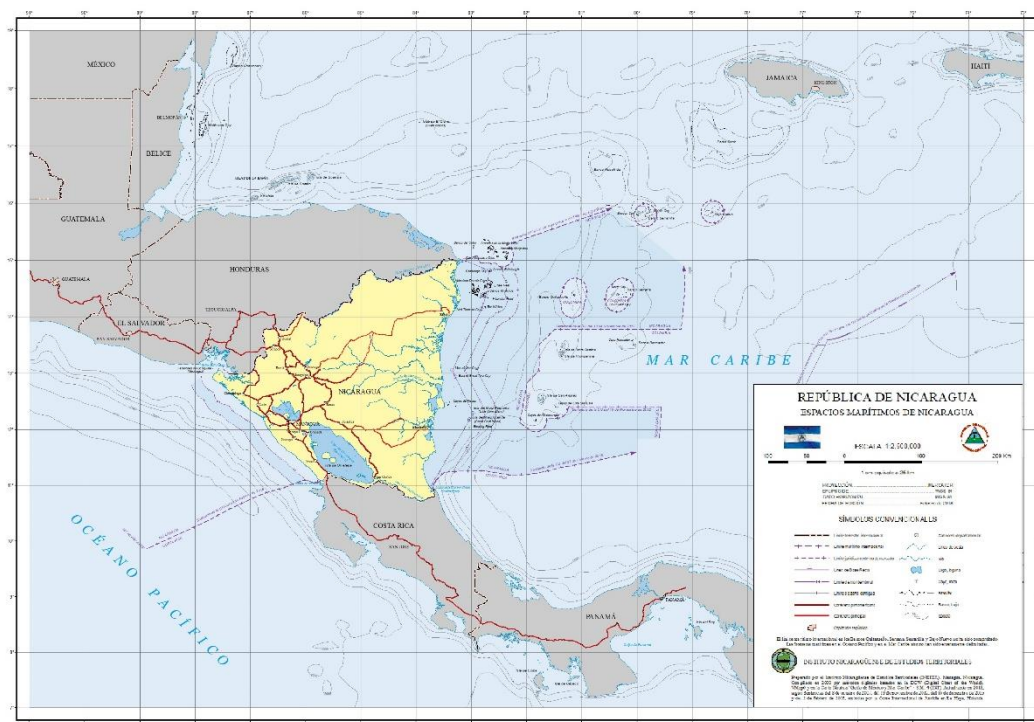


Figure 1: Official map of the Republic of Nicaragua and its maritime spaces. Nicaraguan Institute of Territorial Studies (INETER, 2018)

According to the World Bank (2023), a socio-political crisis in 2018-2019, the pandemic of Coronavirus Disease 2019 (COVID-19), and two significant destructive

hurricanes in 2020, all negatively influenced the country’s economy, resulting in a cumulative Gross Domestic Product (GDP) loss of 8.7%. This impact has had a direct effect on the country’s resources to face the effects of climate change. On the other hand, the Government of Nicaragua (2023) asserts that these four events cost the country’s economy U\$29,543.800. Eckstein et al. (2019) ranked Nicaragua 6th among those most impacted by extreme weather events during 1998-2017, and it has been ranked within the top 10 since 1997.

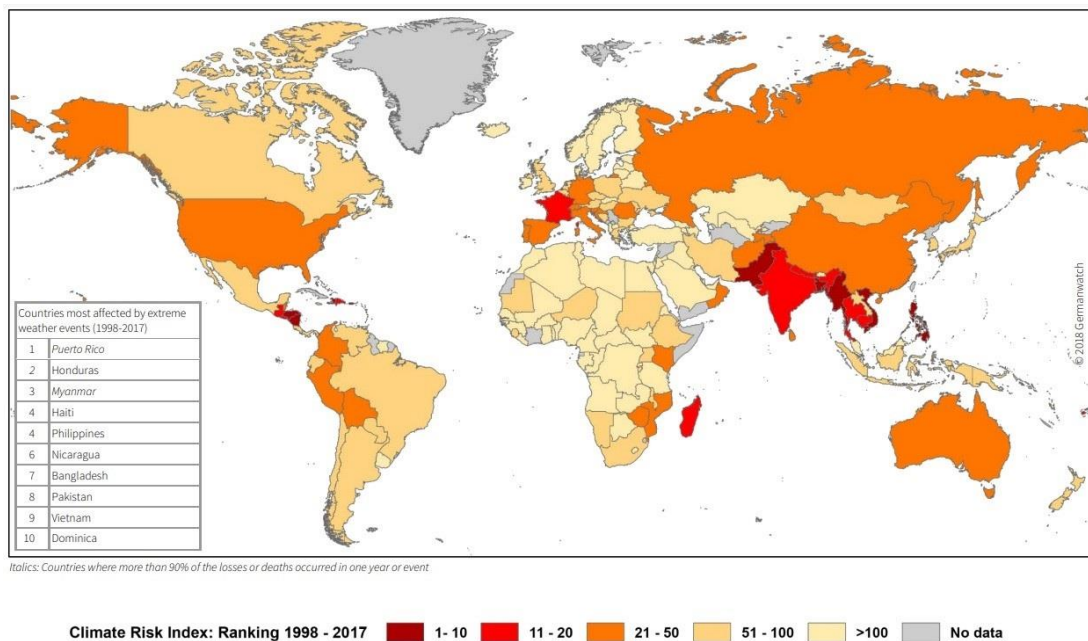


Figure 2: World Map of the Global Climate Risk Index 1998-2017. Eckstein et al. (2019).

Nicaragua proposed to the UNFCCC declaring Central America (CA) and the Caribbean as highly vulnerable regions to extreme weather events, considering that this region has been increasingly impacted by these events recently (Gobierno de Nicaragua, 2021a).

1.2 Problem Statement

Taking into account that Nicaragua is a country located in the Central American Isthmus with coastlines in both the Caribbean Sea and the Pacific Ocean, it has ports on both coasts, and the commercial and touristic activities of these ports contribute to the economic growth of the country. Additionally, the country’s geographical location makes it vulnerable to extreme weather events. These factors evidence the

necessity for research to help policymakers improve the framework to include mitigation, adaptation, and resilience measures in policies, strategies, and planning. Currently, Nicaragua has six commercial ports (Puerto Cabezas, Puerto El Bluff, and Puerto Arlen Siu on the Caribbean Coast; and Puerto Corinto, Puerto Sandino, and Puerto San Juan del Sur on the Pacific Coast); the country also has touristic ports (on the lake of Managua, also known as Xolotlán), and one subsystem of touristic ports located on Nicaragua’s great lake (EPN, 2015). For a better understanding of the vulnerability of the ports of Nicaragua to CC, this dissertation will focus on the six main ports of the country, which are listed in this paragraph. Figure 3 shows the location of each of the six ports in the country. The port of Corinto, which is the object of this research is listed in table 1

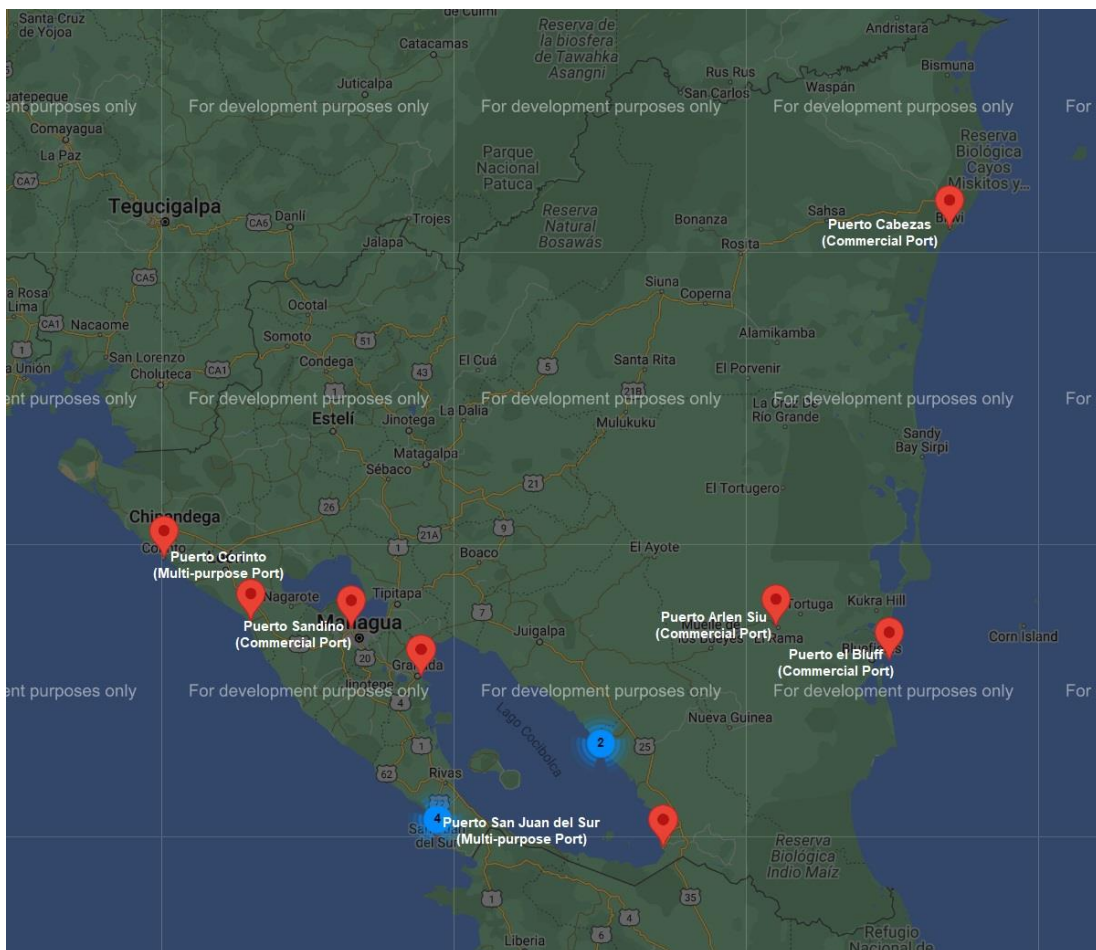


Figure 3: Location of the six main ports of Nicaragua (EPN, 2015)

Table 1: The six main ports of Nicaragua (Table created with data from the Website of ENP)

Location	Name	General Description
Caribbean Coast	Puerto Cabezas	Located on the Autonomous Region of the North Caribbean Coast, provides port services to ships of up to 4m of maximum draft, and international cargo, national cabotage and fishing ships.
	Puerto El Bluff	Located on the Autonomous Region of the South Caribbean Coast, inside the Bluefields Bay, at the mouth of the Rio Escondido, provides port services for ships of up to 5m of maximum draft, and also provides pilot services for ships going to Arlen Siu.
	Puerto Arlen Siu	Located on the Autonomous Region of the South Caribbean Coast, is a river port located on the north bank of Rio Escondido, provides port services for ships of up to 5m of maximum draft.
Pacific Coast	Puerto Corinto	Located on the Pacific Coast, is the main commercial port of the country, provides port services for ships of up to 13 m of maximum draft in its container terminal, it also has liquid terminal for tankers.
	Puerto Sandino	Located on the Central Pacific Coast, it provides services for tankers of up to 12m of maximum draft and for bulk carriers up to 10.5m of maximum draft.
	Puerto San Juan del Sur	Located on the South Pacific Coast, provides services for Cruise ships of up to 5 m.

1.3 Aims and objectives of the study

The aim of the study is to provide an understandable framework for the implementation of the Paris Agreement in Nicaragua. The objectives are

1. To determine the current state of vulnerabilities in the ports of Nicaragua.
2. To identify the laws and policies aimed at combating climate change in Nicaragua.
3. To assess the level of compliance of Nicaragua with the Paris Agreement.
4. To identify adaptation and mitigation measures towards climate change in Nicaraguan ports

1.4 Research Questions

To guide the study, the following questions were formulated:

1. How vulnerable are the ports of Nicaragua to climate change events?
2. What is the legal and policy framework to combat climate change in Nicaragua?

3. How does compliance with the Paris Agreement improve resilience and adaptation in Nicaraguan ports?

1.5 Scope of the Research

This research will focus on the determination of vulnerabilities in the six main ports of the Republic of Nicaragua, which are Puerto Cabezas, El Bluff, and Arlen Siu on the Caribbean Coast; Puerto Corinto, Puerto Sandino, and Puerto San Juan del Sur in the Pacific Ocean; identifying the laws and policies to combat climate change in Nicaragua; and determining the compliance of Nicaragua with the PA commitments.

1.6 Methodology

Statistical data from the *Instituto Nicaraguense de Estudios Territoriales* (INETER), the *Comprehensive Approach for Probabilistic Risk Assessment* (ERN-CAPRA) Volume II Nicaragua, and the 4th *National Communication on Climate Change* were used in order to determine the vulnerability level of the country, especially in the areas along the Caribbean and Pacific coasts.

To analyze the international commitments required by the Republic of Nicaragua under the Paris Agreement and the national legislation regarding this topic, an empirical legal research methodology, which is defined by Abugu (2021), was used in this research through the review of international treaties, Conventions, and agreements ratified by Nicaragua regarding climate change, especially the Paris Agreement, and then a comprehensive description of how these commitments are implemented within the national legislation (legal framework). Additionally, policies and other documents were compared to determine standards on adaptation and mitigation measures to Climate Change (CC). Finally, the institutions, ministries, and agencies of the Nicaraguan government in charge of applying public policies were identified and listed.

In addition, in order to identify examples of adaptation and mitigation measures towards CC, the Nationally Determined Contributions (NDCs) of the following countries' NDCs were reviewed: the United Mexican States, Republic of Guatemala, Republic of Honduras, Republic of El Salvador, Republic of Costa Rica, Republic of Panama, Bolivarian Republic of Venezuela, Republic of Colombia, and the Federative Republic of Brazil.

1.7 Structure of this Dissertation

This dissertation was structured into six chapters, as follows:

Chapter 1 introduction, which includes a brief background of Nicaragua and its ports, and the overall impact of CC on the country. It provides the aim and objectives of the study, as well as the research questions, the scope, and methodology of the study.

Chapter 2 will provide an overview of what CC is, explaining what global warming is, GHG, and how vulnerable Nicaragua is toward CC. Chapter 3 will review the international and national legal framework for fighting against CC. Chapter 4 will identify the current status of compliance by the country with its commitments under the Paris Agreement. Chapter 5 reviews how standards are established. Chapter 6 will provide the findings of the research. The section of Summary will provide the conclusions of the research and will propose future field of study.

Chapter 2 Climate Change

Chapter 2.1 Introduction

Climate change is a world-wide phenomena that implies more climate alteration than anticipated directly related to human activities, such as the extensive use of nonrenewable fuel sources. Such alterations include changes in temperature, precipitation, and wind (Mok et al., 2023). In other words, climate change is a direct result of the harm produced by humans. According to the Intergovernmental Panel on Climate Change (IPCC, 2018) CC alludes to the change of climate by altering its means and/or properties, which continues for a prolonged time, typically decades or longer. This change might be caused by natural processes or external factors, such as anthropogenic effects.

Chapter 2.2 Global Warming

Global warming is the heating of the planet's surface monitored since pre-industrial times (1850-1900), this heating has been caused by human activities, mainly burning nonrenewable fuel sources (fossil fuel/oil), causing an increase in GHGs levels in the atmosphere (NASA, n.d.).

Chapter 2.3 Greenhouse Gasses

Greenhouse Gasses (GHGs) allow energy from the sun to come into the planet, trapping a portion of the outward-bound radiation and warming up the planet. With

this logic, GHGs are beneficial; however, the increasing concentrations of GHGs have dangerously changed the climate (Gore, 2009, p. 28). In other words, the GHGs act like a check valve, trapping the necessary amount of radiation to make life possible on the planet; nevertheless, because of the high concentrations of these gasses this valve is not working as it is supposed to, keeping more radiation on the planet, thereby increasing its temperature and causing climate change.

According to the IPCC (2018), GHGs are carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), ozone (O₃), and water vapor (H₂O), among others. Table 2 presents the major GHGs and the atmospheric lifetime in years.

Table 2: Global Warming Potential and Atmospheric Lifetime for Major Greenhouse gasses (IPCC, 2014, p. 87)

Greenhouse gas	Chemical formula	Atmospheric lifetime (years)	Observations
Carbon dioxide	CO ₂	100*	According to Buis (2019) Carbon dioxide can be in the atmosphere between 300 and 1000 years.
Methane	CH ₄	12.4	
Nitrous oxide	N ₂ O	121	
Tetrafluoromethane	CF ₄	50,000	
Hydrofluorocarbon-152a (HFC-152a)	C ₂ H ₄ F ₂	1.5	

CO₂ is the most important because it accounts for 80% of total GHGs emissions. Every time humans burn nonrenewable fuels, such as natural gas, oil, and coal, in their homes, cars, factories, and power plants, CO₂ is released into the atmosphere. This applies to when they cut or burn down forests or when they produce cement (Gore, 2009, p. 28).

Chapter 2.4 Vulnerability of Nicaragua toward Climate Change

According to the Government of Nicaragua (2021) countries from CA and the Caribbean have been impacted by extreme weather events over the last 10 years, and less developed countries are much more vulnerable to climate risks, although monetary losses are greater in developed countries. In order to present a clearer view of the previous statement, table 3 was created with data from the *Comprehensive Approach for Probabilistic Risk Assessment (ERN-CAPRA) Volume II Nicaragua*,

which contains information from natural disasters up to 2004, and from the 4th National Communication on Climate Change which has records up to 2020, with further research of digital news in order to get data for 2022.

Table 3: Major hydrometeorological events 1971-2022 (ERN-CAPRA, 2011, p. 39), (Gobierno de Nicaragua, 2023, p. 383)

Year	Category	Name	Deaths	Crossed the country entering the Pacific	Observations
1971	Hurricane 5	Edith	80		Heavy rainfall and flooding
1971	Hurricane 3	Irene-Olivia	3	Yes	Heavy rainfall and flooding
1988	Hurricane 4	Joan-Miriam	121	Yes	Heavy rainfall and flooding
1993	Tropical Storm	Bret	10		Heavy rainfall and flooding
1993	Tropical Storm	Gert	11		Heavy rainfall and flooding
1996	Hurricane 4	Cesar-Douglas	9	Yes	Heavy rainfall and flooding
1996	Tropical Storm	Lili	14		Heavy rainfall and flooding
1998	Hurricane 5	Mitch	3,045		Heavy rainfall and flooding
2000	Tropical Storm	Keith	10		Heavy rainfall and flooding
2001	Tropical Depression	Michelle	6		Heavy rainfall and flooding
2005	Hurricane 1	Adrian	3		Heavy rainfall and flooding
2005	Hurricane 3	Beta			Heavy rainfall and flooding
2007	Hurricane 5	Felix	103		Heavy rainfall and flooding
2008	Tropical Storm	Alma	3		Heavy rainfall and flooding
2009	Hurricane 2	Ida			Heavy rainfall and flooding
2010	Tropical Storm	Matthew	65		Heavy rainfall and flooding
2016	Hurricane 3	Otto		Yes	Heavy rainfall and flooding
2017	Hurricane 1	Nate	16		Heavy rainfall and flooding
2020	Hurricane 4	Eta	2		Heavy rainfall and flooding
2020	Hurricane 4	Iota	39		Heavy rainfall and flooding
2022	Hurricane 3	Bonnie	4	Yes	Heavy rainfall and flooding
2022	Hurricane 1	Julia	5	Yes	Heavy rainfall and flooding

Table 3 considers only twenty-two extreme weather events that have hit Nicaragua since 1971 however, several weather events have hit or influenced the country with less intensity. It's worth noting that from the eleven events that were category 3 or higher, six of those events were able to survive crossing the country and managed to enter into the Pacific Ocean, where they were strengthened again. All the events produced flooding, economic losses, and casualties. These statistics show that the country is highly vulnerable to extreme weather events.

In order to identify mitigation and adaptation measures towards CC the government of Nicaragua is making technical and financial efforts to increase the national capacity to evaluate the risks of its territory, economy, and population and foster policies and projects oriented to increasing adaptative capacity and resilience to extreme climate events. The Nicaraguan Institute of Territorial Studies (INETER in Spanish) is the government agency in charge of evaluating the vulnerability of the country's territory. For this purpose, the INETER has established a zone map as shown in figure 4.

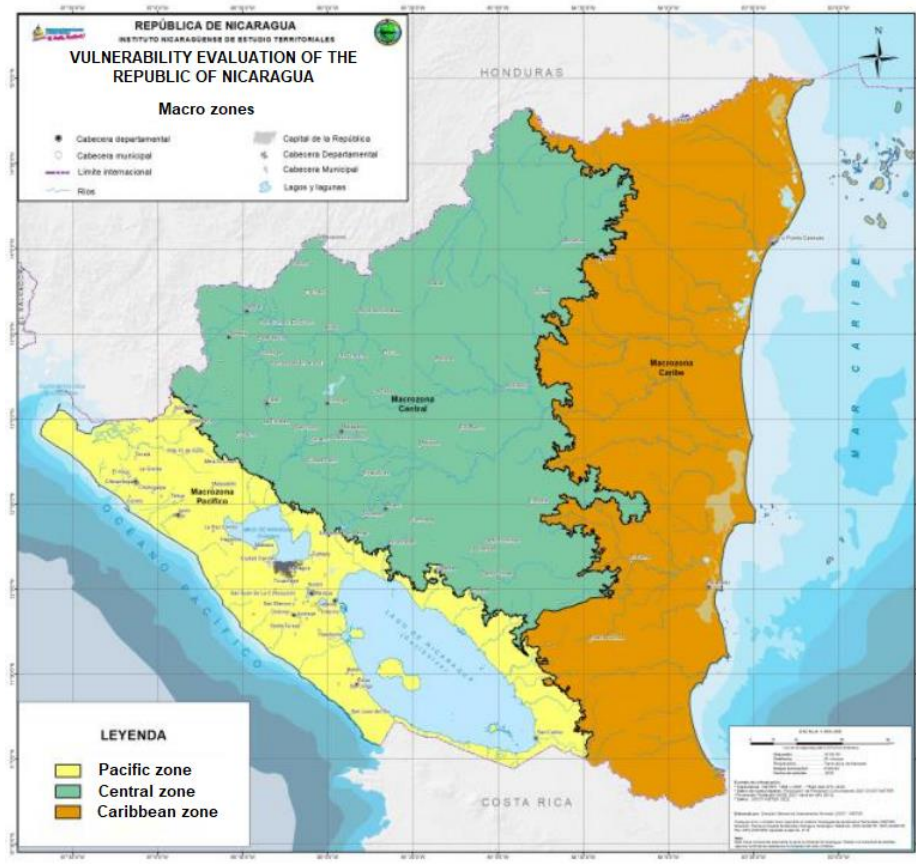


Figure 4: Zones of Nicaragua (INETER, 2022)

With the purpose of effective climate risks evaluation on its territory INETER created a table, presented on table 4, that shows the possible events, their consequents affectations, threats, exposed territories and vulnerable sectors;

Table 4: Identification of Climate Threats (Gobierno de Nicaragua 2023, p. 314)

Events	Affectations	Threats	Expose territories	Vulnerable sector
El Niño	Precipitation	Deficit (30-70%), Drought	Pacific and Central	Population Agriculture Public Health Lakes and Rivers
	Temperature	Increase (1-2°C) heat waves		Population Infrastructure
	Severe Wind	Increase Hight<500m		Power generation
	Ocean/Sea Temperature	Sea Level Rise	Pacific coast	Fisheries
La Niña	Precipitation and severe tropical storms	Increase (30-70%) of precipitations - flooding	Whole country	Population Agriculture Public Health Lakes and Rivers Infrastructure Power generation
		Land slides	Central and the Ometepe Island	Population and infrastructure

In this context INETER produced several maps indicating the areas that are vulnerable to different climate related events, such as, flooding, hurricanes, and sea level rise; these maps correspond to figure 5 (Nicaraguan Map) that shows historical flooding since 1971 to 2010, figure 6 representing the Nicaraguan areas that are more susceptible to be affected by hurricanes, and figure 7 representing the areas of Nicaragua that would be affected by the increase of SLR in two different scenarios.

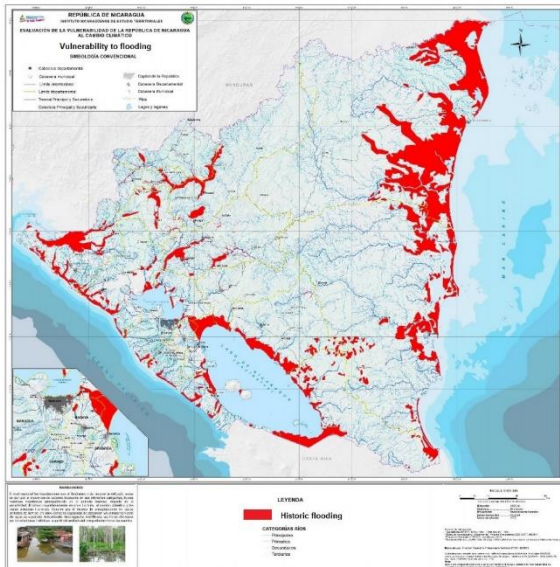


Figure 5: Nicaraguan Vulnerable areas to flooding (INETER, 2022)

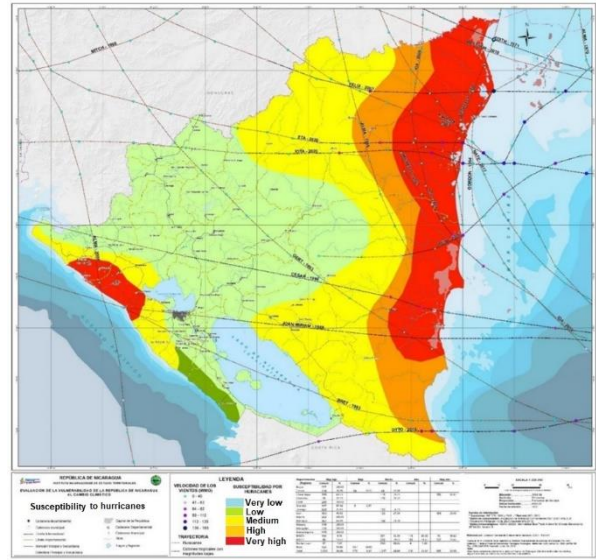


Figure 6: Nicaraguan susceptible areas to hurricanes (INETER, 2022)

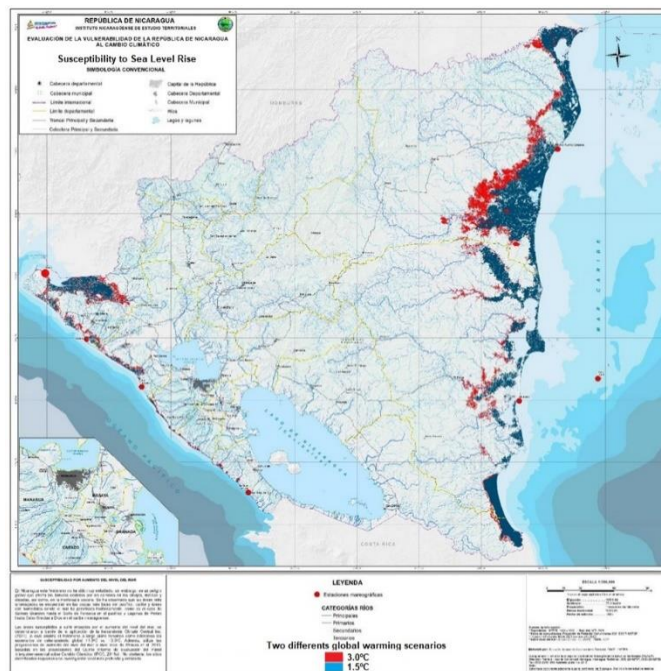


Figure 7: Nicaraguan susceptible areas to SLR with 1.5° GW scenario and 3° GW scenario

From the figures 5, 6, and 7 it can be deduced on one hand that the six main commercial ports in Nicaragua are highly affected by the impact of hurricanes more than any other climate-related event while on the other hand, other events like flooding will highly impact Puerto Arlen Siu and SLR will affect Puerto Corinto, Puerto Sandino, and Puerto San Juan del Sur, thus adaptation, mitigation, and

resilience measures should focus its efforts on the basis of these types of climate-related events nevertheless, no scenario can be dismissed or underestimated.

Chapter 3 Legal Framework to Combat Climate Change (International and National legislations)

Chapter 3.1 Introduction

The cornerstones in terms of international tools for the struggle against CC in Nicaragua are the UNFCCC, the Kyoto Protocol and the Paris Agreement.



Fig 8: Cornerstones of the struggle against Climate Change in Nicaragua

The Republic of Nicaragua has joined several international efforts to fight climate change. The country approved the UNFCCC through the legislative decree 1010 on April 26th, 1995 (Asamblea Nacional, 1995a); and ratified it with the presidential decree 50-95 (Asamblea Nacional, 1995b). On July 7th, 1998, the country signed the Kyoto Protocol, which was implemented within the national legislation through the legislative decree 2295 (Asamblea Nacional, 1999a), of approval on July 13rd, 1999; and then the presidential decree 90-94, ratified it on August 24th, 1999 (Asamblea Nacional, 1999b). The Paris Agreement was ratified on October 23rd, 2017.

Chapter 3.1.1 United Nations Convention on Climate Change (UNFCCC)

The United Nations Convention on Climate Change (UNFCCC) is defined by the United Nations Climate Change (n.d.b) as a convention ratified by 198 countries that recognize the existence of a climate problem caused by human interference. It is considered to be the foundational treaty or Convention that has provided the basis for international negotiations about climate. The global objective of the UNFCCC is the “stabilization of greenhouse gas concentrations in the atmosphere at a level that

would prevent dangerous anthropogenic interference with the climate system” within a timeframe that allows people and the planet to adapt and economies to develop sustainably. The creation of the UNFCCC in 1992 has led to the adoption of subsequent agreements, fostering the development of important policies and infrastructure at national and international levels that lead the fight against climate change (The Grantham Research Institute on Climate Change and the Environment, 2022).

Chapter 3.1.2 Kyoto Protocol

The Kyoto Protocol is defined by Patil (2020) as a global treaty focused on the reduction of carbon dioxide emissions that have caused global warming. It has been ratified by 192 countries. The Kyoto Protocol place a heavier burden on developed countries through binding emission reduction targets. Under the Protocol countries must meet their targets of national emissions which are monitored through a verification and compliance system to ensure transparency (United Nations Climate Change, n.d.c).

Chapter 3.1.3 The Paris Agreement

The Paris Agreement is a legally binding international treaty on climate change, adopted by 196 parties at the UNFCCC Conference of Parties 21 in Paris, France, on December 12, 2015, entering into force on November 4, 2016 (United Nations Climate Change, n.d.a). Its main goal is to halt the increase in the average global temperature to well below 2° Celsius, to pre-industrial levels, and to limit the temperature increase to 1.5° Celsius above pre-industrial levels (Allan et al., 2021). In order to achieve this goal, countries must reach their maximum GHG emission peak as soon as possible, and then they must start to implement reductions to achieve a balance between emissions and the absorption from carbon sinks (such as forests, which absorb carbon dioxide from the atmosphere). The agreement has established that from 2050 and beyond, all signatories must have 0 GHG emissions, guided by its principles, including the principle of equity and common but differentiated responsibilities and respective capabilities, in the light of different national circumstances (United Nations Climate Change, n.d.a).

Chapter 3.2 The Paris Agreement in Nicaragua

The Paris Agreement was ratified on October 23rd, 2017. However, it has a different story regarding approval and ratification in Nicaragua compared with the UNFCCC and the Kyoto Protocol.

According to Democracy Now (2015) the lead negotiator states that the concept of universal responsibility and voluntary commitment doesn't work because Nicaragua had at that time 4.8 million tons of emissions a year representing 0.03% of global emissions. Even though the country had already been working to reduce that percentage, going from 25% renewable energy resources to 52% 2007-2015, the country is expected to reach 50% renewable by 2020.

Dr. Paul Oquist based this statement on the National Company of Electric Transmission (ENATREL), which on its website also shows the evolution of power generation from 2006-2021 in the country.

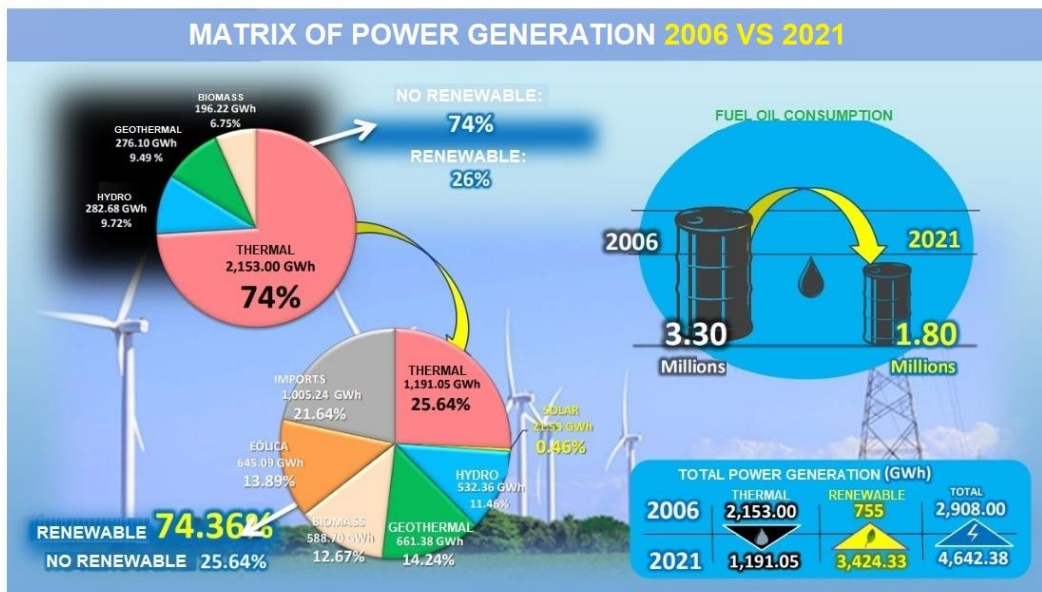


Figure 9: Power Generation Matrix Evolution 2006-2021 (ENATREL, 2023) The legend on the image was translated for the purpose of this dissertation, the original image and legend are available in the reference list.

From figure 9 it can be seen that renewable energy went from 26% in 2006 to 74% in 2021. Furthermore, the country hasn't stopped there, as shown in the next figure.

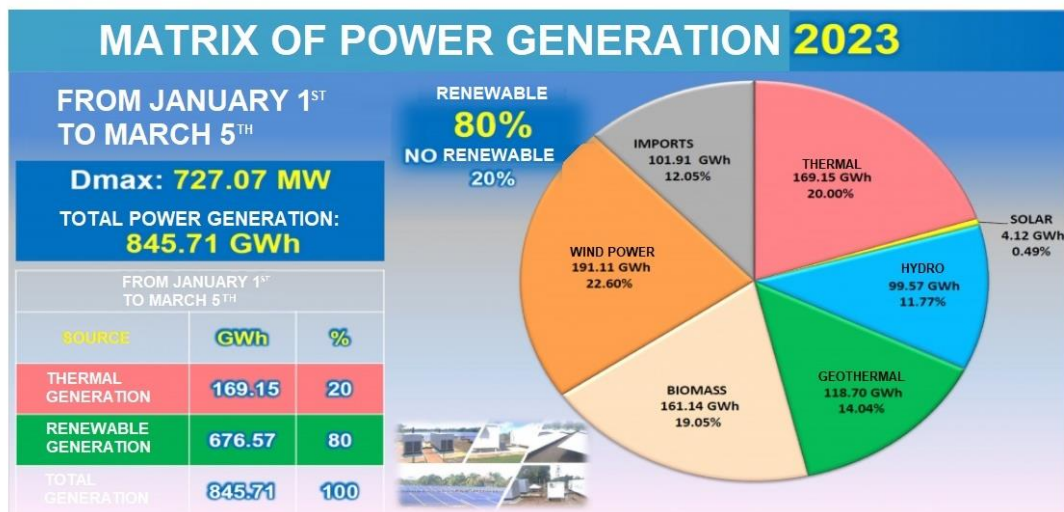


Figure 10: Power Generation Matrix 2023 (ENATREL, 2023) The legend on the image was translated for the purpose of this dissertation; the original image and legend are available in the reference list.

Figure (10) shows the state of power generation in Nicaragua corresponding to the three first months of 2023. It can be seen that power from renewable sources increased by 80% of the total power generated. Dr. Oquist formulated the following question: “Are we going to try to cut out of emissions to a hundred countries with 3% of the CO₂ global emissions, or out of the twenty countries with 78% of the CO₂ global emissions?” (Democracy Now, 2015).

In 2017 Nicaragua, adhere to the Paris Agreement, reiterating the principle of common but differentiated responsibilities, this decision was influenced by the fact that there was already a broad consensus among other countries about the need of a more ambitious goal (Gobierno de Nicaragua, 2021b, p 150). It is worth noting the lack of a presidential or legislative decree to approve or ratify the Paris Agreement (might be related to the circumstances explained above). At the Conference of the Parties (COP26), Nicaragua insisted on the necessity of recognizing that developing countries have not caused the crisis, stating that 10 countries are responsible for 83% of global emissions, while 100 countries represent 3% of these emissions (Gobierno de Nicaragua, 2021a). Nicaragua presented four statements at COP26:

- Statement 1: Central America and the Caribbean as a highly vulnerable region to extreme weather events.

- Statement 2: To elevate Loss and Damage to the same category as Mitigation and Adaptation.
- Statement 3: On the urgency of preserving and recovering of forests.
- Statement 4: On climate justice and reparation, as the basis of the principle of common but differentiated responsibilities.

Despite there being neither a presidential nor a legislative decree that incorporates the PA, there are several legal tools that do incorporate this agreement into the national legislative framework, such as the presidential decree N° 06-2022 *To create the National Committee of Mitigation of Emission of GHGs*, in its article 3.1 the decree orders the regulation of the national implementation of the “International Mechanism to Contribute to the Mitigation of GHGs and to Support Sustainable Development”, according to UNFCCC and the Paris Agreement. Furthermore, article 4.1 mandates representing the Nicaraguan state before the competent authorities of the UNFCCC and the Parties to the Paris Agreement, formed in order to contribute to the mitigation of GHGs emissions and support sustainable development. Similarly, article 4.2 formulates strategies for the national implementation of the mechanisms established within the Paris Agreement and other international voluntary mechanisms of mitigating of GHGs.

To exemplify this, according to Asamblea Nacional (2013), the port authority shall present to the maritime authority the General Directorate of Maritime Transport (DGTA) and to the Ministry of Environment and Natural Resources (MARENA) an Environmental Management Plan (EMP) for the protection of the environment for all the national ports’ spaces.

Chapter 3.3 Implications within the Paris Agreement

The PA works on a five-year cycle of increasingly ambitious climate action. Since 2020 all parties have been submitting their nationally determined contributions (NDCs), in which each party communicates the actions they will develop to reduce their GHGs emissions (United Nations Climate Change, n.d.a). The NDCs are submitted every five years as established in Article 4(9), and every two years,

members shall present reports on progress toward their NDCs to improve transparency as established in Article 13 (Allan et al., 2021).

Each successive NDC is meant to increase the degree of ambition compared to the previous version. Additionally, the PA provides a framework for financial, technical, and capacity building support to developing countries (United Nations Climate Change, n.d.a).

Article 4 of the PA encourages countries to cooperate in their efforts to mitigate climate change by applying the national planification process and adaptation activities, including the evaluation of their vulnerabilities and resilience capacity. Article 5 refers to reducing emissions from deforestation and forest degradation; REDD+ the plus refers to the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks.

This approach incentivizes developing countries to reduce greenhouse gas emissions from deforestation and forest degradation by providing financial and technical support and creating a financial value for the carbon stored in forests, which can then be used to fund conservation and sustainable management efforts. The main goal of REDD+ is to reduce global greenhouse gas emissions while also promoting sustainable development and protecting biodiversity (United Nations Climate Change, n.d.a).

Article 9 states that developed country parties shall voluntarily provide financial resources to assist developing country parties with both mitigation and adaptation efforts; furthermore, Article 13 establishes the responsibility of transparency and accountability in financial flows related to climate change in order to build mutual trust and confidence between the donors and the developing country parties who receive financial assistance. Article 10 refers to the importance of technology transfer development in order to improve resilience to climate change and reduce GHGs emissions, affirming the essential role of technology in the implementation of mitigation and adaptation actions (United Nations Climate Change, n.d.a).

Chapter 3.4 National Legislations and Policies to Combat Climate Change

The National Political Constitution of the Republic of Nicaragua (CPN) establishes the enforcement of sovereign power through four state powers: legislative power, executive power, judicial power and electoral power (Asamblea Nacional, 1986). In order to give an overview of the national legislation of Nicaragua regarding CC, this research identified the relevance of the legislative power and the executive power according to Article 132 of the CPN the legislative power is enforced by the National Parliament, and Article 138 (1) states that the National Parliament has the attribution of elaborating and approving laws and decrees, as well as modifying and derogating the existent ones. On the other hand, executive power is enforced by the President of the Republic as stated in the CPN, Article 138[1]) and Article 150[4] states that the President has the attribution of dictating executive (presidential) decrees.

With this information in mind, this research also identifies the policies regarding climate change in the country, dividing the CC Legal Framework into three phases: Phase 1. Institutional strengthening based on the legal instrument of CC Policies: this phase includes the approval of the General Law of Environment and Natural Resources, whose objective is to conserve, preserve, improve, and restore the environment. It was modified in 2008, adding the formulation of a policy of CC to incorporate adaptation and mitigation in institutional planning (Asamblea Nacional, 1996).

On 2010 the MARENA presented the Environmental National Strategy and CC including its Action Plan 2010-2015 which included the general framework for the management of CC and its guided according to five strategic pillars: (i) environmental education; (ii) environmental defense and protection of NNRR; (iii) conservation and recuperation of water resources; (iv) mitigation, adaptation and risk management on CC and; (v) sustainable management of the land (Gobierno de Nicaragua, 2010).

Phase 2. Institutional involvement based on the creation of a coordination framework for Climate Change response: In this context the Nicaraguan Government approved the *National Policy of Mitigation and Adaptation to Climate Change* and the creation

of the *National System of Response to Climate Change*, using as background (among other factors) the global goal of the Paris Agreement.

This policy is a legal tool that encompasses 13 government institutions and representation from the private sector, and among others has the responsibility of creating the national plan to manage CC, guided by the principles of mitigation and adaptation, evaluating climate risk of the country, elaborate national communications, and the national inventory of GHG (Asamblea Nacional, 2019).

The *National Policy of Mitigation and Adaptation to Climate Change* triggered the creation of the *National System of Climate Change Management*, which replaced the *National Response System to Climate Change*, with the objective of establishing the principles and guidelines for CC National Policy (Asamblea Nacional, 2021a, Article 1). With the implementation of the *National System of Climate Change Management*, its actions were expanded, and power was given to interact within other national entities, especially with the SINAPRED (Asamblea Nacional [National Parliament], 2021b, Article 3). This entity is defined as a strategic political instance of consultation, elaboration, and monitoring of policies and other instruments to comply with national climate goals (Asamblea Nacional, 2021c, Article 3).

According to Article 4 of the presidential decree, table 5 lists all the governmental institutions, agencies, and ministries that are involved in the National System of Climate Change Management (SNGCC) and are coordinated by the CC secretariat of the Presidency of the Republic.

Table 5: NSCCM Integration (Asamblea Nacional, 2021d, Article 4)

Nº	Institution	Type	By its acronyms in Spanish
1	Secretary of Climate Change of the Presidency of the Republic	Secretary	SCCP
2	Ministry of Environment and Natural Resources	Ministry	MARENA
3	Ministry of Finance and Public Credit	Ministry	MHCP
4	Ministry of Foreign Affairs	Ministry	MINREX
5	Ministry of Family, Community, Cooperative and Associative Economy	Ministry	MEFCCA
6	Ministry of Agriculture	Ministry	MAG
7	Ministry of Health	Ministry	MINSA
8	Ministry of Power and Mines	Ministry	MEM
9	Ministry of Woman	Ministry	MINIM
10	Ministry of Youth	Ministry	MINJUVE
11	Ministry of Development Industry and Commerce	Ministry	MIFIC
12	Ministry of Transport and Infrastructure	Ministry	MTI
13	Ministry of Education	Ministry	MINED
14	Nicaraguan Institute of Territorial Studies	Institute	INETER
15	Nicaraguan Institute of Agricultural Technology	Institute	INTA
16	National Forestry Institute	Institute	INARFOR
17	Nicaraguan Institute of Fisheries and Aquaculture	Institute	INPESCA
18	Nicaraguan Institute of Municipal Development	Institute	INIFOM
19	Secretary for the Development of the Caribbean Coast of the Presidency	Secretary	N/A
20	Nicaraguan Council of Science and Technology	Council	CONICYT
21	National Council of Universities	Council	CNU

Table 5 displayed all the institutions involved in the National System of Climate Change Management however, Article 3 gives it the power to interact and articulate with the National System for Prevention, Mitigation and Attention to Disasters (SINAPRED).

The system described above creates the National Policy of CC, whose objective is to contribute to the fight of the country against poverty and human sustainable development and to orient the CC management, using five main pillars: 1) adaptation; 2) mitigation; 3) losses and damages; 4) knowledge and research; and 5) innovation and transference of technology and climate governance (Asamblea Nacional, 2022).

In this context according to UNCC (n.d.) Nicaragua submitted its nationally determined contribution in 2018, and submitted an update in 2020. The task of elaborating and submitting the NDCs is attributed to the SNGCC (Asamblea Nacional [National Parliament], 2021e, Article 5).

Phase 3. Involvement of specialized institutions on CC and strengthening cooperation for the management of CC: This phase included the creation of the CC Secretariat of the Presidency of the Republic, with the objective of strengthening governance on CC Action in Nicaragua (Asamblea Nacional, 2021f). In this context, it was established in phase 2 that the NSGCC has the power to interact with the SINAPRED, which is an interinstitutional system oriented to reduce the risks through activities of prevention, mitigation, and attention to disasters, whether natural or provoked (Asamblea Nacional, 2000). This entity has three new actors and its institution that are not included in table 3.

- President of the Republic or a Delegate.
- Minister of Defense and the Commander in Chief of the Army.
- Minister of Interior and the Chief of the National Police.

Chapter 3.5 Overview of the Selected Laws and Policies

As stated in the Sub Chapter 1.6 an empirical legal research was developed in order to identify the relevant policies, resulting into 29 laws and policies selected, including some created before and after the PA. In this section, a brief overview of each law and policy will be provided, providing a comprehensive understanding of the Nicaraguan legislation on the environment and climate change.

- Law 44 (Law of Emergency): It enables the President to decree a state of emergency, among others, in case of a national catastrophe (Asamblea Nacional, 1988).
- Law 217 (General Law of the Environment and Natural Resources) and its regulation (Decree 9-96): Approved in 1996, its objective is to establish regulations for the conservation, protection, improvement, and restoration of the environment and natural resources, as well as set regulations for including environmental elements in national, regional, and municipal development

planning, and create the National Commission of the Environment as a coordinator entity between the state and the people to harmonize policy making regarding the environment.

- Law 647 (Law of Modifications to Law 217): Approved in 2008, added to Law 217 the concepts of CC, climate change management, CC adaptation, CC vulnerability, and system of environment evaluation (Asamblea Nacional, 2008).
- Decree 1010 and Decree 50-95. Approval and ratification of the UNFCCC, respectively.
- Decree 2295 and Decree 94-99. Approval and ratification of the Kyoto Protocol, respectively.
- Law 838 (General Law of Nicaraguan Ports) and its regulation (Decree 32-2013): Its objective is to regulate everything related to the development, administration, and operation of ports, seaports, river and lake ports, and port facilities. It creates the National Port Company to administer all port facilities and to elaborate and present MARENA with an Environmental Action Plan for the protection of the environment and natural resources located within the vicinity of ports (Asamblea Nacional, 2013).
- Law 337 (Creation of the National System for Prevention, Mitigation, and Attention to Disasters), its regulation Decree 53-2000, its designation of function regulation Decree 98-2000, and its modification Decree 27-2008: Its objective is to establish regulations and general tools needed to create and allow an interinstitutional system oriented on the reduction of risks through prevention and mitigation and attention to disasters, whether natural or provoked, and to designate its functions (Asamblea Nacional, 2000).
- The 1st National Communication on CC was published on 2001. It focused on compliance with the commitments acquired by the country under the UNFCCC. The results of the 1st NCACC are: a) the creation of the first GHGs inventory; b) the evaluation of the impacts of CC on sectors such as

hydropower, forest ecosystems, human health, etc.: and c) the identification and evaluation of vulnerabilities.

- The 2nd National Communication on CC was published in 2012, and as well as the first one was focused on compliance with the commitments acquired by the country under the UNFCCC, describing the impacts of CC on national sectors, providing the 2nd GHG inventory, and a description of how the UNFCCC is implemented in the country.
- The 3rd National Communication on CC was published in 2018, and its objective is to meet the requirements of the UNFCCC. This time, it includes the commitments acquired by the country under the PA, provides a comprehensive description of the climate in Nicaragua, and also provides the 3rd national GHGs inventory.
- The 4th National Communication on CC was published in 2023 and emphasizes compliance with the commitments of the country under the PA presented in the 4th national GHGs inventory. It also provides a clear description of the national climate and the impact of CC on different sectors.
- Decree 07-2019 (To Establish the National Policy of Mitigation and Adaptation to Climate Change): This is a legal tool that provides a strategic framework to guide the transformations developed by the country to face climate change challenges. Its guidelines are:
 - To develop agricultural resilience.
 - To implement a strategy of low-carbon power development with the capacity to adapt to CC.
 - To promote low carbon emissions human settlements adapted to climate change.
 - To develop low-carbon emissions and climate change adapted infrastructures.
 - To use and promote conservation of eco-system services to achieve CC adapted low-carbon emission economic development.

- To promote reforestation, as well as forest conservation, restoration, and rational use of forests.
- To promote research, knowledge, and financing and information about adaptation and mitigation of CC, as well as modernization and strengthening of early warning systems.
- Decree 15-2021: Creation of the National System of Climate Change Management, establishing the functions and national institutions that will form this entity.
- Decree 04-2022: Approval of the National Policy on Climate Change.
- Decree 06-2022: Creation of the National Committee for Mitigation of GHGs emissions.
- The National Environmental Strategy and Climate Change and its Action Plan 2010-2015: It is composed of five main guidelines:
 - environmental education for life.
 - environmental defense and protection of natural resources.
 - conservation, recuperation, collection and water harvesting.
 - mitigation, adaptation and risk management on climate change.
 - sustainable management of the land.

It's worth noting that Guideline 4 (*Mitigation, Adaptation, and Risk Management on Climate Change*) refers to building capacity and the acquisition of resources to build adaptation, mitigation, and reduction of risks due to climate change capacities.

- National Strategy of Reduction of Emissions from Deforestation and Degradation of Forests (REDD+): Its main goal is to reduce deforestation at least 50% by 2040 and to contribute to preventing and reducing CC effects through resilience enhancement and adaptation capacity of forest ecosystems (MARENA, 2017).
- The National Plan for the Fight Against Poverty and for Human Development 2022-2026 (PNLCP-DH): It contains twelve strategic guidelines aimed at transforming the country, in chapter IV includes measures to face the impacts of climate change.

- National Multi-Threat Response Plan which establishes the national framework for operative planification that will orient the national response to natural disasters that may affect, above all, the health and life of the Nicaraguan population (SINAPRED, 2020).
- Voluntary National Review. In this document, Nicaragua reiterates its commitments to keep implementing mitigation and adaptation to CC policies with social and environmental justice, NDCs, and NBS for human development. It also details the advancement, achievements, and transformations of the country in compliance with Sustainable Development Goals (SDGs) of the 2030 Agenda (Gobierno de Nicaragua, 2021c).
- National Determined Contribution. With this document, Nicaragua presents a characterization of its national GHGs emissions, achievements regarding mitigation and adaptation to CC, proposes mitigation and adaptation measures, achievements in the implementation of its NDC in all sectors, and its commitment to the improvement of its NDC (United Nations Climate Change, n.d.d).

Chapter 4 Level of Compliance with the Paris Agreement

Chapter 4.1 Level of Compliance

In this section, an assessment of the level of compliance with the Paris Agreement was conducted. This assessment was built up by listing the policies created with the objective of fulfilling the commitments required under the Paris Agreement, as Nicaragua is a signatory party, in addition to identifying and listing policies created prior the creation of the PA that deal with the environment and CC. A brief description of each policy has been provided. Taking into account that the Paris Agreement was created in 2015 but was only signed by Nicaragua in 2017, the policies that were created after this year have also been identified and listed. Table 6 encompasses the main commitments of Nicaragua under the Paris Agreement.

Table 6: Adaptation of the main objectives of the Paris Agreement for assessment of policies

Paris Agreement	Commitment from Nicaragua
To Limit temperature	The agreement establishes the general goal of keep global temperature well below 2° Celsius, above pre-industrial levels, and to limit increasing temperature up to 1.5° Celsius above pre-industrial levels (The Paris Agreement, 2015),
Submit the Nationally Determined Contribution (NDC)	Article 4 established the commitment of every signatory party to submit a National Determined Contribution (NDCs), to communicate ambitious efforts with the view to achieving the purpose of the Agreement which is to limit the global temperature (The Paris Agreement, 2015).
To Adapt	Article 7 establishes the goal of adaptation: strengthening resilience and reducing vulnerabilities to climate change (The Paris Agreement, 2015).
Capacity building	Article 11 established the necessity of capacity-building, particularly for developing countries (The Paris Agreement, 2015).
Mutual trust	Article 13 establishes a transparency framework in which developing countries shall provide information about: national inventory reports of emissions by sources; track progress made by NDCs; and financial information on support received (The Paris Agreement, 2015).

With this approach, 29 documents were identified and selected, whose objectives are to combat CC and comply with the PA. However, some legislations were enacted prior to the creation of the PA, and others were after enacted the PA. In order make a clear distinction between these legislations Table 7 presents a list of the policies created prior to the ratification of the PA by the country.

Table 7: Policies about environment and CC created prior the ratification PA

Environmental Policies
Law 217 General Environmental and Natural Resources
Decree 9-96 Regulation for the General Environment and Natural Resources Law
Law 647 of modification of the Law 217, adding climate change among other issues
Law 838 General Law of Nicaraguan Ports
Decree 32-2013 Regulations for the General Low of Nicaraguan Ports
Decree 2295 Approbation of the Kyoto Protocol
Decree 94-99 Ratification of the Kyoto Protocol
Decree 1010 Approbation of the UNFCCC
Decree 50-95 Ratification of the UNCCC
Risk Management Policies
Law 44 Emergency Law
Law 337 for the Creation of the National System for Prevention, Mitigation and Attention to Disasters
Decree 53-2000 Regulations of the Law 337
Decree 98-2000 Regulation of functions designations of the SINAPRED to national institutions

Decree 27-2008 Modification of the Law 337 and its regulations to add Work Commissions, and Response groups against disasters

Strategies

National environmental strategy and climate change. Action plan 2010-2015

National Communications on CC

1st National Communication on CC 2001

2nd National Communication on CC 2012

On the other hand, Table 8 provides a list of the policies that were enacted after the ratification of PA, focused on the implementation within the national legislation and compliance with its commitments. It is worth noting that although there is no law that has ratified the PA, Nicaragua ratified the agreement in 2017 as described in Sub Chapter 3.1. Despite this, the PA has not been legally binding or enshrined in law. The Nicaraguan government is working on creating policies to comply with the commitments acquired under the PA, showing a clear determination of the government to contribute to the mitigation of the climate crisis.

Table 8: Policies about environment and CC created after the ratification of PA

Environmental Policies

Decree 7-2019 To Establish the National Policy of Mitigation and Adaptation to Climate Change

Decree 15-2021 To Create the National System of Climate Change Management

Decree 04-2022 Approval of the National Policy on Climate Change

Decree 06-2022 To Create the National Committee of Mitigation of Emission of GHG

Strategies

National strategy to reduce emissions from deforestation and forest degradation 2018-2040

National Plans

National Multi-threat Response Plan 2020 (NMTRP 2020)

National Plan for the Fight Against Poverty and for Human Development 2022-2026

National Communications about CC

3rd National Communication on CC 2018

4th National Communications on CC 2023

International Documents

Nationally Determined Contribution 2018

Nationally Determined Contribution 2020 (updated submission)

Chapter 4.2 Current status of Nicaragua's compliance with commitments acquired under the Paris Agreement

The Nicaraguan Government has approved and implemented several legal tools to ensure compliance with the commitments required under the Paris Agreement. One of the most important is Decree 04-2022, *Approval of the National Policy of Climate Change*. This decree includes an Annex that offers a review of the CC Crisis, including global, regional, national, and institutional efforts to deal with this crisis by including the PA. With this decree, the government has provided the country with a comprehensive legal tool that establishes as a goal to contribute to the fight against poverty and sustainable human development and to promote a low-emission economy, orienting the management of climate change in different aspects such as social, environmental, productive, knowledge management, and strengthening capacities. This policy also establishes that CC management has to overlap with national decisions to fight poverty despite the limited resources of the global scenario, where human adaptation is key. This policy is organized around five pillars of climate action: adaptation, mitigation; loss & damage; knowledge, investigation and innovation, and technology transfer; and climate governance. Each pillar includes specific guidance aimed at specific institutions, orienting them on what to do at a given time, i.e., giving orientations to the SINAPRED, which at the same time works with the SNGCC (reviewed in Sub Chapter 3.3). The policy also gives orientation to improve low emission power generation as presented in the introduction of Chapter 3 including the evolution of the power generation matrix presented in Figures 8 and 9.

Additionally, Nicaragua presented its NDC in 2018 and an update in 2020, reporting the progress made by the country in terms of GHG emissions and power generation from renewable sources, etc. According to the United Nations Climate Change (n.d.a) a Nationally Determined Contribution is a core PA document in which each member reports its endeavors to reduce its emissions and adapt to the impacts of CC. Taking into account that ports are crucial infrastructures of every coastal state, a quick glance at NDCs from several countries in the region was conducted in order to determine whether ports are considered and addressed in these important documents

and to assess whether Nicaragua's DNC is in alignment and harmony with the submissions of those other countries regarding seaport attention.

The result of this review shows that NDC from Mexico talks about strategic infrastructure; on the other hand, NDCs from Guatemala, Honduras, El Salvador, Nicaragua, and Brazil talk about infrastructure in general; and the NDC from Costa Rica talks about the importance of coastal zones, recognizing their value in mitigating CC; and they have planned that by 2025 they will have begun the establishment of sustainable logistics measures in ports. The NDC from Panama does not refer to ports, infrastructure, or coasts.

The Nicaraguan government has created a legal and policy framework with the objective of complying with the commitments required by the PA and has been involved in the fight against climate change since the 90s, developing policies to contribute to face this climate crisis.

Chapter 5 Adaptation and Mitigation Measures towards Climate Change in Ports

In this section, the opinions of several authors about mitigation and adaptation towards CC are considered. For instance, Lin et al. (2020) defined mitigation as an anthropogenic intervention to reduce sources of GHGs that have caused the climate crisis. On the other hand, adaptation is to address and develop resilience to be able to resist imminent extreme weather events. Nevertheless, Yile (2018) concluded that adaptation is used to develop resilience to face an existing impact of CC, while mitigation deals with problems caused by CC from its origins.

On the other hand, Koppe (2017) was able to identify four categories for seaport adaptation: 1) basic port infrastructure (port entrance and maritime access channel); 2) operational port infrastructure (port internal traffic system, quay walls and inner port channels); 3) port superstructure (drainage system, stacking areas, etc.); and 4) port equipment (cranes and cargo handling and storage equipment).

Finally, according to Becker et al. (2013) adaptation involves short and long-term planning, including hard interventions, which are engineering works with a high capital investment, and soft interventions, which involve policy designs.

In this context, Scott et al. (2013) established that adaptation measures cannot be determined without adequate site-specific research and recommended port authorities conduct a location-specific climate risk assessment. This is a very important and key factor that cannot be underestimated when it comes to establishing adaptation standards. Nevertheless, this research will try to identify examples of adaptation and mitigation from different countries.

To begin with this review, Rotterdam has implemented adaptation strategies that are based on three pillars: knowledge (about climate change, and how it will affect Rotterdam); actions (based on the information gathered in knowledge, table 9 shows adaptation measures in the specific case of Rotterdam); and study of the possible consequences of the implementation of each measure (Aboutaleb & Huffelen, 2008).

Table 9: Adaptation Measures Identified in the Rotterdam Climate Change Adaptation Strategy (Aboutaleb & Huffelen, 2008)

No	Measure	Objective
1	Safe Terp	Protection of goods at safe collection points
2	Wet-proof construction	Floodable ground floor and internal moving of goods to higher floors
3	Small compartment dike	Outer to inner protection and vice versa
4	Elevated infrastructure	Guarantees accessibility of the port/safe evacuation
5	Ecological structure	Local cooling/biodiversity/easily accessible pipelines
6	Dry-proof construction/flood wall	Protection of essential functions whose continual operation must be guaranteed.

San Diego Port has developed a climate action plan focusing on the reduction of GHGs. The main measures are shown in table 10.

Table 10: Adaptation Measures of the Port of San Diego, California (Port of San Diego Climate Action Plan, 2013)

No	Measure	Objective
1	Alternative powered vehicles and vessels and advanced technologies	Reduce emissions
2	Roadway System Management	Improve mobility at maritime facilities
3	Land Use	Built connections o public and private transit systems to improve access. Increasing efficiency of transportation network.
4	Parking Policy	Encourage employer-sponsored transportation demand management programs by Port tenants
5	Building Energy Use	Implementing green building standards, building codes to ensure new and existing building optimize new technologies and energy efficiencies.
6	Heat Gain and Shading	Adopt a Heat Island Reduction Plan for new development within port tidelands and Port Operations to reduce urban heat sources and increase shade, and lower building and outdoor temperatures.
7	Lighting	Replace traffic lights and interior and exterior light fixtures with lower-energy bulbs, and promote lighting reduce energy consumption on port facilities.
8	Water Recycling	Promote standards to permit the safe and effective use of gray water and rainwater.
9	Water Conservation	Reduce water use in both indoor and outdoor.
10	Alternative Energy Generation	Increase renewable energy generation from sources, such as solar/wind power, methane recovery, wave power.
11	Smart Grid	Create electricity distribution networks within the port using smart grid and micro-grid technology.

In the Colombian Port Muelles el Bosque, a climate risk study was developed identifying key climate change risks to specific elements of the port. Table 11 shows the main climate change risks with their respective adaptation measures.

Table 11: Adaptation Measures of the Port Muelles el Bosque, Cartagena, Colombia (Climate Risk and Business Ports, 2019)

No	Measure	Objective
1	Raise the height of the causeway road	To prevent flooding
2	Pave the unpaved areas of the ports	To improve mobility at maritime facilities
3	Relocation of storage to less vulnerable areas	To protect perishable cargo from seawater flooding
4	Increase the height of the wall around the patio or increase the height of the patio	To protect cargo from seawater flooding
5	Road system elevation	If Muelles el Bosques elevates the height of its patio there could be the possibility that the road is the most vulnerable part of the system upon the port relies.

These examples reinforce the statement made by Scott et al. (2013) that in order to determine the adaptation measures, an in-site research or risk assessment must be performed to identify the vulnerabilities, and with this information, adaptation measures to build resilience can be designed. Although this affirmation was made ten years ago, as recent as 2021, Asariotis (2021) expressed no right or wrong approach to resilience and adaptation planning for ports, and went further by stating that effective adaptation requires risk assessment. Finally, UNCTAD (2020) established that efficient adaptation and resilience for seaports relies on a risk assessment posed by CC and this assessment must be performed from a spatiotemporal approach.

Chapter 5.1 The Specific Case of the Port of Corinto

The information presented in the previous chapter established that in order to determine adaptation measures for a seaport, a particular study must be performed. With this regard, Law 337 of the Creation of the National System for Mitigation and Attention to Disasters in its Article 8, Numeral 2, Paragraphs 2 and 3, mandates to every institution (the ports of Nicaragua are under the Administration of National Port Company, which is under the rule of the General Directorate of Maritime Transport, which is under the Ministry of Transport and Infrastructure) to elaborate disaster plans according to the threat to which they are exposed, and those plans must include mitigation and adaptation measures, among other elements.

The port of Corinto, SINAPRED, and EPN are working together with the assistance of the CABEI in the Project to Improve the Port of Corinto's Technical and Operational Capabilities, which was approved in 2021 (CABEI, 2021) and aims to modernize the Nicaraguan Port of Corinto. This project includes several plans that are elaborated and implemented by the Port of Corinto and are available to the public. This research identified chapter seven of the project, which is "Risk Analysis". In that chapter, a climatic risk assessment was developed, and risks were identified using an environmental approach performed specifically for the port of Corinto. This analysis include:

- Danger identification: which defines specific situation with the potential to cause harm to human population, infrastructure or the environment or any combination of them. War and terrorism are not included in this identification phase.
- Frequency analysis: defines the frequency of the occurrence of the harm within a period of time or specific circumstances. The classifications are: a) Almost certain (It could happen once a year); b) Very likely (It could happen occasionally in ten years); c) Likely (It could happen in twenty years); d) Possible (It could happen in thirty years); and e) Remote (It could happen in forty years).
- Analysis of the severity of the consequence: Identify the effects of a specific harm that threat human population, infrastructure and the environment, this includes. The classifications are: a) Catastrophic (>US\$40 million and high human fatalities); b) High (>US\$5 million and several human fatalities); c) Moderate (>US\$1 million and human injuries); d) Low (Infrastructure and Environmental damages); and e) None (There is none consequence).
- Risk management: Include the development of mitigation plans and reduction of the risk.

In order to make the Port of Corinto a resilient port toward CC, mitigation and adaptation measures are established based on the risk analysis mentioned above. These measures are included in the Environmental Management Plan, which is part

of the Environmental Impact Study of the Project of Modernization mentioned above, which is performed with the assistance of the CABEI. The plan is located in Chapter 9 of the study and is integrated by 11 sub-planes (CABEI, 2018) however, for the purpose of this research, only three of them were identified as strictly related to CC events, mitigation, and adaptation:

The Climatic Environmental Measures Plan, which established the following mitigation measures for the Port of Corinto:

- Reforestation campaigns to capture CO₂ which were performed in the surrounding areas of the ports. This activity, with the assistance of the town hall of the municipality, has the objective of helping the restoration of the ecosystems.
- Implementation of power savings from the lighting systems of the port in areas such as the refrigerated cargo area.
- Replacement of technologies with more efficient ones, such as the conversion of cranes and forklifts.
- Promote through information and education campaigns the efficient use of air conditioning in the port's building.
- Give the instruction to turn off every non-working vehicle, machine, or equipment.

Additionally, in addition to these mitigation measures, the following adaptation measures are established, again for the specific case of the port of Corinto.

- Adequacy of port facilities to reduce the impacts of flooding, including land shaping by raising elevation levels and the construction of erosion control structures.
- Design and construction of drainage systems should take into consideration climate variability according to Ministry of Transport and Infrastructure (MTI) design criteria.
- Coordinates with the town hall and delegations of institutions at the municipal level, taking actions for search and rescue (SAR) if necessary.

- Maintenance and rehabilitation planning for port infrastructure considering climate variability.

To complement the mitigation and adaptation measures the Contingency Plan encompasses organizational and technical steps to respond to a multi-threat or specific scenario, including (but not limited to) hurricanes and flooding, establishing specific tasks to be carried out by each institution involved before, during and after the event and finally, the Reforestation and Natural Regeneration Plan, gives tasks to each national institution to plant 10 trees for each tree that it's removed for development reasons, prior the reforestation take place it is oriented by this plan to developed an inventory of the species in order to use the same or others present in the affected environment, it also provides guidance on how to effectively plant, type of fertilizer to use, etc.

Prior to the development of the plans referenced above, the EPN presented in 2016 the First Manual of Good Environmental Practices for the Ports of Nicaragua, whose objective was to provide every port terminal worker at the Port of Corinto with specific tasks to reduce the environmental impact of the port terminal (EPN, 2016).

Chapter 6 Findings

This research yields the following results:

1. The ports of Nicaragua are very vulnerable to CC, as established in Sub Chapter 2.4 from the data collected, it can be confirmed that the seaports that lie along the Caribbean side of the country are very vulnerable to the impacts of CC.
2. The Nicaraguan government has created laws and policies to combat CC, and they were identified and listed in Sub Chapter 3.5 making a clear distinction between those created before the PA was signed and those enacted after the signature of the PA in Sub Chapter 4.1.
3. The institutions and government agencies involved in the CC management were identified and listed in Table 5.

4. Specific adaptation and mitigation measures for the port of Corinto were identified; however, it was not possible to identify these measures for other ports in the country because of the lack of information.
5. The NDCs reviewed do not address ports specifically; rather, they are reports that show the efforts and advances made by the parties that would lead to achieving the global goal of the PA. Nonetheless, each party has its own very particular legal framework that address resilience, adaptation, and mitigation of ports toward CC. A good example of this statement is the case of the Federative Republic of Brazil, which according to Veiga & Souza (2022) has well differentiated national, state, municipal and local policies regarding CC, and port development agenda.
6. Nicaragua presented its first NDC in 2018 and an updated version in 2020, in accordance with the commitments required by the country under PA. Some relevant differences and improvements are:

DNC 2018

- The country presented a characterization of its GHG emissions for the period 2000 – 2010, resulting in the total national emissions representing 0.01% of global emissions corresponding to the same period.
- The main efforts of this NDC were focused on power generation from renewable sources.
- It has been identified that economic growth is essential to facing CC and in order to overcome this limitation, the following challenges must be faced:
 - Access to financial resources to strengthen capacities in climate finance.
 - Capacity building to create knowledge and habits that contribute to the adaptation process of the entire country.
 - Developed surveillance, monitoring, and early warning systems for hydrometeorological events.
 - Institutional strengthening regarding CC.

NDC 2021 (update)

- Established the country's responsibility for 0.02% of global emissions in 2018 however, it was ranked the 6th most vulnerable country to CC. Presenting as evidence of this vulnerability that in 2020 the country was hit by two hurricanes (category 4 and 5) within a 10-day timeframe.
- Regarding contribution to mitigation, the country reported that by 2021 it will implement, with the assistance of the World Bank's Forest Carbon Partnership Facility, a program to reduce emissions on the Caribbean coast of the country.
- The country presented an updated version of its GHG emission inventory.
- It was reported that the municipal garbage dump called "La Chureca" (considered one of the largest garbage dumps in the region), was not only sealed, but a recycling plant, 250 houses, and one school were built, benefiting the families that used to work in that garbage dump.
- The country presented gender equality as a principle to achieve the current NDC goals.
- The country reported that by 2021 will create the *National System of GHGs Inventory*.

Summary and Conclusions

Climate change is real, and it's here to stay, and humankind is not doing enough to prevent the worst scenarios for future generations. According to Pacto Mundial (2020), despite a slight reduction in emissions during the COVID-19 pandemic, concentrations of GHGs are still increasing, reaching new records. In this context, the Republic of Nicaragua has been involved in the fight against CC since the early 1990s, and has approved, ratified, and implemented since then all the international conventions regarding this topic, including the Paris Agreement. However, the Nicaraguan government's official position on this topic is that justice must prevail. This position arises from the perspective of a developing country that, along with a hundred countries, is responsible for 3% of global emissions, and even though this

position may be perceived as a lack of willingness to take action, statistics from international organizations won't let this kind of approach be seen as true by the international community. To exemplify this, according to the World Bank (2023), the total emissions of Nicaragua in the year 2019 were 4.6 million metric tons per capita, and for the year 2020, they were 4.3 million metric tons, reducing 0.3 million metric tons of its national emissions through national efforts. It is worth nothing to mention that, according to Rivera & Wamsler (2014), at the regional level, Nicaragua is part of the Central American Integration System (SICA) and has acquired several legal tools regarding climate change that were not included in this study.

This research established that the Nicaraguan seaports are highly vulnerable to the impacts of CC, thus requiring special attention from government agencies as they are vital infrastructure for the country's economy. For that reason, the Nicaraguan government has created a legal framework to combat CC, assigning tasks to specific institutions in order to implement this legal framework. For the port of Corinto, adaptation and mitigation measures to build resilience are clearly established on the basis of an in-site risk analysis.

The country is in compliance with the commitments of submitting its NDCs, which report its improvements in the reduction of emissions in every productive sector, identify challenges to fight against CC, highlight power generation from renewable sources as the main effort of the NDC, and increase its ambitions for the future. Mitigation and adaptation measures for the port of Corinto may be useful for other ports of the country; however, this dissertation, along with other articles, has established that these measures should arise from a well-developed in-site risk assessment to determine the particular vulnerabilities of a specific seaport, even for ports that are close to one another. Finally, the implementation of efficient adaptation and mitigation measures contributes to obtaining a resilient port.

The research was focused on the port of Corinto, which is the most important commercial port in Nicaragua. Adaptation and mitigation measures towards CC to build resilience were identified; however, the country has several ports along the Caribbean and Pacific coasts whose adaptation and mitigation measures weren't

identified because information was not available. This limitation represents a promising area for future research, for instance, specific adaptation and mitigation measures for the port of Puerto Cabezas, which was impacted by two major hurricanes in a 10-day period in 2020 and managed to overcome these impacts and their consequences and is still operational.

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