The Economics of Climate Change Adaptation and Ecosystem Services in The Bahamas:

Lessons from San Salvador Island

Inter-American Development Bank

Country Office The Bahamas
Climate Change Division

TECHNICAL NOTE Nº
IDB-TN-02465

May 2022

The Economics of Climate Change Adaptation and Ecosystem Services in The Bahamas:

Lessons from San Salvador Island

Inter-American Development Bank

May 2022

Cataloging-in-Publication data provided by
the Inter-American Development Bank
Felipe Herrera Library
The economics of climate change adaptation and ecosystem services in The Bahamas: lessons from San Salvador island / Inter-American Development Bank.
p. cm. — (IDB Technical Note ; 2465)
1. Climate changes-Economic aspects-Bahamas. 2. Climatic changes-Risk assessment-Bahamas. 3. Coast changes-Bahamas. I. Inter-American Development Bank. Climate Change Division. II. Inter-American Development Bank. Country Office in Bahamas. III. Series.
IDB-TN-2465

JEL Codes: Q01, Q54, Q57.
Key Words: The Bahamas.

http://www.iadb.org

THE ECONOMICS OF CLIMATE CHANGE ADAPTATION AND ECOSYSTEM SERVICES IN THE BAHAMAS: LESSONS FROM SAN SALVADOR ISLAND

IDB

Check the full version of the report at https://publications.iadb.org

Foreword

Daniela Carrera-Marquis
Country Representative
IDB Country Office The Bahamas

Although further economic diversification is a continuing objective, for decades, tourism has been a key pillar of the Bahamian economy, accounting directly and indirectly for more than 40% of GDP, 51.6% of total employment, and 61.5% of total exports in the country. However, since 2006 the island has faced many challenges, due, in part to the increasing intensity of extreme weather events that negatively impact critical infrastructure and socio-economic development.

Hurricane Joaquin (2015) destroyed large parts of the southern islands, including San Salvador, which suffered approximately US$19 million in damage to its productive assets; this was exacerbated by the impact of Hurricane Dorian (2019) in the country. As a result, the tourism-based island economy is constantly under threat of climate change impacts such as submergence of coral reefs, flooding of coastal lowlands, loss of marine and terrestrial biodiversity, and destruction of cultural heritage sites.

As one of the most researched and recognized historical islands in the country, and given the vulnerability of coastal infrastructure to climate-related risks, and the interdependency of social, economic, and environmental ecosystems, the Government of The Bahamas requested the Bank's support in adopting a multi-dimensional approach to planning and development.

Future development plans will require careful consideration and protection of the coastal habitat which provides critical goods and services (ecosystem services) to the local economy, while considering the historical and ecological importance of San Salvador. Equally important will be the coordination of health, climate, and disaster risk management frameworks to manage the future development scenarios for climate-resilient tourism development in San Salvador.

This publication is one of several products developed through a technical cooperation between the Bank and the Government. The IDB's Country Office in The Bahamas is proud to have partnered with Bahamian subject-matter experts from the University of The Bahamas, Gerace Research Center, and civil society to produce studies which should be utilized by policymakers, students and citizens, as they explore sustainable and resilient development scenarios for San Salvador and other islands in the archipelago, in the context of advancing an inclusive blue economy.

As one of the smallest inhabited islands in The Bahamas, San Salvador is recognized for its historic monuments, pristine beaches, and rich culture. It is hoped that this will contribute to continued national dialogue on the future of this – and other islands in the archipelago which have faced similar developmental challenges – but have a wide range of adaptation measures to consider for the future.

Thank you!

Acknowledgments

The Economics of Climate Change Adaptation and Ecosystem Services in the Bahamas was elaborated as part of the Technical Cooperation “Support to Climate-Resilient Tourism Development in San Salvador” implemented by the Country Office (COF) in the Bahamas and the Climate Change Division (CCS) of the Inter-America Development Bank (IDB). The elaboration of the Report was led and supervised by María Eugenia Roca (Chief of Operations COF Bahamas) and Gerard Alleng (Senior Specialist CCS).

The Report was developed by Factor CO_2 and Instituto de Hidráulica Ambiental de la Universidad de Cantabria (IHCantabria) in 2018. The team was led by Kepa Solaun and consisted of Fernando Liaño, Susana González, Adelle Thomas, Mariana Arroyo, José Antonio Juanes, Raúl Medina, José Barquín, Cristina Izaguirre, José Álvarez, Cristina Galván, Aracelli Puente Trueba, Elvira Ramos Manzanos. Ana Silló-Calzada, Saúl Torres-Ortega, Patricia González-Lamuño Rubiera, Pedro Díaz-Simal, Antonio Espejo, Pelayo Menéndez, María Recio Espinosa, and Hanna Nicole Willey.

The team thanks numerous colleagues from other divisions at the IDB and multiple institutions from the Government of the Bahamas.

The Report was edited by Zachary Zane. Graphic design by Evi Jurado. Publishing support by Natalie Bethel (COF Bahamas) and Adrián Flores (CCS).

Table of contents

List of Figures

List of Tables

List of Acronyms

BAU	Business as Usual
DHW	Degree Heating Weeks
GDP	Gross Domestic Product
IPCC	Intergovernmental Panel on Climate Change
MCA	Multicriteria Analysis
SLR	Sea Level Rise
RCP	Representative Concentration Pathway
TCS	Tropical Cyclones
TWL	Total Water Level

The Economics of Climate Change Adaptation and Ecosystem Services in the Bahamas: Lessons from San Salvador Island 13

Context

Due to San Salvador Island's limited land space, fragile ecosystems, human and technological capacity, and its susceptibility to the vagaries of international trade and exogenous economic shocks, the island is highly vulnerable to climate change impacts such as higher temperatures, sea-level rise, and coastal flooding linked to extreme events.

Concentrated in the coastal areas are most of the population and the country's more critical assets. Therefore, impacts from climate change will significantly affect the sectors that constitute the socioeconomic spectrum of the island, like urban settlements, population, tourist resources, and infrastructure, among others.

Tourism is one of the most sensitive sectors to the impacts of climate change. An increase in future extreme events will negatively affect the infrastructure and population by damaging the coral reefs, causing coastal flooding, losses of surface area due to erosion, and destruction of cultural, historical, and environmental heritage.

Considering all these scenarios and their possible impacts on development issues, the Inter-American Development Bank (IDB) has proposed this project as a strategic program for the island.

Two main objectives were established:

Conduct an Economics of Climate Change Adaptation study that seeks to identify and analyze the main impacts of climate change, estimate potential economic losses, and propose adaptation measures to improve the island's resilience.

Conduct an Ecosystem-Services study that seeks to identify the main ecosystems of the island, evaluate the services they provide, and how they contribute to the economy of San Salvador Island. It also aims to integrate the results obtained from both studies to identify the impacts of the ecosystems on the expected economic losses.

Stakeholders held three consultations to achieve the project objectives. The first consultation was held in Nassau in November 2017 with the leaders of the different departments of The Government of The Bahamas. The second was held in January 2018 on San Salvador Island with the leaders of the main sectors and institutions of the country to validate the proposed economic scenarios. The third and final one occurred the first week of September 2018 to present the results in Nassau and San Salvador Island to the national and local authorities and academia.

1 Development Scenarios

Evaluating losses due to climate change is a complex exercise. It requires developing future scenarios and conducting a probabilistic loss quantification to estimate the total risk of the area under study. This risk must consider the effects of climate change and changes in exposure due to socio-economic growth. Based on the magnitude of expected losses and applied on a local scale, this risk analysis allows decision-makers to decide from a portfolio of the most appropriate adaptation measures.

Four development scenarios were defined for this study, together with the community of San Salvador Island, to estimate the future economic losses. One scenario represents the current situation of San Salvador Island, and three future scenarios represent the different trends in the development of the island's activity at the 2050 horizon. For each scenario, the community validated the characteristics and development priorities.

The three future scenarios are:

Business as Usual (BAU)

Past trends on the relevant behaviors are assumed to continue until the time horizon. This behavior would require demographic policy adjustment to attract permanent population to the island, as young people's social conditions and economic opportunities to stay in the area are far from attractive.

Intense development

An intensive development of human activities on the island is assumed based on the projection of two combined trends: the population growing steeply, and economic activities derived from touristic intensive operations growing to provide the people with an attractive working opportunity.

Sustainable development

Expected growth and population have been capped, focusing on the optimal exploitation of natural resources on an intertemporal basis. The trends limit population growth to a level compatible with preserving the environment and restricts emerging activities to those consistent with empowering natural assets and a sustainable approach to resources.

2

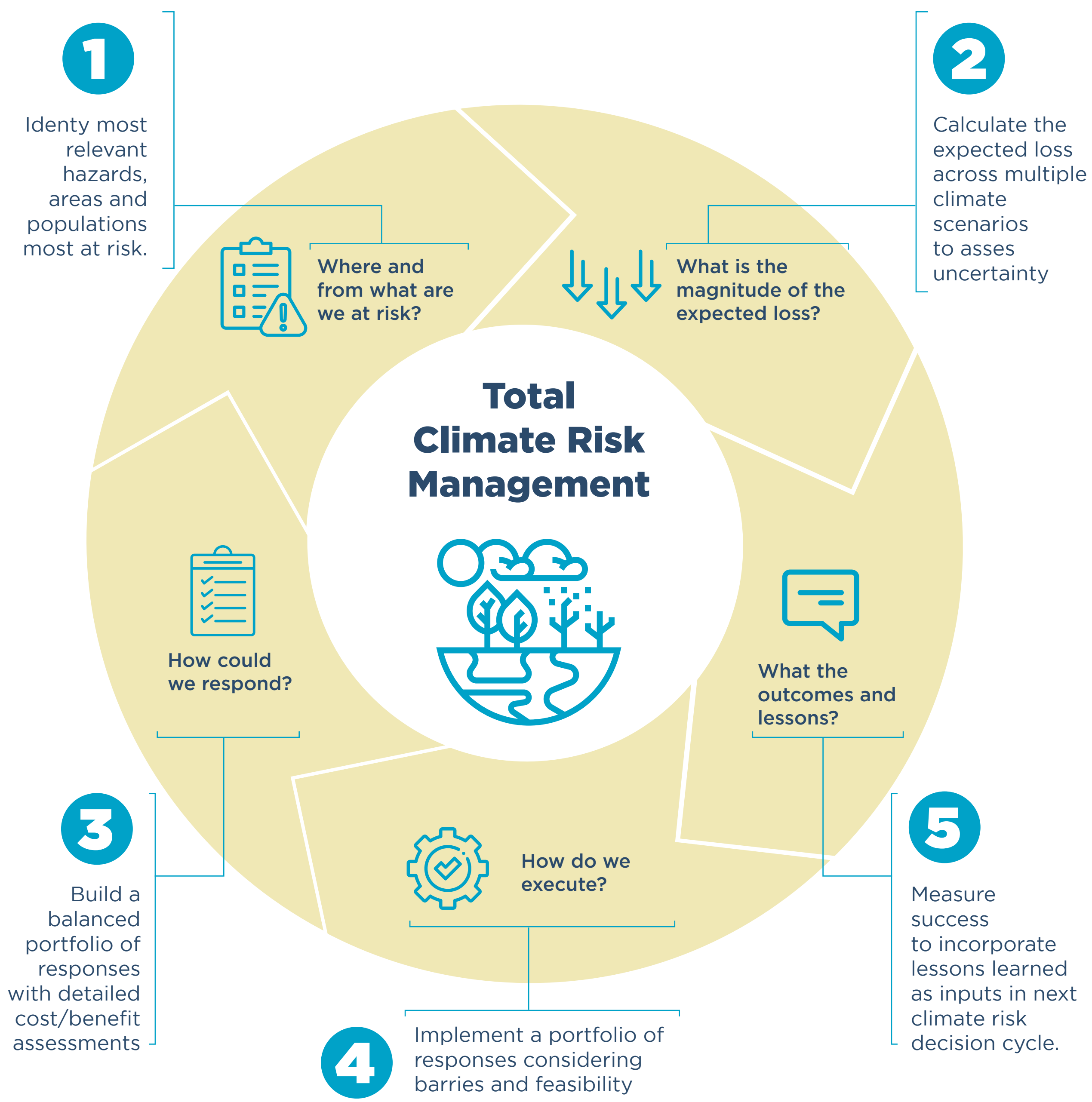
Climate Change Adaptation

The first objective of the project was the implementation of an Economics of Climate Change Adaptation study. Below are the methodological framework and the results obtained from this study.

2.1. The Economics of Climate Change Adaptation framework

The Economics of Climate Change Adaptation methodology enables decision-makers to include risk mitigation and risk transfer into a holistic risk management framework. It aims to provide country and regional decision-makers with a systematic way of answering these questions. The Economics of Climate Change Adaptation focuses focuses specifically on the economic aspects of adaptation and outlines a fact-based risk management approach. National and local leaders can use it to understand the impact of climate on their economies and identify actions to minimize that impact at the lowest cost to society.

Figure 1 The Economics of Climate Change Adaptation framework for assessing and addressing total climate risk



Source: Climate Works Foundation, 2009

2.2. Risks: hazards, vulnerability, and exposure

This study uses the Inter-governmental Panel on Climate Change (IPCC) definition of risk, which describes the risk of climate-related impacts that result from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and the exposure of human and natural systems. When evaluating climate impacts, scenarios must be selected considering the horizon year and the possible climate change consequences of each greenhouse gas (GHG) emissions trend. This selection will determine the changes for regular climate, tropical cyclones (TC) generally defined as tropical storms and hurricanes, and mean sea level.

Sea Level Rise (SLR) poses one of the most widely recognized climate change threats to low-lying coastal areas on islands and atolls. Projected increases to the year 2100 (RCP4.5: 0.35 m to 0.70 m) combined with extreme sea-level events presents severe risks of sea flooding and erosion for low-lying coastal areas and atoll islands.

There is high confidence that wave overwash will degrade fresh groundwater resources and that rising sea surface temperature will increase coral bleaching and reef degradation. Given the dependence of island communities on coral reef ecosystems for a range of services including coastal protection, subsistence fisheries, and tourism, there is high confidence that coral reef ecosystem degradation will negatively impact island communities and livelihoods (IPCC, 2014).

Also, rising sea levels will submerge territory and worsen storm surge and erosion on the small islands, threatening settlements and infrastructure that supports livelihood.

Tropical cyclones are one of the main natural threats in the region. Landfalling TCs combine with associated meteorological and marine dynamics such as winds, rainfall, storm surge, and waves, which generates flooding and erosion impacts on the coast. The effects of climate change on the intensity and frequency of TCs and, significantly, Relative Sea Level Rise (RSLR) will increase future extreme flood elevations (Woodruff et al. 2013).

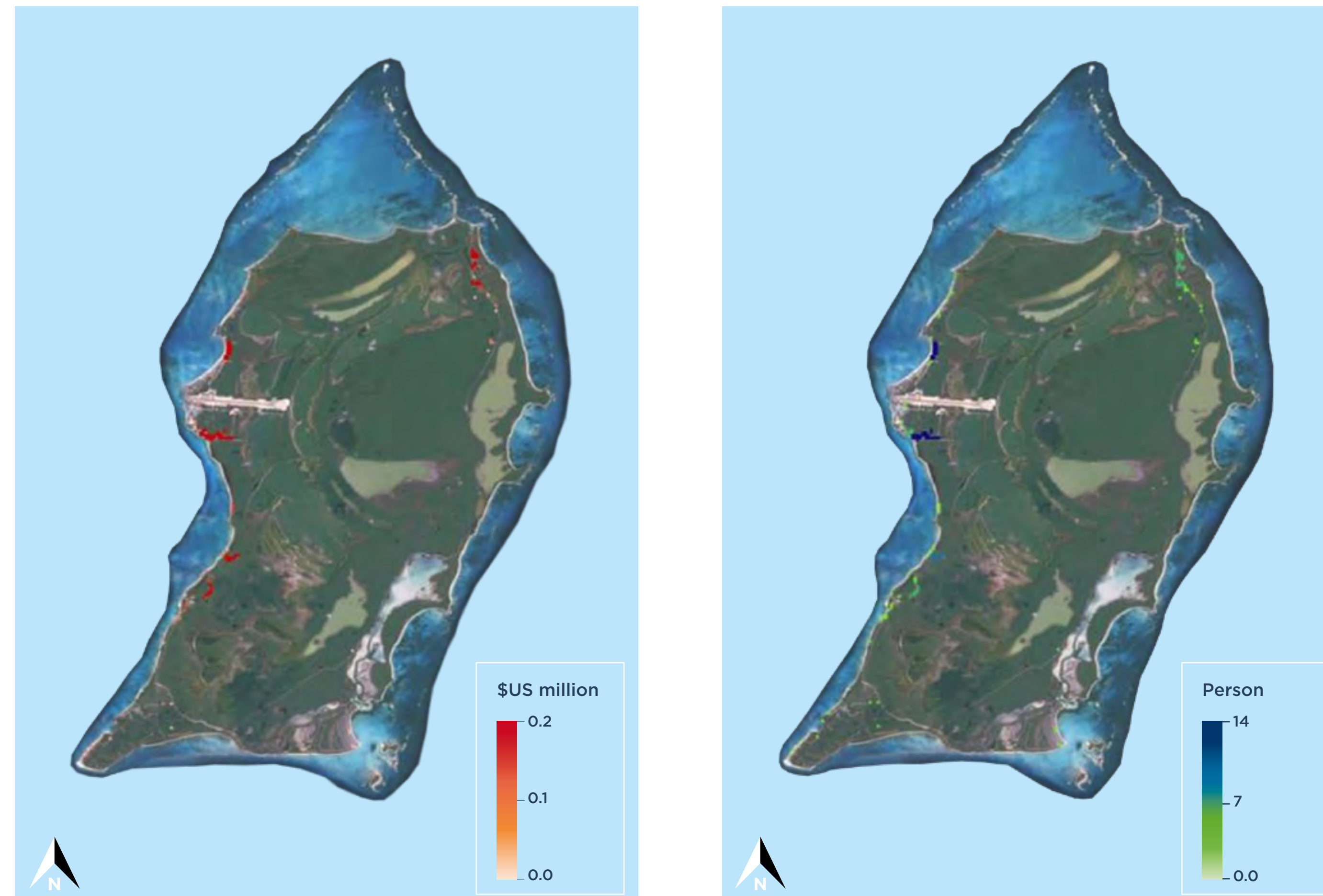
An exposure analysis was conducted to quantify how these hazards will affect the island. The objective was to characterize the spatial distribution of people, natural- and human-produced assets, and activities susceptible to the threats considered in the study. The final output was a map of population exposure and the residential and service stock on the island territory for the different scenarios.

Three climate-related impacts were identified through the results obtained from the analysis: wind, coastal flooding, and coastal erosion.

Figure 2 Residential stock and population exposure distribution

San Salvador Island
Residential Stock - Present Scenario

San Salvador Island
Population - Present Scenario



Source: Own elaboration

Wind

Wind associated with TCs was identified as one of the main climate threats to San Salvador Island. North Point and the northeast zone of the island are the most exposed areas on the island, which are expected t experience winds up to 200 km/hour once every 25 years. Southwest Point and the surrounding areas are the most protected, where the peak wind reaches 150 km/hour.

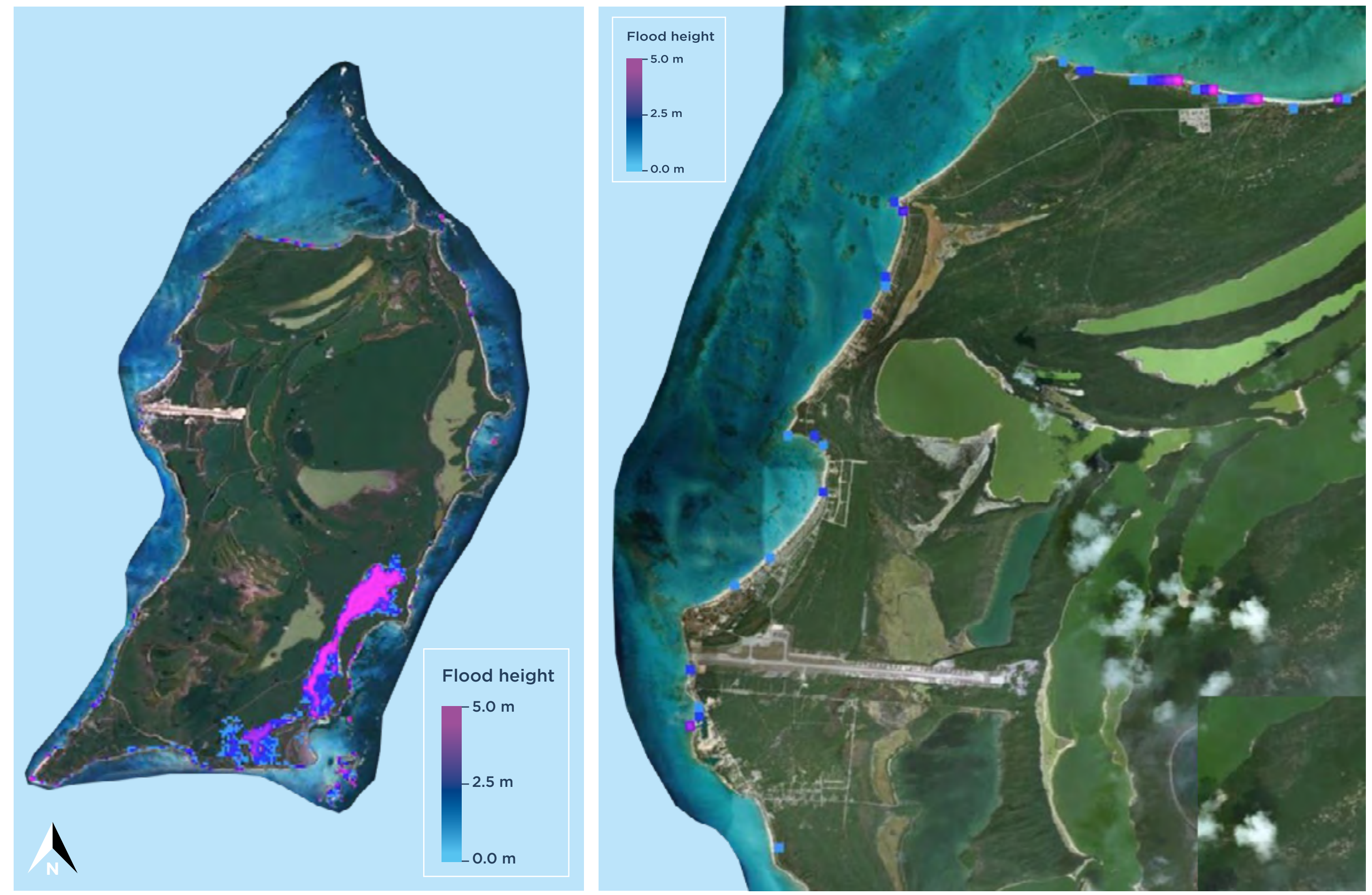
Flooding

Landfalling TCs generate a flooding impact associated with several dynamics: the tidal range and storm timing to the tidal phase, the increase in water level owing to the presence and local behavior of shoaling and breaking waves, and rainfall-driven runoff. Maps of coastal flooding were obtained for the present and future scenarios by combining SLR and the state of coral reefs associated with different socio-economic developments.

Figure 3 Coastal flooding for 100-year period

San Salvador Island
Coastal flooding - Present scenario
Return period 100 years

San Salvador Island
Coastal flooding - Present scenario
Return period 100 years



Source: Own elaboration

Erosion

Climate change–induced erosion is one of the most serious impacts faced by coastal systems worldwide. On San Salvador Island, eleven beaches were analyzed based on their average dry width and retreat. The data showed that four beaches out of the eleven would not be able to adjust to the retreat caused by sea level rise and will completely erode.

2.3. Expected losses

After analyzing the main climate change impacts, and considering the impact of the loss of some ecosystem services, an estimate was calculated the for potential economic losses using damage-loss functions. As a result, damage was quantified for the different scenarios and hazards (coastal flooding, wind, or coastal erosion) considering the residential and services stock and population.

Table 1 Coastal flooding annual expected damage by scenario

Coastal flooding				
	Present (2018)	BAU (2050)	Sustainable (2050)	Intensive (2050)
Population	0.3635	5.8237	0.9880	4.5148
Residential Stock US$	13,100	139,100	30,100	196,300
	4,800	35,600	7,700	51,800
Services Stock US$	33,200	49,300	92,400	152,800
	25,600	36,900	70,000	115,500

Source: Obtained from probabilistic risk assessment methodology

Table 2 Wind annual expected damage by scenario

Wind				
	Present (2018)	BAU (2050)	Sustainable (2050)	Intensive (2050)
Population	27.9242	35.8742	59.7242	62.5442
Residential Stock US$	146,000	176,100	295,400	342,200
	679,000	873,100	1,454,200	1,491,200
Services Stock US$	57,000	73,100	131,300	131,200
	679,000	873,100	1,454,200	1,491,200

Source: Obtained from probabilistic risk assessment methodology

Table 3 Coastal erosion expected damage by scenario

Coastal flooding			
	BAU (2050)	Sustainable (2050)	Intensive (2050)
Population	8.94	8.94	8.94
Residential Stock US$	411,620	411,620	411,620
Services Stock US$	243,900	394,180	362,710

Source: Obtained from probabilistic risk assessment methodology

3

Ecosystem Services

The second objective of the project was to develop an analysis of ecosystem services and their economic implications. The methodology and results obtained from the analysis are presented below.

3.1. The Ecosystem Services framework

The methodology for the Ecosystem Services study has five facets:

- Identification and classification of ecosystems
- Habitat and species data
- Socioeconomic scenarios
- Vulnerability of habitats and species
- Modeling impact on priority ecosystem services

First, the study identified the island's four distinct terrestrial and marine ecosystems:

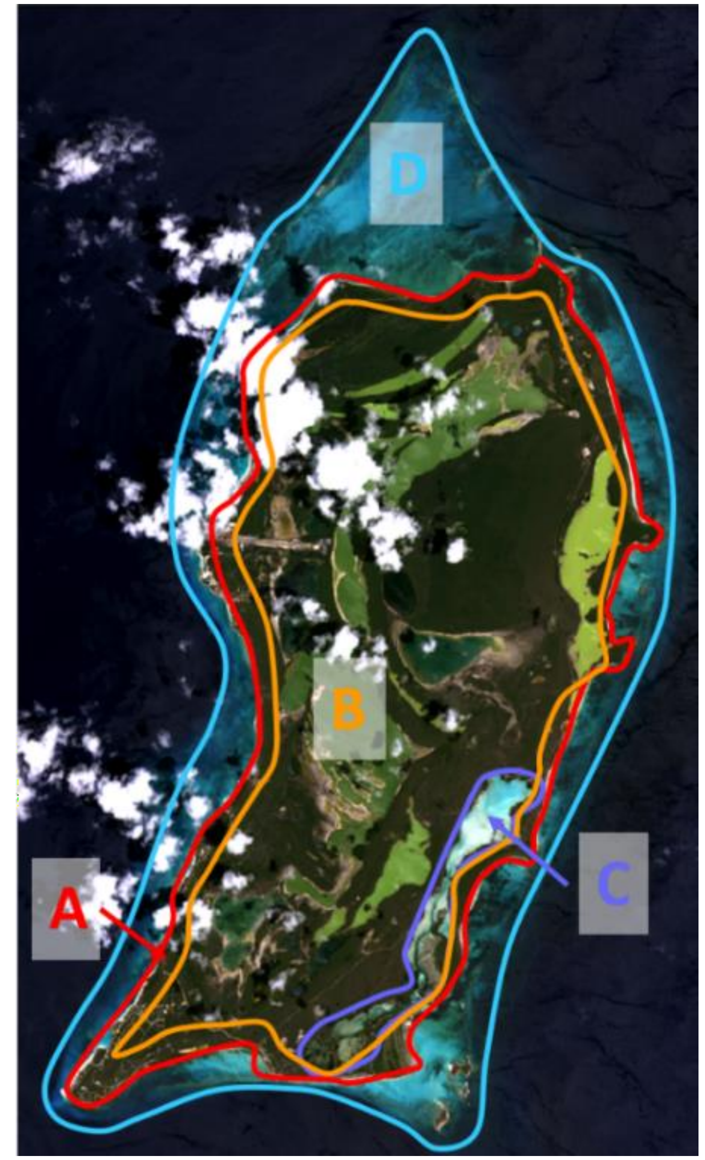
Coastal Zonation:
intertidal seagrasses, coastal rocks, beaches, sand vegetation and dunes, and coastal coppice

Lake-Pond Zonation:
lakes and ponds, brackish mangroves, wetlands, inland and coastal coppice

Estuary Zonation:
tidal creeks, brackish mangroves, wetlands, and coastal coppice habitats

Marine Zonation:
coral reefs, seagrasses (subtidal and intertidal), and beaches

Figure 4 Representative ecosystem zonation on San Salvador Island: A- Coastal, B- Lake-Pond, C- Estuary, D- Marine



Source: Own elaboration

For each of these divisions, associated ecosystem services were analyzed and identified from the discussion with stakeholders and the review of relevant literature. The classification of ecosystem services was conducted based on the Common International Classification of Ecosystem Services typologies (Haines-Young, 2016).

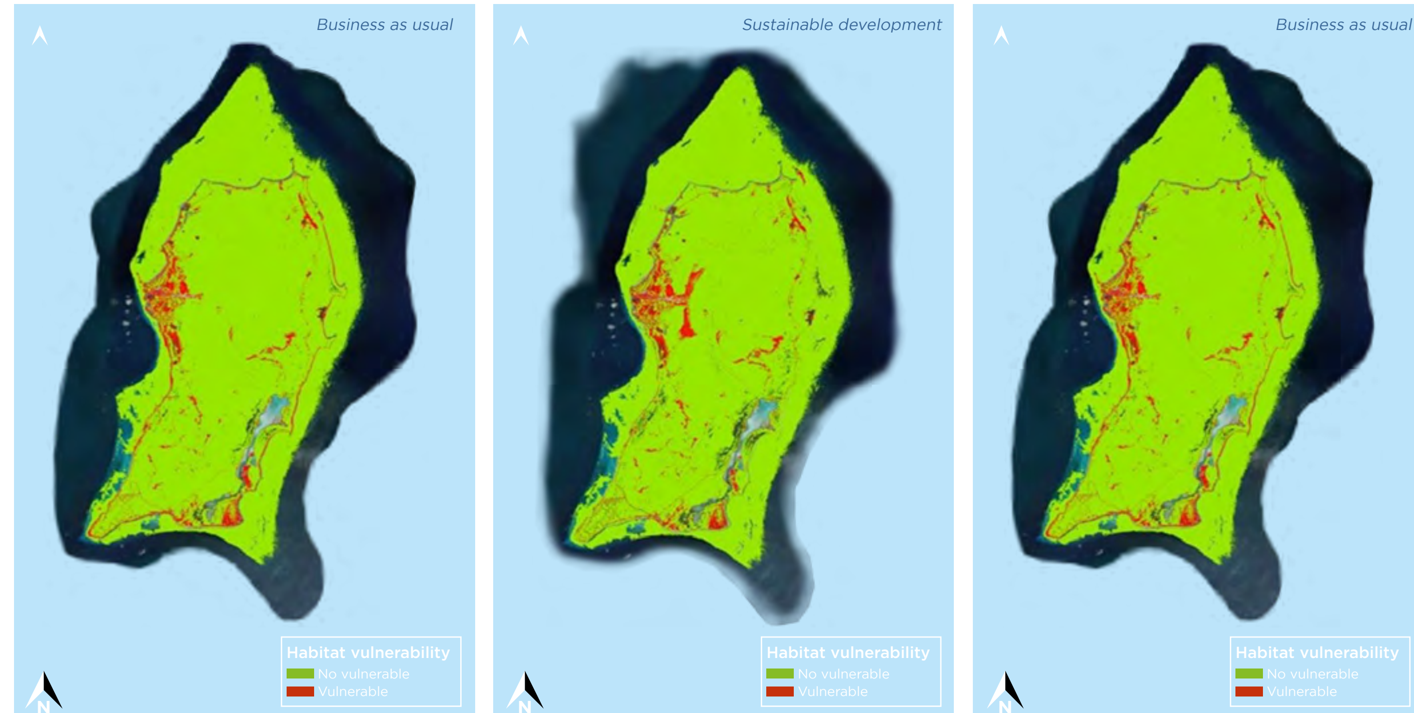
3.2. Exposure and vulnerability of habitats

For this project, the vulnerability of a habitat is defined as the possibility of a habitat's changes concerning a given stress factor (De Lange et al., 2010). The methodology integrates the habitat's sensitivity to stressors and their effects from now to 2050.

The methodology integrated the habitat's sensitivity to stressors and their effects. This approach has been applied to two temporal scenarios: present and 2050.

Exposure, habitats, people, and infrastructures were modified considering the business as usual, intense development, and sustainable development scenarios. Regarding climate change stressors, the study considered two scenarios within the Representative Concentration Pathway (RCP) 8.5: sea-level rise (SLR) and total water level (TWL) for the 100-year horizon. The vulnerability of habitats considering SLR as the flooding stressor is shown in Figure 5.

Figure 5 Vulnerable habitats under the three development scenarios



Source: Own elaboration

Under the Business-as-Usual scenario, the main vulnerable habitats are the inland habitats located in the west and southwest of the island. The loss of habitat from urban development and its potential diffuse pollution and the airport activity are the most determinant factors for the vulnerability of the coastal coppice in the west and northwest and the scrubs around the island.

Corals, seagrasses, and marinas are vulnerable to airport-related pollution and activity in the west of the island. The wetlands in the southeast of the island are considered a vulnerable habitat due to flooding in all future scenarios as SLR is an independent process not related to the socio-economic scenarios of the island.

The Sustainable Development scenario implies vulnerability values near the BAU scenario. Corals in the northeast face vulnerability from the urban development of hotels and houses. However, implementing a wastewater treatment plant in the western inland will minimize this vulnerability. Coppice forests in the west areas are considered vulnerable due to the economic activities of the airport, Club Med, and other small hotels. Lakes and ponds near the airport are also vulnerable to potential diffuse discharges related to airport activity.

As expected, the Intense Development scenario shows the maximum vulnerability to the island. A new port, a large hotel, a desalinization plant in the northeast of the island, and the associated loss of habitat contribute to categorizing the corals and seagrasses as vulnerable. Coastal and inland coppice, scrubs, and mangroves near the airport are also considered vulnerable habitats. New settlements in the southwest and west contribute to the vulnerability of the inland coppice, dense coppice, and scrubs.

Coastal flooding due to extreme climate events (TWL 100) is the main contributing factor to the vulnerability of the natural inland habitats in the east of the island. In all the development scenarios considered, wetlands, mangroves, and sand habitats are categorized as vulnerable.

Coral reef study- main results

Coral reefs are a vital habitat on San Salvador Island. They provide essential food, refuge, and a recruitment habitat to several organisms. According to the Fifth Assessment Report of the IPCC, mass coral bleaching and consequent death, triggered by positive temperature anomalies, is the most widespread and conspicuous impact of climate change with high confidence (Gattuso et al., 2014). Because of this, the thermal stress in San Salvador Island coral reefs was analyzed in detail.

Results show that from the year 2040 (RCP 8.5), Degree Heating Weeks (DHW) is projected to be > 8ºC-weeks, which relates to coral reef bleaching. More severe bleaching is expected to occur in 2050 as the DHW is expected to reach 16 ºC-weeks. This stress response is often followed by high mortality, reduced growth rates and lower fecundity.

3.3. Modelling impacts and the economic assessment of ecosystem services

To understand the economic impacts of ecosystem services, the study analyzed their protection of the island's people, property, and habitats, and their contributions to the tourism and fisheries sectors.

Protection

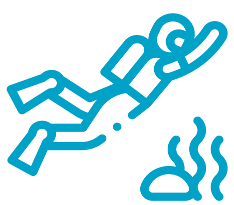
Coral reefs and other coastal ecosystems function as natural defenses from storms, floods, erosion, and other coastal hazards, reducing coastal risk. The protection offered by coral reefs and mangroves contributes to decreasing coastal flooding and erosion risk. Coral reef reduces wave energy and, therefore, wave height and wave setup, while mangroves reduce flow velocities induced by waves and wind. In addition, coral reefs are a sand supplier for sand beaches, while mangroves retain sediments and prevent erosion.

The economic consequences of SLR and the partial or total loss of coral reefs are included in the tables below.

Table 4 Annual expected damage by scenario

	Present Scenario		
	Population (person)	Residential Stock (US$)	Services Stock (US$)
With Corals	0.3635	13,100	33,200
Without Corals	0.9232	23,900	36,300
Difference	0.5597	10,800	3,100
Difference (%)	**153.97%**	**82.39%**	**9.32%**
	BAU Scenario		
	Population (person)	Residential Stock (US$)	Services Stock (US$)
With Corals	5.8237	139,100	49,300
Without Corals	7.2711	178,800	71,400
Difference	1.4474	39,700	22,000
Difference (%)	**24.85%**	**28.53%**	**44.64%**
	Sustainable Development Scenario		
	Population (person)	Residential Stock (US$)	Services Stock (US$)
With Corals	1.2752	30,100	92,400
Without Corals	8.0937	202,600	158,500
Difference	6.8185	172,500	66,100
Difference (%)	**534.70%**	**572.10%**	**71.57%**

Source: Own elaboration based on data from the Bahamas Ministry of Tourism



Tourism

Tourism is the primary source of income for the San Salvador Island economy. Therefore, one main objective of this study was to assess the services provided by ecosystems and analyze how climate change will affect these services in 2050 for the three defined scenarios.

The results show the services divided into the subsectors Beaches and Coral Reefs. Differences between the present and each scenario are presented in each case.

Beaches

Tourism services provided by beaches would increase by 2050 in all three scenarios. We can observe that erosion will not have a significant impact on these services, attributed to the relevant increase in visitors (63-158%) and to the actual underutilization of the beaches on the island[1].

Table 5 Tourism incomes derived from beaches by scenario

	BEACHES			
	Present Scenario	BAU Scenario	Sustainable Development Scenario	Intense Development Scenario
Tourism Expenditure per visitor	1872.65 $	1872.65 $	1966.28 $ (+5%)	1872.65 $
Number of visitors	15759	25773 (+63.55%)	35792 (+127.12%)	40812 (+158.98%)
Time expended in beach	40.0 %	40.0 %	40.0 %	40.0 %
Beach degradation due to CC		2.70 %	2.70 %	4.36 %
Beach degradation due to tourism	24.62 %	40.27 %	55.93 %	63.77 %
INCOMES	**$8 897 778.49**	**$11 219 788.31**	**$12 072 479.63**	**$10 593 204.82**
Difference		+2 322 009.82	+3 174 701.14	+1 695 426.33

Source: Own elaboration based on data from the Bahamas Ministry of Tourism

[1] Degradation of beaches is estimated to be 3.85-5.91%.

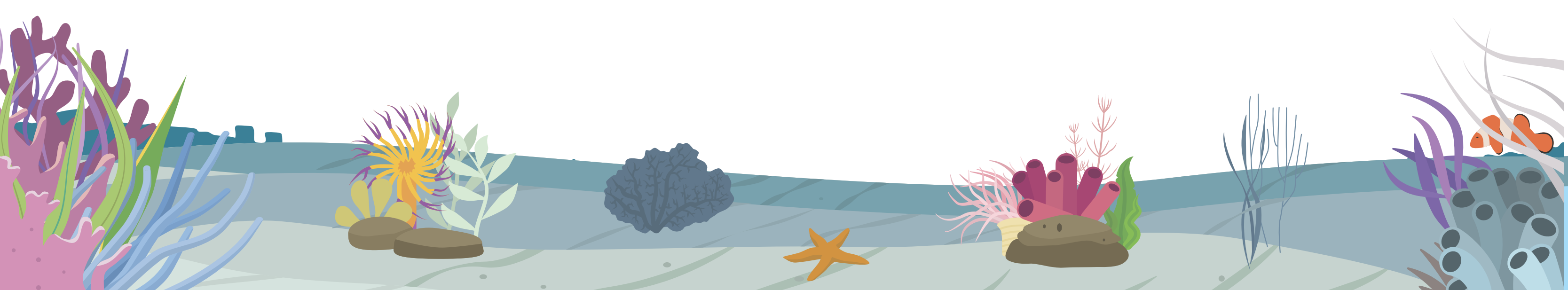
Coral reef

In all scenarios, tourism services provided by coral reefs would be reduced in 2050. The intense development scenario assumes the destruction of the coral for the horizon year due to the intense use of the island's natural resources and the prioritization of other assets and activities over the conservation of ecosystems. In the Business-as-Usual and sustainable development scenarios, although the conservation of the coral reef is foreseen (with different degradation rates due to climate change), the increase of the number of visitors and their pressure on the ecosystem would increase its degradation and reduce the expected incomes.

Table 6 Tourism incomes derived from coral reef by scenario

CORAL REEF				
	Present Scenario	BAU Scenario	Sustainable Development Scenario	Intense Development Scenario
Tourism Expenditure per visitor	1872.65 $	1872.65 $	1966.28 $ (+5%)	1872.65 $
Number of visitors	15759	25773 (+63.55%)	35792 (+127.12%)	40812 (+158.98%)
Time expended in coral reef	30.1 %	30.1 %	40 %	30.1 %
Coral reef degradation due to CC		17 %	17 %	100 %
Coral reef degradation due to tourism	39.40 %	79.30 %	89.48 %	102.03 %
INCOMES	5 383 222.20 $	2 495 768.18 $	2 458018.53$	0 $
Difference		-2 887 454.02	-2 925 203.67	-5 383 222.20

Source: Own elaboration based on data from the Bahamas Ministry of Tourism



Fisheries

The focus of the analysis has been the spiny lobster as this species is the most relevant for the Bahamian economy. However, the impact of the spiny lobster in domestic fishing is not captured on the export accounts and will be indirectly estimated. The summary of effects to consider is summarized in Table 7.

Table 7 Fisheries incomes derived by scenario

CORAL REEF				
	Present	BAU	Sustainable Development	Intense Development
Population	936	1200	2000	2100
Growth	n.a.	-30%	-20%	-50%
Drivers		• Over growth in demand •Ecosystem deterioration •Overfishing •Little control of fishing methods	•Efficient pressure on ecosystems •Limited fishing effort Certified fishing •Value Add tasks	•Overcrowding •Ecosystem pressures
Annual Expected Benefits (US$/year)	650,000	455,000	520,00	325,000

Source: Own elaboration based on literature review

4 Adaptation Measures

Results obtained from the risk analysis present wind, coastal erosion, and coastal flooding as the main impacts of climate change for San Salvador Island. Ten adaptation measures were established and prioritized using experiences from other territories with similar conditions and risks as examples. A cost-benefit analysis was performed for each measure to evaluate the activities and inputs required to put these measures in action, the potential benefits of implementing them, and the payback years.

The results obtained from expected losses analyses assumed benefits and avoided costs from implementing the adaptation measures. A literature review was conducted to find projects where similar actions were implemented to estimate the costs. When possible, the values from these projects were adapted to the island-specific characteristics.

A 1.54% discount rate, obtained from the weighted average of the last ten years (2006-2016) of public debt auctions in the country, is used to calculate the net present values of these costs and benefits. A sensitivity test was conducted using the latest discount bank rate publicly available on the Central Bank of Bahamas website (4%) to quantify the impact of this decision on the results.

Considering that the viability of implementing the proposed adaptation measures will depend on the national and local capital resources, estimations of the costs and benefits of each measure are presented as a percentage of San Salvador Island´s GDP.[2]

Additional to the cost-benefit analysis, two multicriteria-analysis were performed to evaluate and prioritize the adaptation measures based on the results of the cost-benefit analysis and considering social and environmental co-benefits.

First, the consulting team assessed the 10 measures on a scale from 0 to 5 based on six weighted variables:

- Social impact (15%)
- Economic impact (15%)
- Mitigation potential (5%)
- Adaptation to the impacts of climate change (30%)
- Cost-benefit ratio, and Impacts on the ecosystem-based services (20%)

The second analysis occurred during the final workshop with the community of San Salvador Island. Four evaluation criteria were assessed on a scale from 1 to 3:

- Urgency (25%)
- Social impacts (25)
- Economic impact (25%), and
- Viability (25%)

[2] Because of a lack of information regarding San Salvador Island´s GDP, it is calculated as a percentage of The Bahamas´ GDP based on its territory (1%)

The table below presents the ten measures, their objectives, and the results obtained for the different analyses performed. Due to the limited information publicly available for San Salvador Island, national and international data were used as proxies. In some cases, assumptions were made regarding the scope of the measure. Therefore, these results may vary if these assumptions are modified.

Table 8 Climate Change Adaptation Measures

Measure	Objective	Benefits as % of the GDP	Costs as % of the GDP
Institutional capacity			
Strengthen institutional capacity on climate change matters	Evaluate and identify the current institutional and policy framework regarding climate change aspects and propose the required measures/ adjustments to strengthen the public capacity.	1.85%	0.072%
Integrated coastal zone management – Coastal zone management unit	Design and support the development of an ICZM master plan in the Bahamas, reinforcing the current initiatives already being implemented in the country and implement them under one existing plan. It also aims at the integration of a Coastal Zone Management Unit which will oversee all the actions related to the ICZM plan.	4.04%	0,44%
Strengthen meteorological early warning systems	Strengthen meteorological early warning systems and the response capacity of communities	3.01%	0,80%
Water management and supply			
Water management program	Implement a water resource adaptation project to evaluate the current state of the resource in the island and establish a list of actions that should be implemented to improve the quality and quantity of it.	1.74%	1,79%
Rain water harvesting	Supply the community of San Salvador Island an alternative source of water (non-potable). As well it looks for the implementation of sustainable harvesting systems that could positively contribute to palliate the existing stress on the ground water.	0.61%	0,61%
Ecosystem based adaptation			
Improved wastewater treatment	Improve the existing wastewater treatment systems through constructed wetlands.	1.56%	0.78%
Beach replenishment	Perform beach replenishment activities to fight coastal erosion and coastal flooding.	7.07%	6.31%
Coral reef protection and restoration	Evaluate the current state of coral reefs, identify the potential impacts of climate change and plan the restoration activities.	0.90%	0.68%
Buildings and infrastructure			
Enhancing infrastructure and building resilience	Reinforce the existing residential houses and other buildings based on the guidelines of the new building code and improve the enforcement of legal requirements in the new constructions.	7.20%	3.78%
Social awareness			
Social awareness	Educate and raise awareness on climate change risks and adaptation.	2.20%	0.53%

IDB

Inter-American
Development Bank