Design and feasibility analysis of risk-resilient ICZM in The Bahamas

Final Report

September 2016

Inter-American Development Bank

GOVERNMENT OF THE BAHAMAS

IDB

SustainableSeas

Mott MacDonald

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Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	12/08/2016	B Riley J McCue	P Phipps	P Phipps	Draft Issue for comment
B	30/09/2016	B Riley	J McCue	P Phipps	Final Issue

Information class: Standard

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Abbreviations

BAMSI	Bahamas Agriculture and Marine Science Institute
BEST Commission	Bahamas Environment, Science and Technology Commission
BPP&PBA	Bahamas Public Parks and Public Beaches Authority
BNGIS Centre	Bahamas National Geographic Information System Centre
BNT	Bahamas National Trust
CCA	Climate Change Adaptation
CCS	Caribbean Coastal Services
CMIS	Coastal Management Information System
DMR	Department of Marine Resources
EBA	Ecosystem Based Adaptation
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ES	Ecosystem Services
GIS	Geographic Information System
GOBH	Government of The Bahamas
ICT	Information and Communication Technology
ICZM	Integrated Coastal Zone Management
IDB	Inter-American Development Bank
KPI	Key Performance Indicator
MCA	Multi-Criteria Analysis
MoEH	Ministry of Environment and Housing
MoWUD	Ministry of Works and Urban Development
NOAA	National Oceanic and Atmospheric Administration

OPM	Office of the Prime Minister
PEU	Project Execution Unit
SOP	Standard Operating Procedures
TAC	Technical Advisory Committee
TNC	The Nature Conservancy
ToR	Terms of Reference
WSC	Water and Sewerage Corporation

Executive Summary

Design and Feasibility Analysis

In 2013 the Inter-American Development Bank (IDB) approved the technical cooperation 'Feasibility studies for a climate risk-resilient Integrated Coastal Zone Management (ICZM) Program in The Bahamas' (ATN/OC-14521-BH; ATN/OC-14520-BH) with the aim of designing and carrying out the feasibility studies required for the preparation of a climate and risk-resilient ICZM Program (the Program) for The Bahamas for consideration for public investment financing. Since December 2015, Mott MacDonald, in partnership with Sustainable Seas Ltd, has been working on delivery of Component 2 with the IDB and the Government of The Bahamas (GOBH) in addition to Caribbean Coastal Services (CCS) (who are undertaking Component 1), to develop the Feasibility Studies to present a program of initial studies required in order to facilitate the implementation of ICZM within The Bahamas.

The overall objective of this Project is to work with the IDB and the GOBH to prepare an economically and technically justifiable coastal management ICZM Program for The Bahamas for public investment financing.

Coastal Risks in The Bahamas

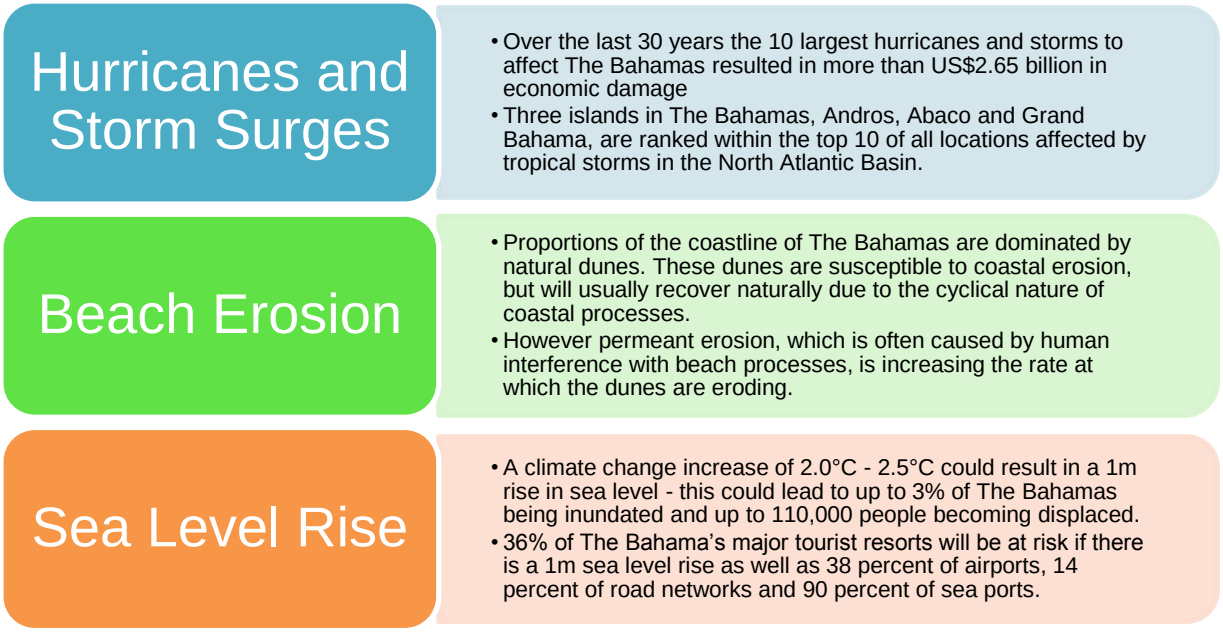
The geographical scope for adoption of ICZM in The Bahamas has been defined by CCS (2016) and is presented below:

The Coastal Zone is limited offshore to the 12 nautical mile boundary including the marine, shoreline and terrestrial parts of The Bahamas where key coastal resources are found, limited offshore to the 12 nautical mile boundary.

The Coastal Risk Index[1], developed by The Nature Conservancy, the Coastal Resources Centre and the United Nations University, assesses the exposure and vulnerability of coastal nations to hazards such as floods, tsunamis and sea level rise. Within the top 20 coastal nations at risk, seven are in the Caribbean, with

[1] CARIBSAVE (2012) *CARIBSAVE Climate Change Risk Profile for The Bahamas*.

The Bahamas in thirteenth place. The main coastal risks that The Bahamas faces include hurricanes and storm surges and the subsequent erosion of the coast. Over the longer term sea level rise will also become a significant coastal risk for The Bahamas.



Current Baseline in The Bahamas

Current baseline data

The literature and data gap analysis exercise clearly demonstrates that there has been a wide range of interest and studies on coastal management related issues, though these remain very sector/subject specific in nature. Most of the data have been classified as either outdated or focused on a very specific site or sector. There appears to be a lack of coordination of information across sectors and on a national scale that is up to date and that people have confidence in.

Current coastal management

Some of the key issues relating to coastal engineering in The Bahamas are:

- Clarity of land ownership and ability to coordinate coastal protection design;
- Control over development by hotels and private developments;
- Need to improve planning with regard to coastal management ;
- Limited design guidance and clarity when designing to climate change scenarios; and
- Inclusion of innovative and green-engineering designs can be improved.

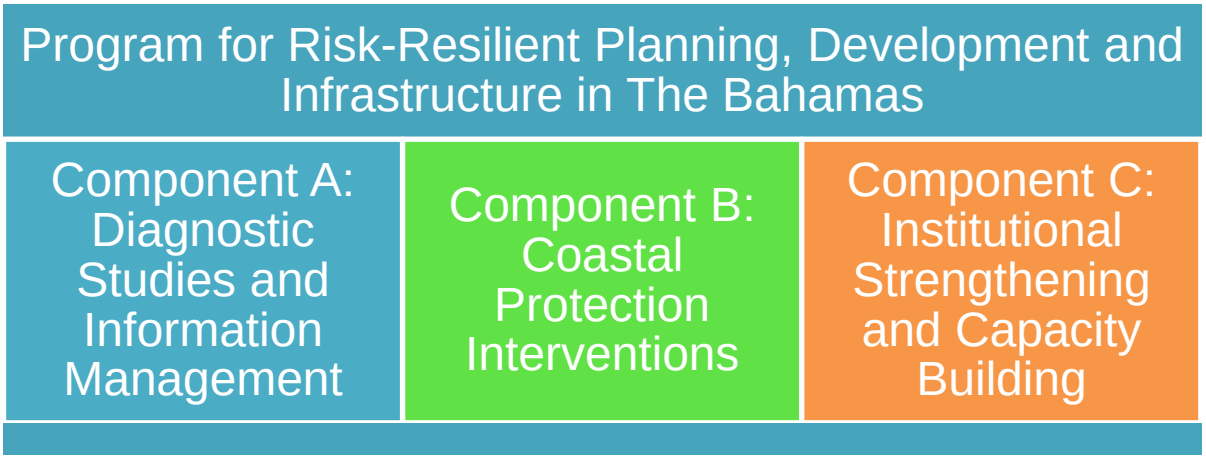
Current institutional capacity for coastal management

The institutional capacity needs assessment has uncovered a number of baseline findings relating to each key Ministry, Department or Institute assessed. Generally, all agencies assessed faced the following challenges in the context of their capacity for risk-resilient ICZM:

- Limited strategic planning takes place;
- Some coordinating mechanisms are in place to effectively encourage data sharing but can be improved;
- Agencies do not have any standardised procedures for public consultation procedures;
- Research functions are limited and limit scientific knowledge basis decision-making;
- Several human resource challenges exist; and
- There are challenges associated to the financial resources required.

Proposed Program for Risk-Resilient Planning, Development and Infrastructure in The Bahamas

The proposed Program recommends three components for implementation as part of the initial loan package:



Component A: Diagnostic studies and information management

This Component is required to address the key national and Family Island scale data gaps that have been identified within the Project. There are a number of national studies proposed that shall help to bridge these data gaps that are required to facilitate engineering interventions and coastal protection studies around The Bahamas within the Program. Furthermore, this Component will aim at bringing together an information knowledge management system that will collate and integrate GIS data from the different activities being carried out within Components A B and C. A summary of specific tasks are presented below:

	Name	Description	Justification for Sub-Component
A1	Oceanographic Data Collection Study	A study to focus on coastal hydrodynamics and water level data collection throughout The Bahamas.	- To help inform and determine design conditions. - For defining boundary conditions and calibration/validation of hydrodynamic models for use in design. - It would be more cost and time effective to have a coordinated campaign for The Bahamas rather than for ad-hoc projects.
A2	Coastal Infrastructure Asset Inventory	An assessment and recording of coastal infrastructure including an assessment of the condition of the structures.	- Need to be inspected and maintained so that the resilience they provide to coastal hazards is maintained.
A3	Beach Monitoring Program	A study to set up where shoreline monitoring is needed and to ensure ongoing long term shoreline monitoring.	- To inform effective management and the decision to provide coastal protection implementation options. - Coastline retreat information. - Cross shore profile information is crucial for design of coastal protection options.
A4	Sediment Resource Study	The purpose of this study is to provide clarity on how carbonate sediment contributions to beaches may change in the future and may interact with engineering solutions.	- Understand impacts of climate change. - Understand potential changes to erosion/shoreline movement. - Link to coastal management practices.
A5	Coastal Management Information System	This shall be the repository for all risk-resilient ICZM related data.	- Support current work by BNGIS Centre. - Support the other sub-components within this overall Program. - Coordinate and accumulate baseline data.
A6	Habitat Monitoring Study	This study will use satellite imagery to facilitate a habitat monitoring exercise, combined with development of a monitoring plan.	- Support to ICZM monitoring planning and monitoring in coastal environments using base layers maps and habitat survey - Up to date bathymetric maps using multi-spectral satellite images.

Component B: Coastal Protection Intervention

Coastal infrastructure interventions should be undertaken using a sound knowledge and scientific basis which is important for sustainable and risk-resilient management practices. Coupled with this, priority works are needed for many vulnerable communities to help reduce the risks of coastal hazards on local livelihoods and economies.

This Component focuses on implementing Pilot Sites infrastructure interventions (soft or hard coastal engineering schemes). The Pilot Sites address a range of societal needs whilst embracing ecosystem services (and habitat protection) on key islands around The Bahamas. Their selection has been participatory in nature and, when constructed, shall demonstrate best practice sustainable coastal protection development.

This Component focusses on 5 Pilot Sites (see below) which require climate resilient infrastructure to be considered and constructed. Initial studies include Strategy studies to collate data on the site specific spatial scale which will feed back into the overall data and information gathering exercises being undertaken under Component A.


Central Downtown Nassau - protection of key infrastructure and regeneration/ increase to tourism
Central Long Island - flood and storm surge protection through increased drainage and ecosystem-based adaptation
Public Beach, Treasure Cay, Abaco - beach erosion control and improve amenity of beach
Pilot Sites
East Grand Bahama Causewas - alter old engineering techniques to increase resilience and provide enhanced marine ecology
Glass Window Bridge, Eleuthera - increase resilience of design of key infrastructure in face of increased storminess

Component C: Institutional Strengthening and Capacity Building

This Component shall include products and activities that help plan for coastal change, through the improved review and formalisation of legislation and institutional arrangements in The Bahamas to ensure future risk-resilient ICZM is mainstreamed into sector planning and is set up to help implement the Vision 2040 National Development Planning process. The Component includes activities that prepare bespoke planning "tools" such as building codes and Standard Operating Procedures to help deliver future ICZM. It shall also include activities that take forward the findings of Components A and B to help Family Islands prepare and implement coastal policies as part of the Island Planning process (Planning and Subdivision Act 2015). A summary of specific tasks are presented below:

	Name	Description	Justification for Sub-Component
C1	Technical Support to the Project Execution Unit (PEU)	To establish and maintain a clear PEU within the Office of the Prime Minister. A clear "ICZM road map" is developed.	- Institutional arrangements need to be established and sustained through the PEU. - Clear guidance on strategic plans and communication (internal and external) is required for long term.
C2	Legislative and Regulatory Review and Institutional Amendment	To formalise legislation and institutional to ensure ICZM is mainstreamed into sector planning.	- To determine how human resources should be reallocated (within and across Ministries). - More focus needs to be given to leadership and management training in tandem with ICZM training.
C3	Standard Operating Procedures and Guidance Manuals for ICZM Delivery	To prepare bespoke, planning "tools" such as Standard Operating Procedures to help deliver ICZM. Furthermore, to produce national regulatory and enforcement related guidance.	- Requirement for the consideration and development of design guidance for coastal protection structures with consideration of climate change and modelling. - A standard way of implementing ICZM into Vision 2040 and Planning Subdivisions Act will be required in addition to training on this.
C4	Shoreline Management Plans	Shoreline management plans for Family Islands, focussing initially on New Providence and Long Island as examples.	- To enable long term, sustainable management for the Family Islands for the key risk areas. - Ensuring interventions do not negatively impact on other areas along the coast.
C5	Knowledge Transfer and Capacity Development	To train and educate staff on risk-resilient issues. This is to include a public education and awareness campaign.	- To ensure effective implementation of the ICZM Program in the long term, staff and stakeholders need to be trained in effective and innovative methods that the Program aims to implement.
C6	Study for the facilitation of private finance	To identify ways of facilitating sustainable private sector participation in financing the implementation of Coastal Management Interventions.	- The financial stability and potential of ICZM for long term sustainability needs to be carefully assessed and considered, and is likely to need to be funded through a number of different sources.

Next steps

Once the Component 1 and 2 studies have been finalised and approved, the next stage is to develop a loan agreement between the Government of The Bahamas and the IDB. Terms of References have been produced for the three key Components (A, B and C) and these would be advertised in the international business arena for future tendering.

1 Introduction

In 2013 the Inter-American Development Bank (IDB) approved the technical cooperation 'Feasibility studies for a climate risk-resilient Integrated Coastal Zone Management (ICZM) Program in The Bahamas' (ATN/OC-14521-BH; ATN/OC-14520-BH). The aim is to design and carry out the feasibility studies required for the preparation of a climate and risk-resilient ICZM Program (the Program) for The Bahamas for consideration for public investment financing. Since December 2015, Mott MacDonald, in partnership with Sustainable Seas Ltd, has been working on the delivery of Component 2 with the IDB and the Government of The Bahamas (GOBH) in addition to Caribbean Coastal Services (CCS) (who are undertaking Component 1), to develop the Feasibility Studies to present a program of initial studies required in order to facilitate the implementation of ICZM within The Bahamas.

1.1 Project Objectives

The overall objective of this Project is to work with the IDB and the GOBH to design the feasibility studies required for the preparation of a risk-resilient ICZM Program for The Bahamas for consideration for public investment financing.

In order to achieve this over-arching objective, a number of specific objectives must be fulfilled as follows:

1. To validate the information needs for, and to design a coastal risk assessment and management system that can serve as a basis for sustainable development, planning and control;
2. Identify, prioritise and design an innovative and cost effective investment program for coastal protection that addresses coastal risks associated with climate change impacts while incorporating relevant ecosystem services;
3. Identify needs for strengthening national capacity for integrated coastal risk management;
4. Analyse the overall environmental, financial and institutional feasibility of the investment package for financing and design the socio-economic feasibility analysis;
5. Provide the technical inputs for the preparation of the proposed public sector investment package; and
6. Facilitate consultations with key stakeholders on the design of the Program.

1.1.1 Work undertaken to date

Two key reports have been produced to date (First Interim Report, March 216 and the Second Interim Report, July 2016) to summarise the draft information for the following Tasks:

- Task 1: Design of Coastal Risk Assessment, Monitoring and Management;
- Task 2: Design of Investment Program for Coastal Protection; and
- Task 3: Institutional Strengthening Needs Assessment and Design of Institutional Sustainability.

1.2 Aims and Structure of the Final Report

Following the requirements of the Terms of Reference (ToR), the Final Report (hereafter referred to as the 'Report') aims to summarise and contain all results of the consultancy. This includes the complete feasibility analysis under Task 4 of the ToR (feasibility studies), documentation of consultations completed under Task 5 of the ToR (consultations with public/private sector and civil society) in addition to the final versions of designs and ToRs for the proposed studies.

To allow the IDB and the GOBH to clearly follow how these aims have been met, the methods and key activities undertaken have been presented within this Report in the following Sections:

- **Section 1:** Introduction to the Report – Introduction, aims and objectives.
- **Section 2:** The Bahamas – Summary introducing the coastal environment in The Bahamas.
- **Section 3:** Current coastal management in The Bahamas- presenting a summary of the baseline for ICZM in The Bahamas.
- **Section 4:** An ICZM Program for The Bahamas – Using the information from stakeholder engagement exercises and the review of the current baseline situation in The Bahamas to propose a Program of initial studies to facilitate ICZM.
- **Section 5:** Component A: Diagnostic Studies and Information Management – Further information and details regarding the various studies proposed for Component A.
- **Section 6:** Component B: Coastal Protection Interventions – Further information and details regarding the various studies proposed for Component B.
- **Section 7:** Component C: Institutional Strengthening and Capacity Building – Further information and details regarding the various studies proposed for Component C.
- **Section 8:** Environmental and Social Viability of The Program – a summary of the key results from the Strategic Environmental Assessment and Environmental and Social Management Plan.
- **Section 9:** Economic Justification of The Program – a review of the requirements for an ex-ante economic assessment.
- **Section 10:** Inter-Institutional Coordination – a description of the recommended tools and methods to facilitate inter-institutional coordination within the ICZM context.
- **Section 11:** Stakeholder Consultation – a summary of the stakeholder consultation undertaken throughout this Project.
- **Section 12:** Results Matrix.

Further supporting reports and documents referred to throughout the text are presented as Appendices and expand on summaries and details presented in the different sections of this Report.

1.3 Geographic Scope and Definition of the 'Coastal Zone'

The geographical scope of this Report is within the 'coastal zone' which delimits the geographical scope for adoption of ICZM in The Bahamas.

It is acknowledged within this Project that The Bahamas consists of a large number of low lying islands separated by shallow sea and deeper trenches. Therefore around The Bahamas the majority of terrestrial and marine resources are all influenced by coastal processes. However, some boundaries within an ICZM context are required to enable management and governance of the coastal zone in an efficient manner.

The following definition of the 'coastal zone' is adopted from the work undertaken by CCS under Component 1 of this Study[2]. CCS has undertaken surveys with key stakeholders and an extensive

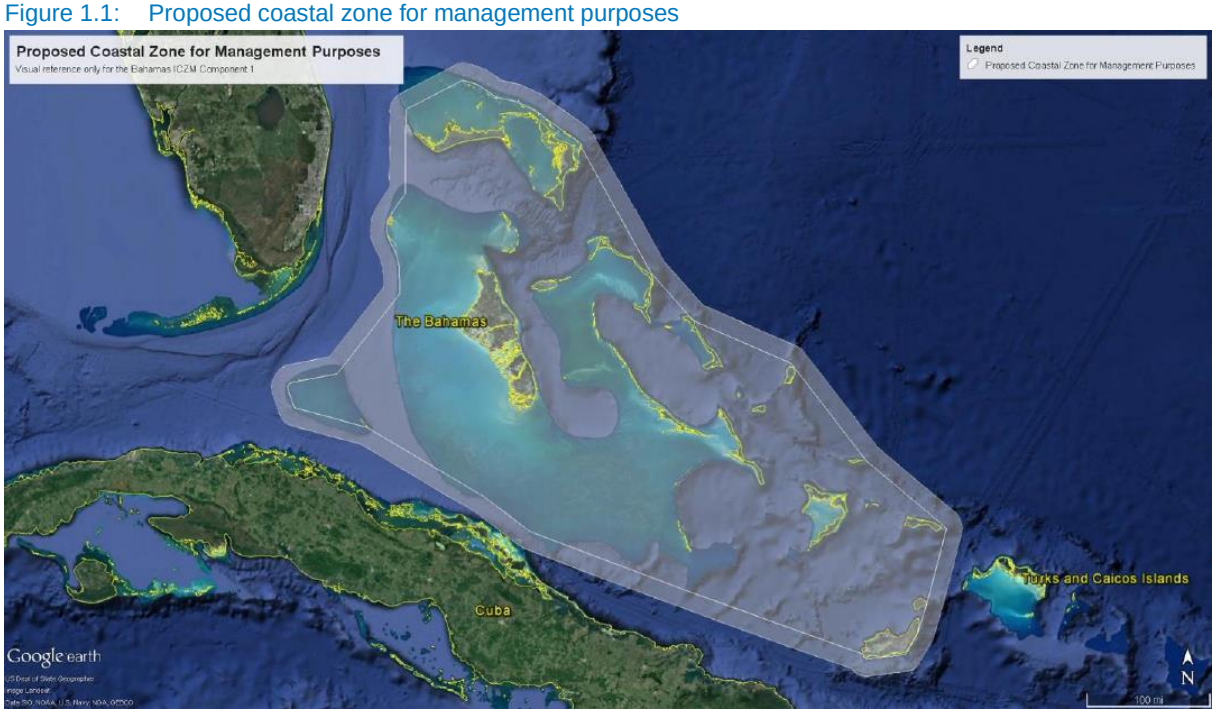
[2] CCS and SEV Consulting Group (2016) Draft National ICZM Policy Framework

literature review to develop the definition. The following boundaries have been defined for the 'coastal zone' which is to be considered within the ICZM Program:

- The territorial sea boundary has been chosen as it is defined as "land" with regards to planning purposes in the 2010 Planning and Subdivisions Act[3] in addition to providing a more manageable area for regulation. Furthermore it provides reduced overlap with the National Maritime Policy[4] and is a preferable alternative to the Exclusive Economic Zone (EEZ), the boundaries of which are still being negotiated; and
- Inland boundary covering the entire land mass of The Bahamas.

Therefore the overall definition for the Bahamian coastal zone for management purposes is as follows and is represented in Figure 1.1: *The Coastal Zone is limited offshore to the 12 nautical mile boundary including the marine, shoreline and terrestrial parts of The Bahamas where key coastal resources are found, limited offshore to the 12 nautical mile boundary*[5].

Figure 1.1: Proposed coastal zone for management purposes



Source: CCS and SEV Consulting Group (2016) Draft National ICZM Policy Framework

[3] Government of The Bahamas (2010) Planning and Sub Divisions Act

[4] Government of The Bahamas (2015) National Maritime Policy

[5] CCS and SEV Consulting Group (2016) Draft National ICZM Policy Framework

1.4 Key Definitions

In addition to the definition of the 'coastal zone' (Section 1.3) this Project also uses a range of terms that, for the perspective of clarity, require a degree of definition to enable inclusive understanding of the project by all Bahamian stakeholders.

1.4.1 Climate Change Adaptation (CCA)

The IPCC defines adaptation as: *"adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities".* [6]

Various types of adaptation can be recognized:

- Anticipatory adaptation – adaptation that takes place before impacts of climate change are observed;
- Autonomous adaptation – adaptation response not specifically to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems;
- Planned adaptation – adaptation that is the result of a deliberate policy decision designed to return to, maintain, or achieve a desired state.

In the context of the principles of ICZM, anticipatory and planned adaptations are the most relevant mechanisms. Therefore, it is proposed that these two terms and their definitions are of direct relevance to the delivery of risk-resilient ICZM in The Bahamas (see definition of risk-resilient ICZM below).

1.4.2 Integrated Coastal Zone Management (ICZM)

There are many definitions for ICZM, some which are used by inter-governmental organizations and those that emphasize process which are generally used by the science community. At an international level a broad definition of ICZM is as follows:

"a process that brings together all those involved in the development, management and use of the coast within a framework that facilitates the integration of their interests and responsibilities. The objective is to establish sustainable levels of economic and social activity in our coastal areas while protecting the coastal environment".

Other Caribbean nations have attempted to define the concept of ICZM for their needs. For example the Coastal Zone Management Unit of Barbados defines ICZM as: "*the management of sectoral components (e.g., fisheries, forestry, agriculture, tourism, urban development) as part of a functional whole (a holistic approach to management). The focus is on the users of natural resources, not on the stock per se of these resources*".

[6] www.ipcc.ch/ *accessed* March 2016

1.4.3 Ecosystem Based Adaptation (EBA)

EBA is defined by the Convention on Biological Diversity as: "*the use of biodiversity and ecosystem services to help people adapt to the adverse effects of climate change*"[7]. As further elaborated by Decision X/33 on Climate Change and Biodiversity, this definition also includes the: "*sustainable management, conservation and restoration of ecosystems, as part of an overall adaptation strategy that takes into account the multiple social, economic and cultural co-benefits for local communities*" [8].

In terms of coastal EBA (for this Project), the key focus is on reviewing the role of coral reefs, mangroves, beaches and coastal hinterland vegetation on coastal zone management.

1.4.4 Coastal Risk

Of all the threats affecting marine and coastal environments in The Bahamas, climate change is considered to pose the greatest risk, as approximately 80% of The Bahamas' landmass lies within 1.5 meters (5 ft) of the high tide mark. Any sea level rise or increased frequency of storm/hurricane events could have significant impacts on marine and human lives.

The effects of climate change are already (and increasingly) impacting the health of a range of coastal habitats, particularly coral reefs. Examples of this include the increasing frequency of physical damage from hurricanes in addition to a number of coral bleaching events which have been observed in the last few years.

The preferred definition of Coastal Risk for this project is suggested to be the probability of occurrence of an event that affects the coastal zone that is associated with natural hazards and disasters as well as with climate variability and climate change (hurricanes, tropical storms and storm surges, earthquakes). This leads to erosion (coastal and cliff instability) and flooding (both coastal and from a lack of permanent natural water courses and poor drainage infrastructure). The probability of occurrence is then multiplied by the (socio-) economic damage caused by the climatic and geological hazard events.

It is critical to understand that ultimately, the coastal risk is considered by multiplying the likelihood of the event occurring by the impact if the event occurs. It is important to note that the likelihood itself does not necessarily involve risk. For example if the area prone to extreme events is free from any environmental or socio-economic assets, the risk will be reduced to zero as there will be nothing to impact.

1.4.5 Risk-resilient ICZM

There is no formal definition of this term, but the IDB in its project profile for the Coastal Risk Management in Barbados states that: "*coastal risks refer to risks that affect the coastal zone that are associated with*

[7] CBD (2009) Connecting Biodiversity and Climate Change Mitigation and Adaptation. Montreal, Technical Series No. 41.

[8] CBD (2009) Connecting Biodiversity and Climate Change Mitigation and Adaptation. Montreal, Technical Series No. 41.

natural hazards and disasters as well as with climate variability and climate change", hence an appropriate definition proposed for this project is:

'To implement coastal infrastructure and development adaptation measures that improve resilience to climate change and natural disasters by adhering to formal risk management procedures that are designed to "future proof" decision making in The Bahamas using the principles and practices of ICZM'.

This definition shall represent the focus of the recommendations from this Project.

1.4.1 Disaster Risk Management

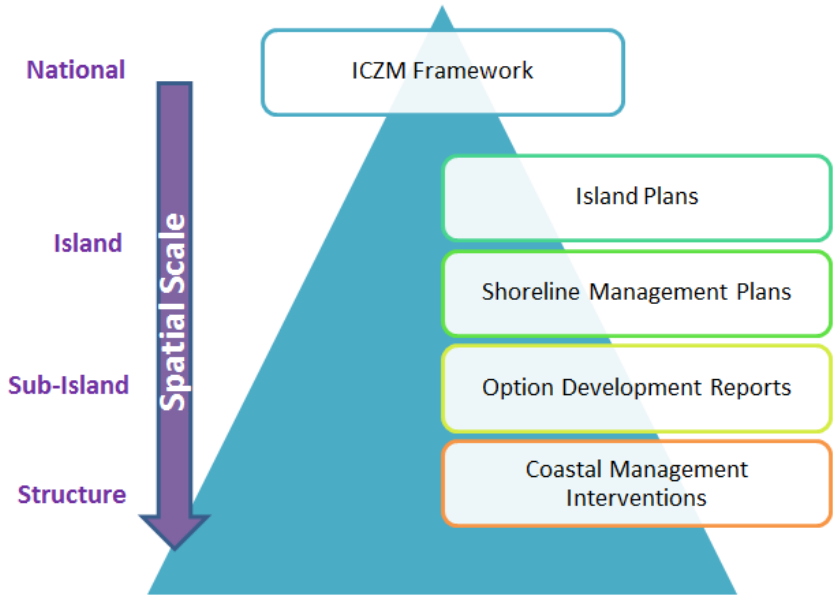
Disaster Risk Management (DRM) aims to avoid, lessen or transfer adverse effects of hazards through implementing measures and activities for prevention, mitigation and preparedness[9]. It refers to a set of legislation and frameworks including skills and capacity to implement these measures and activities.

1.5 Definition of terms for proposed solutions

There are a number of recommendations within this Report for the various studies that are proposed to form an initial Program for ICZM. Many of these look at various levels of studies for coastal management interventions at different scales, from the Island spatial scale to the specific site. Therefore the text below sets out the definition of these studies and these are further summarised in Figure 1.2.

[9] www.unisdr.org *accessed* July 2016

Figure 1.2: Definition of spatial scale of proposed studies



Integrated Coastal Zone Management Framework refers to a national plan that outlines the approach that brings together all decision-making agencies to resolve issues so as to ensure integration among their existing policies and plans to ultimately maintain, restore, and improve the quality of coastal ecosystems and communities they support.

Island Plan refers to a "Land Use Plan" that is required under statute (Planning and Subdivision Act 2010 and Revision in 2015) that is consistent with all National Land Use Development Policies. Article 16 (2c) clearly states the need for each Land Use Plan to designate areas which, for (amongst others) reasons of flooding, erosion, subsidence, instability, other hazards, conservation or other environmental considerations including wetlands, should not be developed. The SMP (see below) shall provide this required information.

Shoreline Management Plan (SMP) is a report that clearly outlines and assesses the risks associated with coastal processes for a specific island. It represents a subset of the Island Plan (Planning and Subdivision Act 2010 Article 16 (2c)). Its aim is to help the Island Plan to identify areas of flooding and erosion risks to people, property and the historic and natural environment. The main objective of a SMP is therefore to propose sustainable long-term management policies for the defined coastal area of each island. These policies are likely to be split into: Improve coastal resilience, Maintain coastal resilience, Set-back or Realignment and Do Nothing approaches.

Option Development Reports are reports that will then focus on a specific section of coastline that has been identified within the SMP (ideally if one has been done) as an area which has a lot of interacting

processes and requires specific coastal management intervention. The key aim of these reports is to define the best intervention solution to enact the policy defined in the SMP. The management options and solutions (soft and hard), modelling and development of designs need to be undertaken in a coordinated manner. These solutions will require more detailed cost benefit assessments to justify the preferred solution (defined as both soft and hard engineering and management). If a SMP has been undertaken for this section, the risk/hazard mapping should exist to enable consideration of this in more detail. If an SMP does not (as in some of the cases under the initial loan proposal) risk and hazard mapping will need to be undertaken at this stage.

Coastal Management Interventions covers the specific detailed design, construction and operation of specific coastal management intervention.

2 The Bahamas

2.1 Background and environmental context

Covering an area of over 231,000 square miles or 600,463 square kilometers[10], The Bahamas archipelago consists of over 3,000 islands, cays and rocks or islets (Figure 2.1). The archipelago contains the largest tropical shallow water area in the Western Atlantic. The unique mix of shallow banks penetrated by deep water channels give rise to three distinct marine ecosystems: coastal and shallow shelf, pelagic, and deep water. There is a total estimated 3,540km[11] of shoreline in The Bahamas.

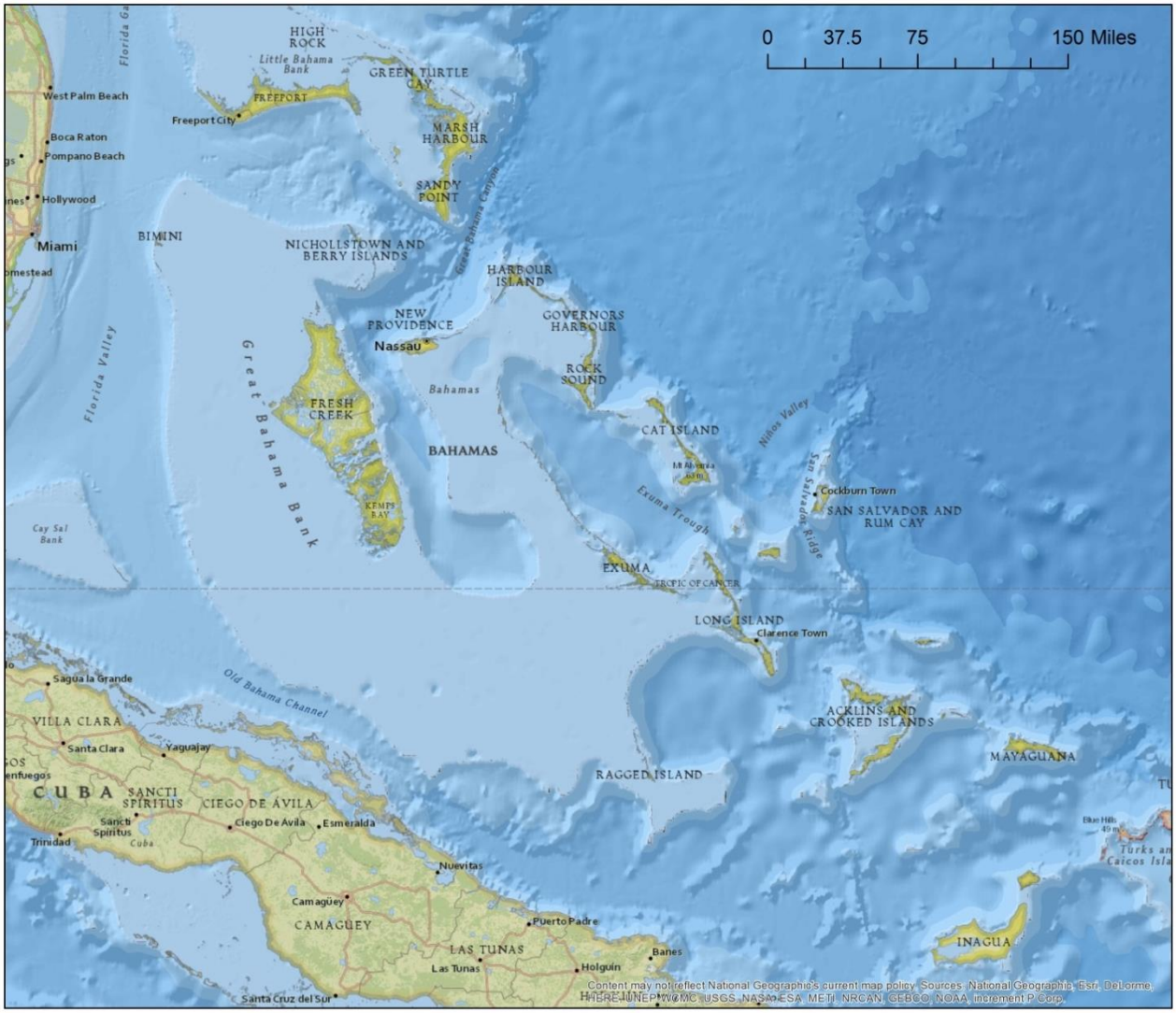
The Commonwealth of The Bahamas has rights and responsibilities over maritime space along with associated living and non-living marine resources such as fisheries, aggregates and potentially oil and gas[12]. These waters also support important and sensitive marine habitats, many of which are globally significant. The islands possess a rich diversity of reef and pelagic fish, lobsters, conch, turtles, algae and resident and migratory birds. Offshore waters are home to numerous species of marine mammal and sea turtles as well as a range of deep water pelagic fish species. These resources are the basis for The Bahamas' largest industry, tourism, and also support a significant and high value domestic fishery for lobster, conch and certain species of fish. Therefore the marine environment provides valuable economic, social and cultural benefits, which can, if managed wisely, contribute to the future sustainable economic development of The Bahamas.

[10] Moss and Moultrie (2014) *Ecological Gap Analysis.* Nassau. The Bahamas: BEST Commission

[11] The Commonwealth (2015) The Bahamas *accessed via* thecommonwealth.org, June 2016

[12] The Commonwealth (2015) The Bahamas *accessed via* thecommonwealth.org, June 2016

Figure 2.1: Map of The Bahamas.



Source: National Geographic, ESRI et al., accessed 2016

2.2 Coastal zone risks

The Coastal Risk Index[13], developed by The Nature Conservancy (TNC), the Coastal Resources Centre and the United Nations University, assesses the exposure and vulnerability of coastal nations to hazards such as floods, tsunamis and sea level rise. Within the top 20 coastal nations at risk, seven are in the Caribbean, with The Bahamas in thirteenth place. The main coastal risks that The Bahamas face include hurricanes and storm surges and the subsequent erosion of the coast. Over the longer term sea level rise will also become a significant coastal risk for The Bahamas.

2.2.1 Hurricanes and storm surges

Atlantic hurricanes and tropical storms directly impact The Bahamas on average once every three years. Over the last 30 years the 10 largest hurricanes and storms to affect The Bahamas resulted in more than US$2.65 billion in economic damage[14]. Three islands in The Bahamas, Andros, Abaco and Grand Bahama, are ranked within the top 10 of all locations affected by tropical storms in the North Atlantic Basin[15].

The predicted effects of future climate change are likely to exacerbate the disaster risk by increasing the frequency and intensity of storms. The coastal defences around The Bahamas are currently insufficient; consequently much of the country is already vulnerable to storm surges and hurricanes. With climate change the risk to The Bahamas is likely to increase unless coastal management measures are introduced. It is predicted that with climate change there could be intensification of coastal erosion and an increased risk of coastal flooding causing damage to coastal structures, properties and businesses[16,17].

2.2.1 Beach erosion

Proportions of the coastline of The Bahamas are dominated by coastal beach ridges. These dunes are susceptible to coastal erosion, but will usually recover naturally due to the cyclical nature of coastal processes. However permeant erosion, which is often caused by human interference with beach processes, is increasing the rate at which the dunes are eroding. For example at San Salvador, a marina sea wall and road reduce the ability of the natural dunes to roll back and provide erosion protection, in addition to encouraging erosion and scouring along the sea walls[18].

[13] CARIBSAVE (2012) CARIBSAVE Climate Change Risk Profile for The Bahamas.

[14] Inter-American Development Bank (2013). Country strategy with the commonwealth of The Bahamas.

[15] Inter-American Development Bank (2013). Country strategy with the commonwealth of The Bahamas.

[16] Gibbs (2001). Natural hazards in the Caribbean

[17] ICF Consulting (no date). The Bahamas national report integrating management of watersheds and coastal areas in small island developing states (sids) of the Caribbean

[18] Mylroie and Sealey (2006). Coastal Erosion Field Guide for The Bahamas.

In addition to human interference with coastal process, dunes are sometimes breached by path construction and direct human impact[19], reducing further the natural erosion protection offered by the dunes.

It is considered in some studies that Casuarina trees, which are common along The Bahamas coastline, are reported to inhibit the growth of native dune vegetation and thus lead to increased dune erosion and subsequent shoreline retreat as the cyclical process of erosion is interrupted[20].

2.2.2 Sea Level Rise (SLR)

A large proportion of The Bahamas is only a few meters above mean sea level; the highest point at Mount Alvernia is just 206ft above mean sea level. Hydrological records demonstrate that over the last century sea level has risen by one foot in The Bahamas[21]. Therefore the risk of coastal flooding to the islands is likely to significantly increase in future with climate change and sea level rise acceleration.

According to emission scenarios from the Intergovernmental Panel on Climate Change (IPCC)[22] Fourth Assessment reports project, average global air temperatures could be expected to rise by 1.5 degrees Celsius by 2023. According to regional studies[23], the mean annual temperature within The Bahamas could be expected to rise by an average of 0.8 degrees Celsius to 2.3 degrees Celsius by 2060.

Simpson *et al.,*[24] have predicted that a climate change increase of 2.0°C - 2.5°C could result in a 1m rise in sea level. Even if global temperatures are stabilised at 2.0°C or 2.5°C, the breakup of parts of the Greenland Ice Sheet and West Antarctic Ice Sheet will continue to encourage sea level rise over many centuries. The question is therefore, not if the Caribbean will face sea level rise of 1m or 2m under either a 2.0°C or 2.5°C global warming scenario, but rather when this sea level rise will occur.

Based on climate change and rising water levels, there are a number of different estimates regarding the potential impacts from sea level rise to The Bahamas (Table 2.1). Although these vary in nature, it is clear that The Bahamas is a very low lying country and therefore and rising sea levels could cause significant damages. However, it should be noted that these differ to a large degree (Table 2.1) and further hazard risk assessment work is required to look at this in more detail.

[19] Sealey (2011). Beach Erosion at Green Turtle Cay, Bahamas.

[20] Sealey, (2006). The Cycle Of Casuarina-Induced Beach Erosion – A Case Study From Andros, Bahamas.

[21] The Governemt of The Bahamas (2015). Intended nationally determined contribution (indc) under the United Nations framework convention on climate change.

[22] IPCC (2014) Climate Change 2014: Synthesis Report. Contribution of Working Groups 1, 2 and 3 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland.

[23] McSweeny *et al.,* (2010) UNDP Climate Change Country Profiles Improving the Accessibility of Observed and Projected Climate Information for Studies of Climate Change in Developing Countries.

[24] Simpson, Scott, *et al* (2010). Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean.

Table 2.1: Predictions on impact of SLR in The Bahamas

Source	Potential Impact
Simpson, Scott, *et al.,* (2010). Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean.	Based on a climate change increase of 2.0°C - 2.5°C which could result in a 1m rise in sea level, they predict that many low-lying urban areas in The Bahamas will be inundated (up to 3%), which could lead up to 110,000 people becoming displaced . This is approximately 30% of The Bahamian population, the highest national percentage compared to other Caribbean Community (CARICOM) nations.
NDP Secretariat (2016) State of the Nation Report. Nassau.	A 1m SLR would inundate 80% of the country's landmass. This statistic has most likely been derived from the statistic that 80% of The Bahamas is less than 1m below Mean Sea Level.
Simpson, Scott, *et al.,* (2010). Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean.	A 1m SLR with 3.5m (1in100 year) storm surge could cause inundation of 21% of the Land Area in The Bahamas.

2.3 Social Background to The Bahamas

The archipelagic state of The Bahamas consists of approximately 700 islands, of which 40 are inhabitant. However, the majority of the country's population (95%) resides on just 11 of these islands and the capital Nassau, on New Providence, and Freeport on Grand Bahama are where the major populations are centred.

The population of The Bahamas is approximately 385,000[25]. The relatively young population is distributed as follows 0-14 years (24%), 15-64 years (69%) and 65 years and over (6%)[26].

The country's population is unevenly disturbed across the islands and is sustained by the continuous movement of population from the Family Islands to New Providence in addition to Grand Bahama. This population movement is driven by residents seeking better economic opportunities, social services and improved living condition[27]. This continuous net movement of the population to New Providence has placed increased demand on the State's social services, by occupying substandard housing in marginal areas and contributing to the growth of communities where declining living standards are observed.

The Bahamas, in general, has been experiencing an overall increase in unemployment since 2001, with the highest level of unemployment being found among 15-24 year olds, at 30.8% of the population[28]. This increasing unemployment pattern suggests that there is a growing inability of the labour market to supply sustainable employment to local job seekers.

[25] Government of The Bahamas (21016) Vision 2040

[26] CCS and SEV Consulting Group (2016) Draft National ICZM Policy Framework

[27] The Caribbean Development Bank (2014) *College of The Bahamas Transformation Project.* Paper BD 4/14

[28] Department for National Statistics (2014)

Though the country has one of the highest per capita incomes of the Caribbean it also has the highest inequality rate of the Caribbean[29]. Gender inequality between men and women has led to women struggling to access the higher paid jobs across all occupation categories. With high inequality levels in The Bahamas, particularly in the Family Islands, there is a need for improved welfare assistance for parts of the population and strategic development interventions. The overall poverty rate is 9.3%, though it is higher in rural communities. For example, in Region 2 (Abaco, Eleuthera, Andros) the poverty rate is 14%, in Region 3 (Exuma and Long Island) 17% and in the other Family Islands, it is 21%. Despite the higher rates in the rural communities, 76% of poor people are found in the two urban centers[30].

However, The Bahamas has also achieved favourable social indicators, such as attaining 0.794 for the Human Development Index (HDI) in 2012 which placed The Bahamas in the high development category ranking at 49 out of 187 countries. The Bahamas has also achieved the Caribbean Millennium Development Goals (CMDGs) target of gender parity in educational enrolment and basic education enrolment for all children[31].

2.4 Summary

The vulnerability and importance of the coastal zone in The Bahamas provides a requirement for careful planning and management. This needs to ensure a holistic and integrated approach which considers the wider range of functions and activities within the coastal zone. Approximately 60% of the country's economy is tourism based, while 80% of its land lies less than 1 metre above sea level[32]. A 1 metre sea level rise would place more than a third of major tourism properties at risk, as well as 38% of airports, 14% of road networks and 90% of sea ports[33].

[29] Survey of Living Conditions for the Bahamas (2001)

[30] FAO and Ministry of Agriculture, Marine Resources and Local Government. (2014). Technical Cooperation Program – Strengthening Fisheries and Aquaculture Governance in The Bahamas Project Document. TCP/BAH/3501.

[31] The Caribbean Development Bank (2014) *College of The Bahamas Transformation Project.* Paper BD 4/14

[32] NDP Secretariat (2016) State of the Nation Report. Nassau

[33] Simpson, Scott, *et al* (2010). Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean

3 Current Coastal Management in The Bahamas

3.1 Current information and data availability to support Coastal Management

As part of the project process of developing the proposed structure of initial components to facilitate a risk-resilient ICZM in The Bahamas, the baseline studies that are required to fill key data gaps have been identified. Initial considerations were developed within the First Interim Report[34] and Second Interim Report[35], and the Key Stakeholder Workshop in February 2016 was used to augment, focus and agree these ideas with stakeholders.

The conclusions from the literature and data gap analysis were presented in the First Interim Report[36]. A summary of the literature review is presented in Appendix A. Key data gaps identified within the data gap analysis are presented in a table in Appendix B. These have been summarised under the different data categories and the definition of the categories and results from the data gap analysis as follows:

- Physical data:
  - ***Definition:*** Physical data have been categorised as data which is required to undertake risk-resilient ICZM coastal protection design of both hard and soft engineering structures. Design parameters required include topographic, bathymetric, metocean and geological data. Furthermore, base mapping photography data (incorporating aerial and satellite images) have been included in this category.
  - ***Results:*** Overall there is a lack of coordination and national coverage of physical data. In particular, the data gaps are: national coverage of topographic/elevation data (in particular clarity of the Shattuck datum), sediment, wave and current data, sea level data and base mapping (including aerial photography, base maps and satellite imagery).
- Asset data:
  - ***Definition:*** Asset data are classified for the purpose of this Study as information on coastal management and coastal protection assets. This includes soft and hard engineering assets such as sea walls, revetments, offshore breakwaters, beaches and dune ridges.
  - ***Results:*** There is a critical lack in data describing the quantity, location and importantly the condition of coastal structures owned by the GOBH, including both coastal structures as well as long term beach profile/condition data.
- Environmental data:
  - ***Definition:*** The environmental data category covers ecological data regarding key flora and fauna in the coastal zone for The Bahamas.
  - ***Results:*** Compared to other data types, the coverage, quality and availability of environmental data are greater and more comprehensive. However, environmental data collection needs to be continued to ensure long term datasets exist for monitoring. There is detailed environmental data available for specific sites such as Andros Island but

[34] Mott MacDonald (2016) Bahamas ICZM Program First Interim Report

[35] Mott MacDonald (2016) Bahamas ICZM Program Second Interim Report

[36] Mott MacDonald (2016) Bahamas ICZM Program First Interim Report

unfortunately this is not replicated across The Bahamas. There is also a specific lack of mangrove health data available across all sites.

Social data:

- ***Definition:*** Social data incorporates statistics and information about the population of The Bahamas living in the coastal zone.
- ***Results:*** Although a lot of data exists on the national scale, there is a lack of site or island specific social data which would likely be needed for assessing justification and outcomes of particular engineering interventions. There is a big drive in particular locations under the Sustainable Nassau project to collect some of this data.

- Climate change data:
  - ***Definition:*** Inclusion of any future environmental and climate change data which could impact the coastal zone within The Bahamas.
  - ***Results:*** There is a wide diversity of global to regional climate change data (such as from the IPCC[37]), however specific climate change impacts relating to coastal management and engineering needs to be developed (such as regional climate change and hurricane impacts).

The overall availability of all data and information can be summarised as:

- **Spatial scale of data and information:** Nationally, organisations are often using old or unreliable data to aid policy decisions and there is a lack of data relevant to risk-resilient ICZM. At the local level there is some more detailed site specific information but this doesn't support understanding to the overall national resilience to climate change. At the sector level data the data is generally very disparate and not integrated.
- **Data and information ownership and storage:** Existing data is held by a number of organisations including: different Ministries of the GOBH; private organisations within The Bahamas; Non-Governmental Organisations; private organisations outside of The Bahamas and research institutions. This makes it difficult to collate and coordinate data for an integrated management Program. These entities often operate in silos, with no resources directed at agencies to integrate and share data.
- **Data quality and coordination:** The quality (reliability and accuracy) of the data that are available is often questioned. Furthermore, there appears to be a lack of data management guidelines for collection, monitoring and sharing of the data. For example the Water and Sewerage Corporation (WSC) collects and distributes data in WGS84 projection, whilst the Land and Survey team collect data in NAD27. Therefore when data are shared the data often cannot be easily used or combined and layers of digital GIS data may not overlay properly. The Ministry of Works and Urban Development (MoWUD) has also stressed the inadequacy of current design guidance being used for coastal protection structures and assets in addition to the out of date Shattuck Datum.
- **Data format and training:** The development of GIS data and training on this is often related to specific opportunities and associated with specific projects. However the platforms, software and training for each of these projects will have been varied and therefore the platforms and knowledge that exists between agencies is varies and disparate.

[37] www.ipcc.ch/ *accessed* March 2016

The Bahamas National GIS Centre (BNGIS Centre) are involved in ongoing national projects looking generally at data across The Bahamas, with a particular effort ongoing to build a library of national data. However the team at the BNGIS Centre are facing many of the data issues as detailed above. It will be imperative that efforts as part of an ICZM Program to improve data availability, quality, management and coordination is undertaken with close coordination with BNGIS Centre.

3.1.1 Summary of key conclusions and data gaps

The literature and data gap analysis exercise clearly demonstrates that there has been a wide range of interest and studies on coastal management related issues, though these remain very sector/site specific in nature. Most of the data have been classified as either outdated or focused on a very specific site or sector. There appears to be a lack of coordination of information across sectors and on a national scale that is up to date and that people have confidence in.

In order to address the key gaps and facilitate development of a risk-resilient ICZM, it is considered that further studies required fall into three categories:

- Baseline national surveys to bridge data gaps and improve understanding;
- Studies to improve information management; and
- Strategic level studies to improve the knowledge base and assist the planning process.

3.2 Current coastal defence and beach use management practices

Much of the coastline of The Bahamas interacts with, or is owned by, private developments, namely: residential properties, hotels and ports. This makes coastal management practices in The Bahamas very fragmented and disjointed in many places. There are no specific guidelines relating to beach infrastructure, safety, building structures close to or on the beach and different approaches are used by different people.

More recently, The Bahamas Public Parks and Public Beaches Authority (BPP&PBA) was set up in October 2014 under a specific statute[38]. It was created to assist the GOBH in fulfilling its commitment to: "*establish green spaces throughout the country in order to further preserve the environment, and also to help this lead to greater employment for Bahamians, while creating a cadre of trained public officers similar to those employed with the United States Park Service*".

The functions of the BPP&PBA are to:

- control, plan, design, develop, administer, manage and maintain the public parks and public beaches designated by the authority;
- conserve the natural beauty and topographic features of public parks and public beaches;
- propagate, protect and preserve the animals, plants and other organisms within the public parks and public beaches;
- preserve objects and places of aesthetic, historical or scientific interest; to remove derelict objects from any public park or public beach or from public access to any public park or public beach;

[38] Bahamas Public Parks and Public Beaches Authority Act - BPP&PBA Act 2014

- maintain public access to and to provide a lifeguard service at public beaches as it thinks fit; and
- maintain green verges and the facilities at public parks and public beaches.

This Authority presents a good opportunity for ownership over the management and control of beaches, however it does not cover beach protection structures and therefore ownership and responsibility for different aspects of coastal engineering needs to be clarified in the future. The construction and maintenance of coastal engineering structures is, instead, undertaken by the MoWUD (notably the Dept of Public Works – DPW). The asset information held by the structures team within the DPW covers all Government-owned structures however it is unlikely to cover all coastal protection structures[39]. Therefore specific coastal engineering capacity remains very limited within The Bahamas.

A technical review of different coastal management protection structures used within The Bahamas is provided in Appendix C. The key issues relating to this within The Bahamas that have been observed are:

- Clarity of land ownership and ability to coordinate coastal protection design;
- Control over development by hotels and private developments;
- Need to improve planning with regard to coastal management – ensuring a holistic approach that considers the larger island or sub-island scale;
- Limited design guidance and clarity when designing to climate change scenarios; ad
- Inclusion of innovative and green-engineering designs can be improved.

3.3 Current legislation and governance relating to ICZM

The full analysis has been presented in the Institutional Framework Analysis Report (Appendix L).

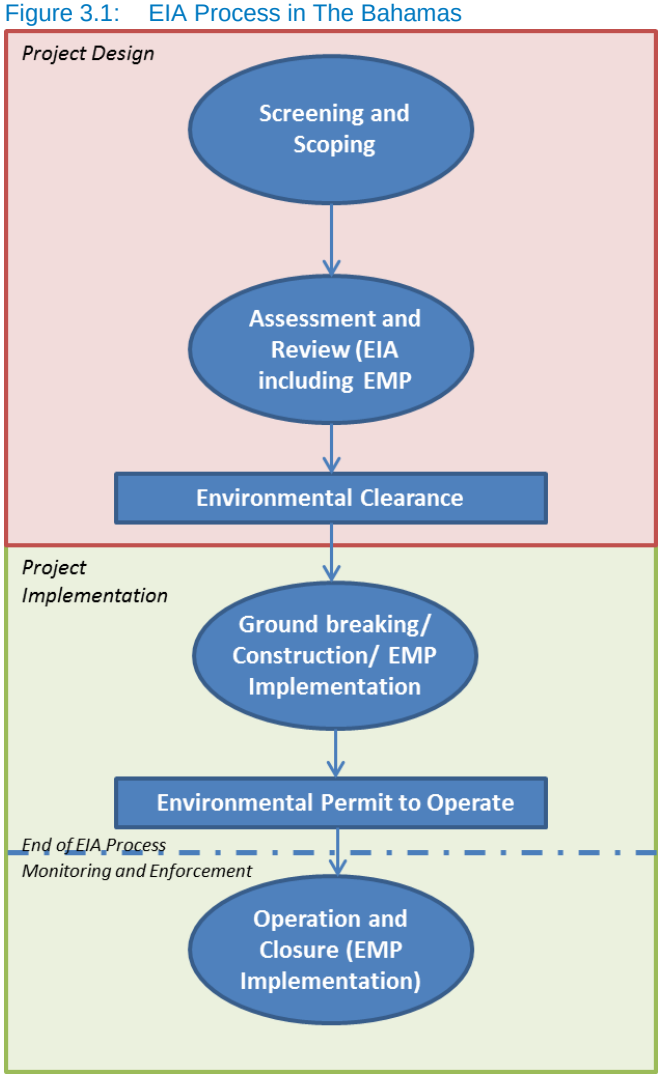
3.3.1 Current legislation

There is currently no specific legislation relating to coastal management or ICZM, however there is a current EIA process under which many of the coastal developments/coastal defence engineering work would fall. The current EIA process is presented on the BEST Commission Website[40] and is summarized in Figure 3.1 below.

[39] Ministry of Works and Urban Development (2016) *Personal communication*

[40] www.best.gov.bh *accessed 2016*

Figure 3.1: EIA Process in The Bahamas



Source: The BEST Commission accessed 2016

3.3.2 Summary of institutional capacity

The institutional capacity needs assessment has uncovered a number of baseline findings relating to each key Ministry, Department or Institute assessed. These baseline findings are summarized below. The full details of these findings as they relate to each capacity area are discussed in Appendix L. Generally, all agencies assessed faced the following challenges in the context of their capacity for risk-resilient ICZM:

- Limited strategic planning (within Ministries/Departments) takes place, with no coordinated approach to ICZM mainstreaming. In places, Strategy Plans are in existence, however they often need updating or have proven difficult to implement.

- Some coordinating mechanisms are in place to effectively encourage data sharing between agencies however this can be improved and more widely applied.
- Agencies would benefit from an increase in standardised procedures to help standardise the effective implementation of public consultation procedures.
- Research functions of agencies are limited and therefore there is limited integration of scientific knowledge into decision-making.
- Monitoring and evaluation frameworks are in operation however these mainly only exist when linked to a donor funded project.
- Several human resource challenges exist.
- There are challenges associated to the financial resources required to effectively undertake functions.

3.3.3 Key Challenges

Although a Draft National Maritime Policy is in existence for the Bahamas (MoTA – 2015), this does not address all principles of ICZM. Consequently, with no current policy specific to ICZM in place, there is no clear mandate for its implementation within any national agency. For example, there is no written policy for coastal set-backs for coastal developments. As a result of this, coastal development around the country is essentially unrestricted and un-guided in terms of set-back of buildings and infrastructure which is further compounded with the lack of formal EIA regulation in the country. Coastal development (without any formal regulation or enforcement in place) often includes the removal of coastal vegetation, which can expose coastlines to storm surges, erosion, and reduced plant material composition. The 2003 Building Code regulates the requirements of physical buildings, and the Code contains a flooding elevation requirement (vertical set back) of the lowest floor being at least 12 inches above any known flood level. However, in the absence of any minimum lateral coastal setbacks, the Code helps little with regard to reducing developments on the coast.

The institutional framework of The Bahamas is therefore currently too fragmented in its current state to deliver an effective ICZM program without some preliminary support, guidance and direction. In addition, there is no one comprehensive statute in place that can help to establish a lead agency that will be responsible for management of the coastal zone (nor is there one in place to manage the wider environment, hence ICZM issues (or sectors making up ICZM) take place through a number of different pieces of legislation under a variety of institutions. To this end, the process to develop the National Development Plan (NDP – Vision 2040) is likely to be a very important vehicle to begin integrating development planning with environmental protection[41].

3.4 Technical Briefs

In addition to undertaking a baseline review of data and literature (Section 3.1), coastal engineering 3,2) and institutional capacity (3.3) within this Project, Technical Briefs have been developed under Component

[41] NDP Secretariat, (2016) the National Development Plan

1 of the overall Study[42]. These Technical Briefs outline current understanding, key issues for ICZM and provide recommendations under five key topics:

- Governance and Planning;
- Policy;
- Environment;
- Economics; and
- Climate Change Vulnerability and Adaptation Considerations.

Key summaries of these Technical Briefs have been provided in Appendix K of this Report, however the details behind these summaries can be found in the Technical Briefs[43]. Key thematic themes were identified within the Technical Briefs and the recommendations (both short term and long term) have fed into the development of the recommendations presented within this Report.

[42] CCS and SEV consulting (2016) Technical Briefs *found in* Second Interim Report

[43] CCS and SEV consulting (2016) Technical Briefs *found in* Second Interim Report

4 Framework for an ICZM Program for The Bahamas

4.1 Overview

Following the work undertaken to review the current situation (as presented in Section 3) and the stakeholder workshops which have been undertaken (Appendix J.), three components have been suggested to form the structure of The Bahamas' ICZM Program (henceforth referred to as the Program). Further detailed background and justification for these components are presented in Sections 5 to 7 of this Report.

4.2 Developing the Program

The proposed structure for studies and surveys for ICZM in The Bahamas has been developed following a number of key activities:

a. Inception meeting with the Technical Advisory Committee (TAC) on the 13th January 2016;
b. Individual meetings with TAC members and other stakeholders during the week beginning 11th January 2016 and 22nd February 2016;
c. Stakeholder workshop event on the 22nd and 23rd February 2016;
d. Review of key institutional data and legislation relating to coastal management and protection within The Bahamas by the Mott MacDonald Project Team;
e. Site visits by the Mott MacDonald Project Team to each identified Pilot Site; and
f. Literature and data gap analysis undertaken by the Mott MacDonald Project Team.

Further to the above activities, the Project Team has considered other ICZM funded projects within the Caribbean. There are some key lessons learnt that are built into the overall consideration for the proposed structure of the program for The Bahamas:

- **Lesson 1** : A strong execution agency is critical to Program success;
- **Lesson 2**: Strong technical support for design and supervision is critical;
- **Lesson 3:** The Investment Program should be based on final designs and associated construction. If this is not possible a Program should include *two phases*: a design phase and a separate construction phase, with financing for the second phase tied to the benchmarks of completion of final design, planning approval, legally-documented access to work sites and land acquisition (where required);
- **Lesson 4**: Timelines for project execution need to consider all factors that affect implementation (approval, access, acquisition, procurement); and
- **Lesson 5:** The planned timelines for project execution should consider specific actions which are not within the control of the GOBH (coordination with other Government entities, necessary approvals and permits, access agreements with property owners, taking into account the high rate of turn-over in coastal property; agreements with business regarding construction schedules).

Although three separate components have been developed as part of the program, they are very much interlinked and together address the key issues highlighted in Section 3. Although broadly three components have been proposed to focus on data collection, coastal management interventions and institutional capacity, governance and legislation respectively, there are many interlinks between the components. Table 4.2 details the proposed timing of the components due to any critical path links that exist between the different components.

4.3 Road map for ICZM in The Bahamas

In order to clearly identify what initial studies should be undertaken, as well as undertaking a baseline review (Section 3), consideration of the long term road map for ICZM in The Bahamas has also been undertaken. This allows clear consideration of where The Bahamas is aiming in the long term for developing ICZM and therefore where the proposed initial Program fits into achieving this long term vision.

4.3.1 Lessons learnt from Barbados

Although the contexts of the two countries are unique, ICZM in Barbados possibly represents a good "window" from which to view and possibly propose the ICZM "Road Map" for The Bahamas in the future. In Barbados, ICZM has undergone a significant evolution over the past 30 years. The country is among a few countries now at the forefront of the practice across the Caribbean, and its success has contributed to a thriving coastal tourism industry that continues to remain at the core of the country's economy. Over three decades, the IDB have supported and collaborated on four investment programs in the country. Between 1983 and 1984, a Diagnostic and Pre-Feasibility Study of the island's coasts was conducted by the Government of Barbados (GoB) with financial support of the IDB. Two further programs were subsequently supported through pre-investment loans: the Coastal Conservation Pre-Investment Program (Loan 57110C-BA for US$4.7 million, 1991 –1995) and the technical cooperation Coastal Conservation Program Phase I (Loan 856/0C-BA for US$3.6 million, 1996-1999). The Coastal Infrastructure Program (CIP) was the fourth IDB-financed loan operation in Barbados in support of GoB efforts to implement coastal zone management in the country (2002-2009). To complete the story, the IDB has prepared its Country Strategy with Barbados (2014-2018); and the sector Integrated Coastal Zone Management (ICZM), Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) is identified by the GOB as a potential priority area of support and Bank intervention. The Coastal Risk Assessment and Management Program (CRMP), started in 2014 through to the end of 2018, is aimed at building resilience to coastal hazards (including those associated with climate change) through enhanced conservation and management of the coastal zone.

From these investments and interventions (notably over circa 30 years), the GoB has established the legal and institutional framework needed to protect its coast; acquired the technical know-how to assess, monitor and manage complex physical processes that shape its shoreline; has contributed to the scenic beauty and recreational value of its beaches; has implemented coastal infrastructure works that have had successfully controlled coastal erosion, stabilized beaches, improved public coastal access; and provided tangible economic and social benefits, both to its international tourism product and to locals alike.

So what is this "window" displaying and what lessons can be taken from it? The main lesson is that ICZM is a journey. It takes time to show results. The early Feasibility work (1983-84) in Barbados allowed for the bringing together of appropriate funds and human resources, and to "establish specific milestones". This is the critical stage and to learn from Barbados. The Bahamas feasibility stage of work needs to be convincing at this stage, demonstrating clear evidence based outcomes, and through sound scientific evidence gathering, this case can more effectively be made.

The next “phase” of the approach is to take forward the early feasibility study work, and fine tune research findings according to help prioritise national needs (possibly from Vision 2040) and from this to demonstrate early successes as quickly as possible (initiating and celebrating visible “quick wins” is really important). For example, in Barbados, the 1991-5 Pre-investment work re-focused its attentions in line with the need for support and attention on the strategic areas of: Beach creation and stabilization; Water Quality Improvement and Legal and Institutional Arrangements. It was not until the 1996-8 Coastal Conservation Program – Phase 1 was started did the set up and training for the Coastal Zone Management Unit formally start (i.e.: 13 years after the first IDB project). Consequently, the lessons learned from Barbados (for the Bahamas) clearly implies that a focus on priority national needs is required, whilst adhering to the concept of picking “low fruit” in the early years will be a wise strategy. In addition, building partnerships (private, public and regional) is of paramount importance for the long term sustainability of ICZM in The Bahamas.

4.3.2 Short term focus for ICZM in The Bahamas – 0-5 years

The short term focus for ICZM in the Bahamas should derive from the country’s own unique vulnerability analysis and response to natural disasters (both slow onset such as climate change and more rapid onset hazards such as hurricanes) and the economic implications of such events. This is exemplified in the recent Hurricane Joaquin Economic Impact Analysis and the significant additional risks of low lying archipelagic islands to climate change impacts (including sea level rise). In this context, it is recommended that ICZM initially, within the Bahamas, should focus on providing environmentally sustainable responses for Bahamian islands to mitigate these hazards whilst providing the adaptive capacity to facilitate “climate compatible development in the future”. This is hereby termed “shoreline management” for the Family Islands and New Providence. Its contribution to strategic Bahamian planning is to identify the spatial location and type of climate compatible development protect that shall be resilient to slow and rapid onset hazards (such as coastal erosion and storm flooding) to thereby prevent inappropriate development whilst in tandem, to reduce damage to existing and future infrastructure and the economic development of the country. This can be implemented by focusing on executing a series of work components as follows: (i) baseline studies; (ii) demonstration projects implemented in the context of a shoreline management approach; and (iii) some modest advances on legal reforms and capacity building.

This approach may be inculcated within the new Planning and Subdivision Act 2015 request for Family Islands to produce specific Land Use Plans. Shoreline Management policies and plans could hereby be easily incorporated into the draft Land Use Plans, and be based on new climate / meteorological datasets that shall help islands to plan for climate change and disaster risk reduction as appropriate. These shall seek to standardise the approach towards defining a “zone” that reflects the inland limit of flood related inundation occurring from either sea/fluvial or storm drainage sources on each Family Island.

4.3.3 Long term focus for ICZM in The Bahamas (5-10 years)

Undoubtedly, there are a number of key legislative and institutional reforms that need to occur in The Bahamas to be able to set the platform for an effective ICZM program. These are likely to be long term and are proposed as follows. First and foremost, there needs to be an overall environmental management framework within which the proposed ICZM Framework can become embedded. This environmental

management framework should also include a comprehensive national physical development (land and sea use management) plan to help guide the sustainable use of land and marine resources across the Bahamian archipelago. The framework also needs to seek to incorporate key elements of the global Sustainable Development Goals (SDGs) that the GOBH has committed to implement by 2030 on behalf of the Bahamian people whom they serve. The GOBH will also need to report regularly on progress of implementation of the SDGs to the global platform established by the United Nations.

It is also proposed that a new ICZM Secretariat is set up with supporting Technical Working Groups which in time, could eventually become part of a separate Directorate of ICZM within a new Ministry of Environment Protection and Management (currently in discussion with GOBH).

4.4 Summary of the proposed components

4.4.1 Component A: Diagnostic Studies and Information Management

4.4.1.1 Description and Justification

This component is justified in light of the key national data gaps that have been identified within the Project (Section 3). There are a number of national scale studies that are now required to bridge the data gaps. Information and data needs are urgently required to address climate resilience and to ensure that the aspirations of Vison 2040[44] are met with regards to climate change resilience. To this end, the new data collected shall help to better design and facilitate coastal management interventions to embrace climate resilient development around The Bahamas. Furthermore, this component will aim at bringing together an information management system that will collate and integrate GIS data from the different activities being carried out throughout the proposed ICZM program (store and analyse information collated from all Components – A, B and C).

4.4.1.2 Key Outputs

- Establishment of data catalogue, data coordination and tools within the CMIS;
- Up to five new water level and wave monitoring systems;
- Ongoing monitoring and measurement of beach condition;
- Record of position and condition of coastal protection structures;
- Increased understanding of sediment supply and transport; and
- Coverage of an initial 6 islands with up to date aerial images and LiDAR/bathymetric data.

[44] NDP Secretariat, (2016) the National Development Plan

4.4.2 Component B: Coastal Protection Interventions

4.4.2.1 Description and Justification

There are many vulnerable coastal communities within The Bahamas that shall increasingly require a range of possible adaptation strategies (in part linked and coastal protection interventions) to be implemented in the short term in places.

This component focuses on providing Pilot Sites for coastal management (involving soft or hard coastal engineering interventions). The Pilot Sites cover a range of natural habitats that are typically found around The Bahamas. Approaches have thereby been developed into a Program of Works to demonstrate best practice in developing ecosystem services through coastal management interventions around The Bahamas.

The 5 Pilot Sites were first defined in the First Interim Report[45] as sites requiring climate resilient intervention to be undertaken (further details around these sites are provided in Section 6 of this Report). The proposed works include collation of data on the site specific spatial scale which will feed back into the overall data and information gathering exercises being undertaken under Component A.

4.4.2.2 Key Outputs/Outcomes

- Five new coastal management intervention schemes;
- Two (of the five) sites focus specifically on the improvement to ecosystem services; and
- Improved coastal protection to at least 530 residential and commercial properties.

4.4.3 Component C: Institutional Strengthening and Capacity Building

4.4.3.1 Description and Justification

This component shall include products and activities that help to formalise legislation and institutional arrangements in The Bahamas to ensure risk-resilient ICZM is mainstreamed into sector planning and is set up to help implement the Vision 2040 National Development Planning[46] process. It shall also include activities that prepare bespoke, planning “tools” such as two Shoreline Management Plans, updates and development of new climate resilient infrastructure building codes and Standard Operating Procedures to help deliver ICZM. The Component focuses also in long term financial sustainability through the establishment of alternative cost recovery and financing options including possible “Technical Interface Agreements” to help integrate private sector engagement into ICZM delivery. It shall also include activities that take forward the findings of Components A and B to help Family Islands prepare coastal policies as part of the Island planning[47] process.

[45] Mott MacDonald (2016) Bahamas ICZM Program First Interim Report

[46] Office of the Prime Minister (2016) The National Development Plan: State of the Nation Diagnostic Overview and Data Report; Vision 2040.

[47] The Government of The Bahamas (2015) Planning and Subdivisions Act 2010 updated 2015.

4.4.3.2 Key Outputs

- Amendment to environmental legislation to better embrace ICZM;
- Six new operating procedures to help mainstream risk resilient ICZM to the Family Islands;
- Two new guidance manuals to provide planning tools and design guidance;
- Two pilot Shoreline Management Plans;
- Up to ten training events for stakeholders; and
- A finance strategy to develop tools to facilitate private sector financing.

4.5 Proposed Structure

The three components that have been listed within Section 4.4 will be made up of sub-component tasks. Table 4.1 provides further detail and the justification for the sub-component tasks and Table 4.2 provides the implementation program.

Table 4.1: Program for studies and surveys for ICZM in The Bahamas

Sub-Component	Name	Description	Tasks within Sub-Component	Justification for Sub-Component
Component A: Diagnostic Studies and Information Management				
A1	Oceanographic Data Collection Study	A study to focus on coastal hydrodynamics and water level/tidal data collection throughout The Bahamas. The study will look at specifying equipment type and placement through high level modelling and an assessment of current data availability.	- Specification of key oceanographic data parameters. - Production of a data monitoring plan including preliminary hydrodynamic and wave modelling. - Consultation with key organisations. - Determination of a consistent datum throughout the islands. - Development of a plan for creation of small network of permanent tide gauges. - Considerations of costs and long term funding. - Training.	Oceanographic data is required to be used directly or indirectly to help inform and determine design conditions, for example extreme waves/water levels will be required for coastal protection schemes. Where long-term data sets of waves, for example, are not available then shorter term sets of such data could be used for calibration/validation of hindcast wave models. Similarly, water level and current measurements can be used for defining boundary conditions and calibration/validation of hydrodynamic models for use in design, understanding of coastal processes and impacts brought about by potential coastal management schemes. Limited data is currently available in The Bahamas and rather than collecting data ad-hoc for individual projects, it is considered that it would be more cost and time effective to have a coordinated campaign for The Bahamas.
A2	Beach Monitoring Program	A study to set up where beach monitoring is needed (to help feed into Component B) and the methodology that should be put in place to ensure ongoing long term beach monitoring.	- Identify and prioritise locations. - Develop a framework for the Beach Monitoring Program including definition of equipment and methods. - Develop the institutional framework including training in using equipment and processing data. - Set up initial Pilot Studies and produce reports for the Pilot Studies. To include at least three sites with one being Treasure Cay, Abaco.	Beach erosion is a concern for many sites around The Bahamas. However, effective management and the decision to provide coastal protection implementation options requires a better understanding of the long term beach processes and trends. Although some information on coastline retreat can be gained from aerial photographs, this is spatially and temporally limited in The Bahamas by availability of data. Furthermore, more detailed information on cross shore profiles is also crucial to feed into the design of coastal protection options.
A3	Coastal Infrastructure Asset Inventory	An assessment and recording of coastal structure including an assessment of the condition of the structures and setting up an ongoing survey platform for future surveys and management.	- Condition survey of structures for the Family Islands. - Logging of data within GIS. - Setting up of GIS for further condition surveys and ongoing maintenance. - Coordination of this database with the Coastal Management Information System (A5). - Training and hand over of information to Ministry of Works and Urban Development.	Currently, the condition, and even the location, of critical coastal protection structures is not well documented or understood. It is crucial that these structures are not only documented but inspected and maintained so that the resilience they provide to coastal hazards is maintained.

Sub-Component	Name	Description	Tasks within Sub-Component	Justification for Sub-Component
A4	Sediment Resource Study	The purpose of this study is to attempt to quantify reef sediment contributions to each Family Island in the future and provide clarity on how carbonate sediment contributions to beaches may change in the future and may interact with soft/hard engineering solutions.	- Collate reef health data from BNT/TNC/other stakeholders. - Quantification of carbonate sediment contributions. - Assessment of potential impacts with climate change. - Recommendation for impact on engineering solutions.	It is acknowledged sediment supply is fundamental in maintaining and designing beaches. There are a number of significant risks to the potential future sediment types within The Bahamas, particularly in the context of climate change. It is therefore important to develop a focussed understanding of the sediment resources within The Bahamas, the links with the reef systems and potential future risks and how this may impact coastal protection infrastructure.
A5	Coastal Management Information System (CMIS)	This shall be the repository for all risk-resilient ICZM related data collated in Component A, B and C. It shall be undertaken closely with BNGIS Centre and in conjunction with other national spatial infrastructure related work that is proposed.	- Work with BNGIS Centre and other stakeholders to identify where ICZM specific information falls within the GIS library, current platforms used and training that exists in different organisations. - Assessment of the platforms available in the institutions for collation of data. - Develop specific tools and applications for ICZM delivery. - Work with BNGIS Centre to set guidelines for ICZM data collation – including setting of coordinate and datum systems. - Training. - Collection of additional data including satellite imagery, DTM, aerial imagery etc. - Processing of this data.	Although a central repository for data does not currently appear to exist in The Bahamas, BNGIS Centre is currently undertaking a lot of work to develop this. In order to support the other sub-components within this overall Program, specific ICZM related platforms will be required. Furthermore, there are some national data sets and guidelines that are required to inform other studies. This should be a prioritised sub-component so it has started before other sub-components commence.
A6	Habitat Monitoring Study	The purpose of this study is to use satellite imagery to facilitate a habitat monitoring exercise, combined with development of an ongoing monitoring plan.	- Specification of parameters and acquisition of satellite imagery. - Production of habitat monitoring plan. - Habitat mapping and desk study. - Habitat assessment.	As part of ICZM planning, monitoring in coastal environments using base layers maps and habitat survey can assist in a variety of applications such as ecosystem service modelling, coastal defence considerations and, risk assessments. New satellite technology combined with ecological assessments is recommended for The Bahamas to help generate valuable up to date bathymetric maps using multi-spectral satellite images.

Sub-Component	Name	Description	Tasks within Sub-Component	Justification for Sub-Component
Component B – Coastal Protection Interventions				
B1	Glass Window Bridge, Eleuthera	Design and optioneering of the preferred option for the Glass Window Bridge.	- Undertake and analyse surveys including topographic survey, bathymetry survey and asset condition survey. - Undertake a met-ocean study. - Undertake option appraisal study and concept design. - Develop outline design and cost estimates. - Preparation of specification for detailed design.	From the option scoring (see Section 3), it is suggested that upgrading of the current bridge, and if not possible the design of a new bridge would be the preferred option here. However, there is a need to build the survey information required in this area to allow the detail design of an option. Therefore, a design and optioneering study is proposed.
B2	Treasure Cay, Abaco	An Option Development Study including a Hazard Risk Assessment to identify the key coastal erosion risk areas. In addition an Optioneering Study can identify potential alternatives that can be developed in support of a future investment package(s) for detailed design, construction and maintenance costs.	- A new topographic survey of the public beach. - Sea level rise modelling. - Sediment modelling. - Storm surge inundation assessment. - Vulnerability assessment. - Optioneering study. - Potential design and construction.	It is considered that there are a large range of possible options along this frontage, however there is a large risk with carrying out a scheme in this area which is related to the land ownership complexities of the site. The area of public beach is only a small section of the overall frontage, however the coastal processes are linked along the frontage and consideration of the whole frontage is required for longer term erosion control. It is considered that a better understanding of the processes along the frontage are required to allow an assessment of coastal processes to be undertaken on more sound scientific knowledge.
B3	Deadman's Cay to Mangrove Bush Settlement, Long Island	Undertake a strategic review of flood risk and disaster risk management between Deadman's Cay and Mangrove Bush Settlement.	- Data review, data gap analysis and topographic data collection. - Probabilistic Hazard Assessment and preparations of Hazard Maps. - Vulnerability Assessment and preparation of Vulnerability Maps. - Risk Assessment and preparation of Risk Maps. - Develop options for coastal protection design and recommend preferred option. - Stakeholder engagement.	Due to the long stretch of coastline within this Pilot Site, it is likely that a number of solutions will be required to reduce the vulnerability of the area. These are likely to include mangrove rehabilitation/planting, improved drainage and focussed sea walls/raising of roads in focussed sections which are particularly low lying. However, to focus the coastal protection interventions in this area, more information will be required regarding where the most vulnerable areas are. Therefore, a strategic level study is proposed to allow a focussed consideration of the preferred intervention options in this area.
B4	Central Nassau, New Providence	To produce a Strategic Coastal Development Report for Arawak Cay to Potters Cay focussing on varied land use, flood risk, regeneration etc.	- Data review, data gap analysis and topographic data collection. - Definition of zones along the frontage and priorities/outcomes for each zone. - Develop options for coastal protection design and recommend preferred option. - Stakeholder engagement.	Due to the very complex interaction along this frontage of different types of infrastructure, different receptors of risk, different hazards and different priorities a strategic level study is required to ensure that the preferred options for coastal protection are inclusive and holistic of the different needs of the frontage, whilst promoting added value and wider benefits for the area.

Sub-Component	Name	Description	Tasks within Sub-Component	Justification for Sub-Component
B5	East Grand Bahama	To produce a strategic Option Development Report for East Grand Bahama focussing on the impact of causeways on the marine ecosystems, infrastructure and flooding.	- Data review and gap analysis. - Baseline surveys including habitat mapping. - Develop options and a preferred option including quantification and valuation of the ecosystem services associated with each option. - Detailed design and contract specification.	It is likely that the preferred option for this area will look at improving drainage and potentially revising layouts of causeways to improve the marine ecology in the area in addition to providing improved resilient infrastructure and reduced flood risk. An ecology survey will be required to quantify potential improvements to the marine ecology and modelling will be required to produce designs for the causeways and drainage through the causeways. Therefore, a strategic level study is proposed.
Component C: Institutional Strengthening and Capacity Building				
C1	Technical Support to the Project Execution Unit	To establish and maintain a defined Project Execution Unit within the Ministry of Works and Urban Development with transition mechanisms agreed and set up for after the IDB loan funds cease.	- Engagement with the proposed Project Execution Unit. - Development of a Strategic Action Plan for delivery of risk-resilient ICZM. - Presentation of Plans with a workshop. - Development of a communications manual.	Institutional arrangements need to be established and sustained through the PEU. This will help deliver the risk-resilient ICZM Program in the short term throughout the duration of the IDB loan. Clear guidance on strategic plans and communication (internal and external) is required to support the PEU and in particular the long term transitional arrangements beyond the initial Program.
C2	Legislative and Regulatory Review and Institutional Amendment	To formalise legislation and institutional arrangements in The Bahamas to ensure risk-resilient ICZM is mainstreamed into sector planning and is set up to help implement the Vision 2040 National Development Planning process.	- Consolidate review of legislation and recommendations from Component 1 and 2. - Undertake stakeholder engagement. - Consult on proposed amendments to key institutional documents. - Report on integration with Vision 2040. - Institutional training.	Findings of the human resource capacity needs assessment suggest that ICZM related experience is very low in all Ministries and Departments. What is now needed is to determine how human resources should be reallocated (within and across Ministries) to improve efficiency, such as through the adoption of ICT, or through greater internal planning so that staff responsibilities align with targeted outcomes and that more focus is also given to leadership and management training in tandem with ICZM training.
C3	Standard Operating Procedures and Guidance Manuals for ICZM Delivery	To prepare bespoke, planning “tools” such as Standard Operating Procedures to help deliver ICZM and the establishment of “Technical Interface Agreements” to help integrate private sector engagement into ICZM delivery. Furthermore, to produce national regulatory and enforcement related guidance on risk-resilient coastal protection, environmental policy guidance for coastal infrastructure.	- Prepare Standard Operating Procedures. - Provide training on proposed Standard Operating Procedures. - Evaluation of existing design practices in The Bahamas and international guidance. - Identifying required sources of data. - Recommending the appropriate approach, methods and techniques for the investigation, design and construction of coastal and maritime structures. - Stakeholder engagement and participation including workshops.	It was highlighted from the stakeholder engagement exercises and within the First Interim Report that there needs to be consideration and development of design guidance for coastal protection structures with consideration of new climate change data and modelling scenario approaches. Furthermore, a standard way of implementing ICZM into Vision 2040 and Planning Subdivisions Act will be required. Training on this will be integral due to the number of different institutions and ministries who will be involved in ICZM planning and implementation.

Sub-Component	Name	Description	Tasks within Sub-Component	Justification for Sub-Component
C4	Shoreline Management Plans	Shoreline management plans for Family Islands, focussing initially on New Providence and Long Island as examples. This shall support the Land Use Plan for the Island.	- Categorisation of Islands into Coastal Management Units and determination of Key Objectives. - Assessment of hazards and vulnerabilities of the coastal zones and development of risk maps. - Habitat process study and SEA. - Option development and long term management implementation plan proposed for the island.	To enable long term, sustainable management for the Family Islands, specific plans and policies are required to ensure the coastal management is undertaken in an holistic way – ensuring interventions do not negatively impact on other areas along the coast and that resources and finances are focussed on the highest risk areas. A common theme reported by the majority of institutions assessed was that even where plans are in existence (e.g.: Department of Marine Resources), they were either outdated, or day to day work practices could not adhere to the regulatory expectations set out due to resource related issues, hence the strategic plan is almost worthless as a guiding manual for legislative/regulatory enforcement delivery.
C5	Knowledge Transfer and Capacity Development	To train and educate staff (both members of the Project Execution Unit and wider key stakeholder groups) on risk-resilient issues. This is to include a public education and awareness campaign.	- Preparation of a Training Needs Assessment Report. - Training programs on coastal risk modelling, habitat and beach monitoring, data management, stakeholder engagement and coastal zone enforcement. - Training of targeted audience in disaster risk management. - Design of a public communications strategy and action plan.	To ensure effective implementation of the ICZM Program in the long term, staff and stakeholders need to be trained in effective and innovative methods that the Program aims to implement. This includes climate change adaptation methods, ecosystem based adaptation and the use of ecosystem service methods to drive optioneering and planning.
C6	Study for the facilitation of private finance in the implementation of coastal management interventions	To identify ways of facilitating sustainable private sector participation in financing the implementation of Coastal Management Interventions and to identify ways of facilitating the recovery or offsetting of CMIs investment costs from direct or indirect beneficiaries of such interventions.	- Initial consultation and diagnostic assessment. - Identification and assessment of project finance models. - Development of the Assessment Guidelines Framework for Coastal Management Interventions. - Development of an implementation plan.	The financial stability and potential of ICZM for long term sustainability needs to be carefully assessed and considered, and is likely to need to be funded through a number of different sources.

4.6 Program for Implementation

Despite being split into three components and several subcomponents, the Program presented in Table 4.1 needs to be considered as one holistic program with several dependencies and links between the components. The programming of the Program will be an important consideration as it will be required to be implemented with the correct critical links to ensure effectiveness in terms of data use and availability and training of GOBH staff.

The recommended program is set out in Table 4.2.

Table 4.2: Programming of the initial ICZM Program

	Yr1		Yr2		Yr3		Yr4		Yr5		Notes
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	
A1 Ocean Data Collection Study	X	X	X	X							
A2 Beach Monitoring Program	X	X	X	X	X						
A3 Coastal Infrastructure Asset Inventory	X	X									
A4 Sediment Resource Study	X	X									
A5 Coastal Management Information System	X	X	X	X	X						
A6 Habitat Monitoring Study	X	X	X	X							
B1 Treasure Cay, Abaco					X	X	X	X	X	X	Will be a Pilot Site under A2 and therefore should start when 1 year of data (over seasons) has been collected
B2 Glass Window Bridge				X	X	X	X	X			Needs ocean data for modelling/design parameters and high level topographic information from A5
B3 Long Island				X	X	X	X	X	X		Could use ocean data and high level topographic information from A5
B4 Nassau				X	X	X	X	X	X	X	Can use ocean data, asset data and beach monitoring data for the Strategy and high level topographic information from A5
B5 East Grand Bahama				X	X	X	X	X			Will need initial ocean data for model set up and high level topographic information from A5
C1 Technical Support to the PEU	X	X	X	X							
C2 Legislative and Regulatory Review and Institutional Amendments		X	X	X	X						
C3 Standard Operating Procedures and Guidance Manuals for ICZM Delivery				X	X	X	X	X			To build upon initial ocean data collated in A1 and topographic data collated in A5
C4 Shoreline Management Plans			X	X	X	X					To build upon initial data collected under A1 to A5
C5 Knowledge Transfer and Capacity Development	X	X	X	X	X	X	X	X	X	X	Throughout Program
C6 Study for the facilitation of private finance			X	X	X	X					Using more detailed costs coming out of the initial strategy reviews under Component B

4.7 Costs

From all of the elements considered in Table 4.1, the program and activities required to complete them has been incorporated into terms of references (ToRs). The Program has been developed to be split into the three separate components as presented in above, and the overall costs and program as well as the individual costs and programs have been developed to show the detailed breakdown.

The overall costs associated with the initial Program that is to be implemented are presented in Table 4.3. Breakdown of these costs are provided with further details of the activities in Sections 5, 6 and 7 of this Report for Components A, B and C respectively.

Table 4.3: Estimated costs

Activity	Estimated cost (USD)
Component A	
Oceanographic Data Collection Study	235,000
Beach Monitoring Program	220,000
Coastal Infrastructure Asset Inventory	250,000
Sediment Resource Study	340,000
Coastal Management Information System	1,221,000
Habitat Monitoring Study	188,000
Total for Component A	**2,454,000**
Component B	
Glass Window Bridge, Eleuthera	5,750,000
Treasure Cay, Abaco	3,830,000
Deadman's Cay to Mangrove Bush Settlement, Long Island	7,665,000
Central Nassau, New Providence	26,165,000
East Grand Bahama	4,335,000
Total for Component B	**47,745,000**
Component C	
Technical support to the PEU	150,000
Legislative and regulatory review and institutional amendments	225,000
Standard operating procedures and guidance manuals for ICZM delivery	450,000
Shoreline management plans	600,000
Knowledge transfer and capacity development	425,000
Study for the facilitation of private finance	275,000
Total for Component C	**2,125,000**

4.8 Terms of References

Draft ToRs have been undertaken for each sub-component and are presented in Appendices E, F and G for Components A, B, and C respectively. Individual ToRs have been developed for each sub-component to provide the flexibility in procurement of the different studies. The program presented in Section 4.6 demonstrates the overlapping timeline between many of these studies and therefore the ToRs could be grouped together and let as a package rather than smaller individual jobs. This would likely provide some cost efficiencies in background data collection, review and project management.

5 Component A: Diagnostic Studies and Information Management

5.1 Component A – Diagnostic studies and information management

This component is designed to generate high quality key data on a national scale (a critical element of data currently missing) in The Bahamas. The proposed data outputs (physical, asset, and climate change data)are considered to be critical for the development of risk-resilient ICZM planning and design. It is to be noted that although there is also a lack of social data, the development of social data needs to be undertaken on an island level and it is therefore recommended in the long term that this is linked in with the Island Plans that are to be developed under the Planning and Subdivisions Act (2015)[48]. In the short term the Shoreline Management Plans under Component C will address in the first instance social data gaps for New Providence and Long Island and the management guidance under Component C will recommend the level of social data which will be required for other studies.

As well as developing key data on a national scale, this component also aims to assess data management and quality issues by providing a GIS information planning platform that shall support ongoing national initiatives currently underway. This will improve the quality and access to information available for design and engineering of coastal protection structures.

National level data collection and coordination feeds in as a fundamental part of the overall ICZM road map for The Bahamas (Section 4), and needs to be undertaken earlier in the program as it will critically feed into other components, in particular Component B and the Shoreline Management Plans in Component C. In the longer term, the data will facilitate not only ICZM projects but also the development of Island Plans under the Planning and Subdivisions Act (2015)[49].

Appendix B presents a summary of the data gap analysis and the recommendations for the ICZM program under each data category. All of the short term recommendations have been collated and are proposed to be addressed through the following specific studies:

- Oceanography – to obtain **physical** oceanographic data as well as **climate change** sea level rise data;
- Beach monitoring– to develop database of information on beaches (**asset** data);
- Asset assessments – to develop database of information on coastal engineering structures (**asset** data);
- Sediment data assessment – to provide better understanding of the sources and processes dictating sediment supply and linking into potential future beach erosion risks (**physical** and **environmental** data); and
- Information planning platform – to consider how to best **manage data information**, ownership and sharing, storage, coordination and quality issues including existing data, but also data to be collected as part of Component A, B and C.
- Habitat Monitoring – Use of remote sensing to undertake terrestrial and nearshore habitat (**asset and environmental data**) mapping and setting up future long term monitoring.

[48] GOBH. (2015). Planning and Subdivisions Act. Amended 2015.

[49] GOBH. (2015). Planning and Subdivisions Act. Amended 2015.

Details regarding each proposed sub-component under component A are presented below, including the justification for the work, outline of the work to be done and the timescale/program. More detailed descriptions of the activities to be undertaken as part of this work are presented in Appendix E.

The programming of the Components in Table 4.2 demonstrates the importance of Component A activities in driving many of the Component B and C activities.

5.2 Oceanographic Data Collection Study

As part of ICZM planning, oceanographic data is a key component in developing an understanding of coastal processes in and around the Bahamas. Such data can be used directly or indirectly to help inform and determine design conditions, for example extreme waves/water levels will be required for coastal management schemes. Where long-term data sets of waves are not available then shorter term data can be used for calibration and validation of hindcast wave models. Similarly, water level and current measurements can be used for defining boundary conditions, calibration and validation of hydrodynamic models for use in design. This will help baseline understanding of coastal processes and any potential impacts from coastal management schemes.

Without oceanographic datasets, effective modelling and sustainable design of structures cannot be undertaken effectively. This can lead to ineffective designs which require increased maintenance spend or replacement in the future.

5.2.1 Baseline situation in The Bahamas

Limited long-term water level data is available in The Bahamas, with the only long-term data set being located at Settlement Point on Grand Bahama. A number of tide gauges were installed on different islands to record water levels by the Caribbean Planning for Adaptation to Climate Change, however all were destroyed/moved by storms and hurricanes[50]. The tidal gauge on Grand Bahama at Settlement Point still exists (15 years of data) and is owned by the US Government. The GOBH did not download any data from the previous units as it was all sent to the University of Hawaii, however this dataset is likely to be short term and intermittent.

There are also two wave buoys east of the Bahamas in the Atlantic which are operated by National Oceanographic and Atmospheric Administration (NOAA)[51,52]. It is believed that NOAA undertook some current speed measurements in the 1990's, however there seems to be limited information on this currently.

[50] J. Lee, Chapin. (2001). Caribbean Planning for Adaption to Climate Change.

[51] http://www.ndbc.noaa.gov/station_page.php?station=41047

[52] http://www.ndbc.noaa.gov/station_page.php?station=41046

5.2.2 Proposed studies

An integrated network of permanent tide gauges covering the island chain is required so that consistent datums and long-term water level measurements can be recorded and analysed. Such data should be collated via telemetry in real-time for instantaneous logging. Whilst the initial loan proposal and Program will not look to fund permanent tide gauge deployments beyond the period of the proposed study below, additional funding streams should be investigated so that the long-term collection of tidal data can provide future benefit for risk-resilient coastal management in The Bahamas.

Both shorter-term and longer-term data collection requirements will need to be identified taking into account the needs of the Beach Monitoring Study (Section 5.3) as well as those of the wider ICZM Program.

It is therefore proposed that an oceanographic data collection study is undertaken which has two key tasks:

- **Task 1:** Specification of key oceanographic data parameters and production of a data monitoring plan; and
- **Task 2:** Develop plan for a small network of permanent tide gauges including an update of the Shattuck Datum which is currently out of date.

Task 1 will include development of specifications and an oceanographic data monitoring plan. This should include the identification of data collection locations, monitoring frequency, parameters, data collection and processing methodologies alongside estimated costs to implement sufficient data collection to facilitate ICZM. Furthermore, preliminary hydrodynamic and wave modelling is likely to be undertaken using high level regional data as part of the study to aid the determination of the most appropriate location for data collection.

Task 2 focusses on expanding the long-term water level data availability outside of Settlement Point (Grand Bahama) by providing a specification for the development of a plan for small network of tide gauges spanning the island chain. This will provide the start of a long-term water level monitoring strategy for The Bahamas. As part of this network, a real-time logging system should be put in place so that remote access to the data can be made. Consideration should also be given to security and exposure of the locations to reduce the risk of theft or dislodgement during extreme events. Furthermore, consideration will be made to updating the current Shattuck Datum used in The Bahamas which is now out of date.

5.2.3 Outputs

Specification of key oceanographic data parameters is required for the purposes of aiding coastal protection design, understanding coastal processes and calibration of numerical hydrodynamic, sediment transport and wave models. This will support development of coastal structure designs in addition to port/marina designs, as necessary. This specific study will also include training GOBH staff to undertake

future monitoring and data collection and provide a long term data collection plan (including required funding and funding sources).

The update of the Shattuck Datum will feed into the development and update of design guidance under Component C of the Program.

5.2.4 Indicative program and costs

Table 5.1: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
Component A baseline studies	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
A1 Oceanographic data collection study	X	X	X	X						

Table 5.2: Estimated costs

Task	Estimated cost (USD)
1- Specification and production of data monitoring plan	70,000
2- Plan for permanent tide gauge network	35,000
Hydrodynamic modelling (to support Task 1 and 2)	130,000
TOTAL	**235,000**

Table 5.3: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Specification of key parameters	12		13,200
1b Oceanographic data monitoring plan	15		16,500
1c Preliminary wave and hydrodynamic modelling	55	5000	65,500
1d and 1e Consultation with agencies and investigation to funding schemes	5		5,500
2a and 2b Determination of consistent datum	5		5,000
2c Specification of equipment for tide gauges	12		13,200
2d Installation of equipment	25	30000	57,500
2e Training for GOBH staff	15	10000	26,500
TOTAL			**203,400**
15% Risk			**235,000**

5.3 Beach Monitoring Program

It has been identified, through the work undertaken by Component 1[53] and through stakeholder engagement, that coastal erosion and in particular beach erosion is a key ICZM issue. Minimising the

[53] CCS and SEV Consulting Group (2016) First Interim Report for Feasibility Studies for a Climate Risk-Resilient Coastal Zone Management Investment Program

erosion of beaches and optimising the future stability of the Bahamian coastline is important for the tourism economy, as well as providing wider protection for the low lying islands within The Bahamas.

There have been a number of previous studies that have identified the economic importance of the beaches of The Bahamas. For example work on Exuma and Andros identified an Ecosystem Service annual flow value of $216,000 and $93,682 per km^2 respectively[54]. The value of beaches to the Bahamian economy and Bahamian people is clear, however what is less certain is the current condition of the beaches and potential future stability.

Although there are reports that suggest current erosion patterns on particular beaches[55,56], these reports are site specific and for a large proportion of the coastline of The Bahamas there appears to be no quantifiable information around the potential current and historic erosion rates. The current and historical erosion rates are critical to provide understanding of the current (and previous) performance of a coastline, and allow projection of potential future change when considering sea level rise. This then would facilitate hazard risk management studies to identify and map the key vulnerable areas of the coastline and prioritise beach management activities and structural investments.

There are a number of key considerations when assessing beach extent and topographic change:

- The geomorphology of a shoreline area is should account for the geology of the area and natural forcing;
- That investigation of a number of features at a site can help the driving forces of the system to be understood even if there is a lack of data available as the form and shape of the system directly reflects those forces. The various indices that are presented are a collection of the type of information that may be used to help build up this understanding of the dynamics depending on the local specifics; and
- The shape of the shoreline is a function of the existing mix of forces and contingency therefore needs to be built in to combat disasters and climate change. That contingency will ultimately depend on the shoreline and whether it can roll back and up and maintain existing functioning, or the line has to be held through lack of space.

Beach monitoring is critical to inform risk assessments, prioritise limited funding and to understand potential future changes in the coastline of The Bahamas.

5.3.1 Baseline situation in The Bahamas

The baseline data available is limited to enable a continued assessment of trends in beach morphology change. The data availability currently has been summarised below:

[54] Hargreaves-Allen, V. (2011). The Economic Value of Ecosystem Services in the Exuma Cays; threats and opportunities for conservation. Conservation Strategy Fund.

[55] Caribbean Coastal Services (2011) Site Visit Report for Treasure Cay

[56] Caribbean Coastal Services (2011) Site Visit Report for Gillam Beach

Beach profile data – The GOBH does not currently undertake beach profile monitoring or beach condition assessment and no beach profile or beach condition data is known to exist. However it is likely that some private developments may undertake monitoring in specific locations.

Sediment data – Although there is a wealth of literature and research that has been undertaken around both reef structures and health (and the processes associated with carbonate deposition within the Bahamian Platform) there is a need to coordinate and review this information and its relation to sediment budgets. This has been assessed in further detail in Section 5.5.

Coastline/marine boundary – A shape/word file layer is held by BNGIS Centre which provides an outline for the coastline for The Bahamas. However it has been developed using a variety of images and is therefore likely to refer to a number of tidal extents.

Aerial photography – Aerial photography exists at the island scale and is variable in data quality and coverage. For example 2010 imagery exists for New Providence; however it is of poor quality and is not accurate. Imagery for 2007 is available for Abaco.

Satellite imagery – Open source satellite imagery is available from Google/ Bing Maps/ Landsat. However this can vary in quality and it is hard to get temporal consistency for a national coverage. There is a lack of coordination between satellite data and a central repository for the data. BNGIS Centre is currently working on collating this data.

Topographic data – Contours for a number of islands from 1999 and 2004 are available. However it has been suggested by the data users in The Bahamas that there are inconsistencies and potential data quality issues with the 2004 data. There are no recent national topographic surveys in existence (within the last 5 years). Recent LIDAR data (May 2015) is available for Andros island as identified by the USGS[57] . Flight coverage is on land only and does not appear to cross the shoreline into the nearshore zone anywhere in Andros.

It is also important to consider the datum used in The Bahamas, the Shattuck Datum, the reference point of which is located on Cable Beach, New Providence. However the 'mean sea level' is constantly changing, which means the reference point is changing and is now estimated to be approximately 2-3ft lower than it should be. Therefore in existing datasets there is no one consistent reference to mean sea level.

5.3.2 Proposed studies

It is proposed that a beach monitoring study should be designed to provide preliminary recommendations on how the Bahamian Islands could generate ongoing periodic data collection and information. This information would support assessments of how inundation and erosion potential may change under different future climate change scenarios.

[57] United States Geological Survey. www.usgs.gov/ Accessed 27th September 2016

The key tasks in the study would be to:

- **Task 1:** Identify and prioritise locations where beach monitoring is required based on current and future land use, considering the importance of the beach in terms of tourism, flood protection and ecosystem services.
- **Task 2:** Develop a framework for the collection, collation and analysis of beach morphology data to effectively monitor beach profiles and condition at significant locations around the Bahamas.
- **Task 3:** Consider the institutional framework and identify the organisation/ government department that will be responsible for the implementation of the monitoring program. Provide this organisation/government department with training in GIS and the use of beach monitoring equipment.
  Task 4: Set up initial pilot studies and produce an analysis report collating all data currently available.

5.3.3 Outputs

The outputs from this study will be to assist climate change risk assessments associated with:
- Climate proofing land and development planning;
- Support the Shoreline Management Plans (Component C);
- Assessing areas at potential risk from inundation including consideration of frequent events, such as, high tides, as well as less frequent storm-related events) and how these may change in time;
- Providing information for future setting of coastal hazard and setback lines;
- Providing details to set minimum ground levels or floor levels for development activities; and
- Establishing the extent of existing building inundation risk and how this may change in the future.

With regards to coastal development protection in the Bahamas, beach monitoring data would help in:
- Deriving coastal structure design wave / water level conditions that account for climate change effects;
- Assessing the adequacy of the design of existing coastal structures; and
- Providing basic assessments of how overtopping of existing coastal defence structures may change and how this relates to dangerous overtopping limits.

It is considered that one of the initial areas to be monitored would be based on Treasure Cay Public Beach, Abaco and another on Junkanoo Beach, Nassau. This would therefore provide the necessary beach information to inform the potential coastal management investment in these locations as described in Section 6 of this Report.

5.3.4 Indicative Program and Costs

Table 5.4: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
Component A baseline studies	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
A2 Beach monitoring program	X	X	X	X	X					

Table 5.5: Estimated costs

Task	Estimated cost (USD)
1: Identify and prioritise locations where beach monitoring is required	25,000
2: Develop framework for the collection, collation and analysis of beach morphology data	55,000
3: Institutional assessment and GIS training	35,000
4: Set up Pilot Sites and analysis report	105,000
TOTAL	220,000

Table 5.6: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Identify and prioritize locations	10		11,000
1b Agree geographic scope	3		3,300
2a Identify sediment cells	15		16,500
2b Determine spatial and temporal resolution	5		5,500
2c Define consistent datum	2		2,200
2d Determine standard levels	3		3,300
2e Determine grain size data collection	5		5,500
2f Consideration of LiDAR and aerials	10		11,000
2g Identify GIS for collation	10		11,000
2h Determine best practice	2		2,200
3a Identify responsible organisation	10		11,000
3b Provide GIS training	8		8,800
3c Provide beach monitoring training	8		8,800
3d Provide processing and analysis training	8		8,800
4a Select 3 Pilot Sites	15		16,500
4b Set up exemplar GIS systems	25		27,500
4c Provide reporting on 1 year of data	35		38,500
TOTAL			**191,400**
15% Risk			**220,000**

5.4 Coastal Infrastructure Asset Inventory

The definition of coastal assets present in The Bahamas covers a number of different features, from hard engineering structures to beaches, mangroves and coral reefs. However for the purposes of this asset condition task the focus will be on hard engineering structures and their condition. The assessment of beach monitoring and condition of beaches, as well as mangrove and coral reef monitoring and health is addressed in Section 5.3 and 5.7 respectively.

It has been highlighted through engagement with the MoWUD that there does not exist a consolidated list of coastal protection engineering structures in The Bahamas. This makes it very difficult to identify areas which need maintenance or significant capital works input to maintain the protection and role they currently provide. The approach appears to be more ad hoc when structures fail and then need replacing as emergency works. This reactive approach is not an efficient way of managing assets and through providing ongoing maintenance, the residual life of a structure can be increased and maximised. By understanding the condition of structures it will be possible to understand their functionality and effectiveness in relation to other assets and hence support an integrated approach to coastal management.

Monitoring the location and condition of coastal protection structures will allow more cost effective and sustainable management of coastal assets.

5.4.1 Baseline situation in The Bahamas

There is very little record currently existing of coastal protection structures. The MoWUD, through the Department of Public Works, own and manage a database in the form of an excel spreadsheet which details some of the GOBH owned assets and where they are located. However it does not appear to include all of the coastal protection assets and does not likely include structures such as groynes. The current information available also does not include an assessment of the condition of the asset or details regarding when the assets were last maintained or works were carried out.

5.4.2 Proposed studies

The following Tasks are proposed:

- **Task 1:** An asset condition survey is undertaken of New Providence and the Family Islands. This should build on existing data available and record the information within a GIS format that can be easily utilised by the MoWUD.
- **Task 2:** Set up and run a GIS system to collate information and allow effective future monitoring.
- **Task 3:** Training workshops. Training of MoWUD staff in undertaking the condition assessment and future monitoring as well as updating of the database should be undertaken so that the system can be passed on to and maintained by the MoWUD in the future.
- **Task 4:** Future maintenance plan which will help extend the residual life of structures and reduce the longer term costs for undertaking works to structures. This will use the information collected in

Task 1 and 2 but also use feedback from Task 3 training to ensure that the plan is appropriate and tailored for MoWUD staff.

5.4.3 Outputs

The key output from this study is to be a database of the GOBH owned coastal asset structures (and other privately known structures as appropriate) that is kept within a GIS platform and that the MoWUD can take forward and incorporate as a monitoring and maintenance plan. This will include information on the current condition of structures which will help identify key areas which need works undertaken. It is considered that by setting up this system for the GOBH, the future management and maintenance of assets will be much more efficient.

Furthermore, this will be an important database that will feed into the Coastal Management Information System (Section 5.6)

5.4.4 Indicative program and costs

Table 5.7: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
Component A baseline survey	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
A3 Coastal Infrastructure Asset Inventory	X	X								

Table 5.8: Estimated costs

Task	Estimated cost (USD)
Task 1: Undertake asset condition survey	100,000
Task 2: Set up and run GIS	45,000
Task 3: Training workshops	35,000
Task 4: Future maintenance plan	70,000
TOTAL	**250,000**

Table 5.9: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Review existing material	12		13,200
1b Prepare methodology	8		8,800
1c Undertake condition assessment	30	30000	63,000
2a Record data in GIS	15		16,500
2b Develop vector file	15		16,500
2c Record photographic record	10		11,000
3a Undertake Condition Report	25		27,500
3b Training of GOBH Staff	20	8000	30,000
4a Prepare Monitoring and Maintenance Plan	30		33,000
TOTAL			**219,500**
15% Risk			**250,000**

5.5 Sediment Resource Study

From the work undertaken by Component 1[58] and through stakeholder engagement, coastal erosion and in particular beach erosion is believed to be a key ICZM issue and challenge. Potential future erosion of beaches and ensuring future stability of the Bahamian coastline is important for the tourism economy as well as providing part of the erosion defence mechanism for the low lying islands within The Bahamas.

There have been a number of previous studies that have identified the economic importance of the beaches of The Bahamas. For example work on Exuma and Andros identified an Ecosystem Service annual flow value of $216,000 and $93,682 per km^2 respectively[59]. The value of beaches to the Bahamian economy and Bahamian people is clear, however what is less certain is the current state of the beaches and potential future stability.

The discussions and studies proposed in Section 5.3 aim to increase the current understanding of beach erosion patterns and status. However in order to build on this information and recommend future management and maintenance of the beaches around The Bahamas, the sediment supply processes and potential changes need to be recognised and recorded There are a number of beach management procedures that can be implemented to control erosion and sediment movement. However, without a good understanding of the sediment supply processes and patterns, these procedures may not work effectively or may not be sustainable in the long term. In particular, the impact of climate change within The Bahamas[60] may have significant effects on sediment supply through increasing sea surface temperatures,

[58] CCS and SEV Consulting Group (2016) First Interim Report for Feasibility Studies for a Climate Risk-Resilient Coastal Zone Management Investment Program

[59] Hargreaves-Allen, V. (2011). The Economic Value of Ecosystem Services in the Exuma Cays; threats and opportunities for conservation. Conservation Strategy Fund.

[60] Simpson, M. C., *et al.,* (2012) *CARIBSAVE Climate Change Risk Atlas (CCCRA) – The Bahamas.* DFID, AusAID and The CARIBSAVE Partnership

ocean acidification, changes in ocean currents, increases in frequency and severity of hurricanes and sea level rise acceleration.

An understanding of sediment transport is required to provide effective and innovative beach management solutions that are adaptable to climate change.

5.5.1 Baseline situation in The Bahamas

There have been a large number of academic studies undertaken on the Bahamian Bank[61,62,63]. The current understanding is that much of the beach sediment around The Bahamas is generated from the carbonate depositional environment within the Bahamian Platform. The Bahamian Platform is one of a chain of sixteen carbonate platforms that stretches for 1500km. The environment around The Bahamas provides the factors required for creation of shallow water carbonates, which are then deposited on the continental shelf.

Current research suggests the Holocene carbonate sedimentation in the Bahamas Platform has been accumulating at a rate of 2.3m/1000 years[64]. However, the future accumulation rate could vary significantly due to the influence of internal and external controls, as well as anthropogenic influences. These influences are likely to include:

- **Sea level rise**: there is some suggestion that carbonate accumulation will be able to accelerate and 'keep up' with sea level rise, but there are concerns and uncertainties around this;
- **Changes to the currents/Gulf Stream**: potential changes in ocean circulation could impact the chemistry and water temperatures within the Bahamian Platform;
- Increase in **Sea Surface Temperatures**;
- **Ocean acidification**;
- Increases in frequency and intensity of **hurricanes**;
- **The amount of space within the basin**: as the space for deposition decreases, the deposition rates decrease - the average of ancient carbonate deposition and preservation is thought to be between 0.05 – 0.05 m/1000 years; and
- **Anthropogenic influences** in basin morphology through fishing activities and sand mining.

The Bahamas has a number of fringing reefs which also contribute to the sediment supply (although this is generally less than other Caribbean Islands). A number of organisations are involved in reef monitoring, in particular The Nature Conservancy (see Appendix B).

[61] Strasser, A. and Samankassou, E. (2003) Carbonate sedimentation rates today and in the past: Holecene of Florida Bay, Bahamas and Bermuda vs. Upper Jurassic and Lower Cretaceous of the Jura Mountaines Geologica Croatical 56/1: 1-18

[62] H. Allen Curren and B White (1995) Terrestiral and Shallow Marine Geology of the Bahamas and Bermuda *Geological Society of America*

[63] A. C. Maloof and J P Grotzinger (2012) The Holocene shallowing-upward parasequence of north-west Andros Island, Bahamas *Sedimentology* 59: 1375-1407

[64] Miami University (2004) Comparative Analysis of Ancient and Modern Carbonate Depositional Environments *Marine Ecology available from* http://jrscience.wcp.miamioh.edu [accessed 2016]

Although overall there is a wealth of literature and research that has been undertaken around both reef structures and health, and the processes associated with carbonate deposition within the Bahamian Platform, there is a need to coordinate and review this information in a focused study which considers:

- Where is the source of carbonate sediment for beaches and how much is generated and stored offshore (sources and sinks);
- What are the processes controlling sediment transport (i.e. waves, currents, wind etc.);
- How this supply could be impacted by future changes – both natural environmental change and anthropogenic activities; and
  How this can influence beach management to ensure effective and efficient long term sustainable beaches.

5.5.2 Proposed studies

A sediment study is proposed to provide an overview of the sediment supply processes controlling beach sediment within The Bahamas. The sub-objectives of the study are to:

1. Identify key sources and sinks of sediment to beaches around The Bahamas;
2. Identify the critical controlling factors on this sediment supply and littoral drift;
3. Assess how these controlling factors may change over the next 20, 50 and 100 years (to include at least an assessment of climate change, natural environmental change and anthropogenic activities); and
4. To recommend beach management processes and activities to ensure effective and efficient long term sustainable management of the beaches with The Bahamas.

The key activities that will be proposed as part of this study will likely include the following tasks:

- **Task 1: Background literature review** including the collation of academic papers/research;
- **Task 2: Review and identify the critical controlling elements** of sediment supply including identification of sources and sinks and assessment of littoral drift in The Bahamas. This should include a quantification of the overall sediment budget for The Bahamas;
- **Task 3: Review of the historic trends in sediment supply** where possible and project potential future sediment supply trends of three epochs: 0-20 years; 21-50 years and 51-100 years utilising modelling.
- **Task 4: Produce a Sediment Study Report** which will not only summarise Tasks 1 – 3 but will analyse how these results may impact future coastal management in The Bahamas.

5.5.3 Outputs

The outputs generated will provide an overview of the key sediment processes within The Bahamas. This will facilitate beach management and will directly feed into Shoreline Management Plans under Component C and development of options under Component B. The information will complement the beach monitoring data which will be gathered in the study proposed in Section 5.3.

The data can also be assessed alongside information and work that is likely to be carried out under the National Maritime Policy[65]. In particular, this may provide information on aggregate dredging/sand mining and help provide scientific data to feed into the research and policy decisions currently undergoing around these topics.

This study will include an assessment of climate change and potential future scenarios with regards to sediment supply. This will provide data to compare what could occur over the next decade to provide greater information to aid assessment of future change and projections and allow these to be refined in the future as appropriate.

5.5.4 Indicative program and costs

Table 5.10: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
Component A: baseline surveys	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
A4 Sediment Transport Study	X	X								

Table 5.11: Estimated costs

Task	Estimated cost (USD)
Task 1: Background literature review	35,000
Task 2: Identify critical controlling elements of sediment transport	17,000
Task 3: Review of the historic trends in sediment supply and sediment modelling	228,000
Task 4: Sediment Study Report	60,000
TOTAL	**340,000**

Table 5.12: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Background review	15		16,500
1b Summarise literature and data gap	20	5000	27,000
1c Identify critical controlling elements of sediment supply	15		16,500
2a Review historic data and collate in GIS	20		22,000
2b Calculate historic trends	40		44,000
2c Sediment modelling	90	1000	109,000
3a Analysis on coastal management impacts	20		22,000
3b Reporting	30	5000	38,000
TOTAL			**295,000**
15% Risk			**340,000**

[65] Government of The Bahamas (2015) Draft National Maritime Policy

5.6 Coastal Management Information System

Within the data gap analysis, there were a number of concerns highlighted around data management, including:

- Data storage and ownership of data;
- Data quality;
- Data formats – ensuring different sets of data can be used together and related;
- Access to data; and
- Management of data.

One of the key themes through discussions with national stakeholders and from the TAC was the need to improve the scientific knowledge base that underpins key decisions within the coastal zone, particularly relating to planning decisions. The critical aspect is having the necessary data available in correct formats and of good quality.

The various studies proposed under Components A and B aim at improving the information and data available to facilitate coastal zone decisions. However it will be important to ensure that all the data collected under the ICZM Program, as well as data collected under other related initiatives and studies, is organised and stored somewhere centrally for the future use by the GOBH.

This will enable a shared knowledge base and analytical capacity to support stakeholder interaction, planning and decision making for coastal protection and coastal management activities within The Bahamas. It can be an information tool supporting disaster (natural and anthropogenic) and climate risk management in the coastal zone.

An information planning platform will provide a fundamental central storage for data and provide innovative tools for coastal management which reduce future management and monitoring costs. This platform will facilitate the overall ICZM Program.

5.6.1 Baseline situation in The Bahamas

The BNGIS Centre is currently working to create a central depository for data for The Bahamas. There is now recent legislation[66] which establishes the BNGIS Centre as a Department of the Government to establish the Bahamas spatial data infrastructure system and the Geospatial Advisory Council. This legislation dictates that agencies should create data in a friendly format to reside in the central depository. This legislation[67] which was approved in 2014 has established the BNGIS Centre and importantly set up a legislative process to ensure the sharing and update of data by Government Ministries and Departments.

However, the process of setting up the central depository is still in early stages and the BNGIS Centre often struggle with capacity and resourcing issues. There is no specific platform dedicated to coastal

[66] Government of Bahamas (2014) Bahamas Spatial Data Infrastructure Act, 2014

[67] Government of Bahamas (2014) Bahamas Spatial Data Infrastructure Act, 2014

management and work is required to tie in a coastal management system into the overall spatial data infrastructure of The Bahamas in addition to developing data available to populate the system.

Furthermore, the current legislation only points to the requirements by the Government Departments and Ministries and does not address the need to collate data from private companies where they may be collecting data on government-owned land.

5.6.2 Proposed studies

It is proposed that a Coastal Management Information System (CMIS) is developed to build on previous and ongoing work conducted by BNGIS Centre and to provide the GOBH with a tool for developing a comprehensive analysis and description of coastal hazards for The Bahamas. This work is intended to facilitate the mainstreaming of data being collected as part of the ICZM Program through the incorporation of this information into the CMIS.

The CMIS should be based on an initial functional design and ensure that the system design allows for future extension of functionality. As part of CMIS development, selected users will be trained to use, maintain and further improve the Information Platform.

The CMIS should contain tools for mapping, evaluating, visualizing and communicating coastal risk. It should also be able to represent and interrogate different scenarios to facilitate decision-making in coastal planning that incorporates risk criteria. Furthermore, the CMIS should be designed to facilitate several disaster management components. New management strategies may be added at a later stage after the first version of the CMIS has been developed (for instance including emergency hazard warning systems etc.).

It is also proposed that as part of this study additional topographic data and aerial photography for The Bahamas is collected and incorporated into the CMIS. This will provide baseline data which can then be used alongside innovative techniques to inform Option Development Reports for the Pilot Sites (under Component B) and Shoreline Management Plans (under Component C).

Sub-objectives for the CMIS study include:

a. Working with the BNGIS Centre to develop the data and platform in parallel with their key studies and activities;
b. Providing planning and training on platforms that are developed; and
c. Collecting additional topographic information for The Bahamas to facilitate other coastal zone management studies.

This will involve the following tasks:

- Task 1: Consultation with BNGIS Centre, existing data and information systems review;
- Task 2: Data collection;
- Task 3: Development and population of the Information Platform; and
- Task 4: Delivery, training and presentation of results.

5.6.3 Outputs

The outputs of this study would complement and facilitate the work that is being undertaken by BNGIS Centre as part of the Bahamas Spatial Data Infrastructure Act 2014[68]. It would facilitate additional data collection which would in turn feed into Shoreline Management Plans (see Section 7) and other studies undertaken within the coastal zone of The Bahamas.

There is further opportunity to link this in with the work that needs to be carried out under the National Maritime Policy[69] due to the overlap in spatial areas.

The CMIS would ensure that the data collected within The Bahamas for ICZM is stored and can be used in the future, reducing ongoing costs of data collection and management. This would ensure that the investments by the GOBH in data collection provide reliable and easy to access data.

5.6.4 Indicative program and costs

Table 5.13: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
Component A baseline studies	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
A5 Coastal Management Information System	X	X	X	X	X					

Table 5.14: Estimated costs

Activity	Estimated cost (USD)
Task 1: Consultation with BNGIS Centre, existing data and information systems review;	75,000
Task 2: Data Collection (including topographic data)	798,000
Task 3: Development and population of the Information Platform	203,000
Task 4: Deliver, training and presentation of results	145,000
TOTAL	**1,221,000**

[68] Government of The Bahamas. (2014). Bahamas Spatial Data Infrastructure Act.

[69] Government of The Bahamas (2015) Draft National Maritime Policy

Table 5.15: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a and 1b Meet with stakeholders and data review	35	5000	43,500
1c GIS review	20		22,000
2a Agree geographical extent	10		11,000
2b and 2c Scope and undertake data collection and present in GIS	75	600000	682,500
3 Develop platform including Developer Manual and warranty information	160		176,000
4a Acceptance test	65		71,500
4b Workshops and training	50		55,000
TOTAL			**1,061,500**
15% Risk			**1,221,000**

5.7 Habitat Monitoring Study

As part of ICZM planning, monitoring in coastal environments using base layers maps and habitat survey can assist in a variety of applications such as ecosystem service modelling, coastal defence considerations and, risk assessments. New satellite technology combined with ecological assessments is recommended for The Bahamas to help generate valuable up to date bathymetric maps using multi-spectral satellite images. The following vegetation categories should be considered: sea grass, macro-algae, mussel beds, coral reef types and substrates such as sand, gravel, boulders and rocks. This will help baseline understanding of coastal processes and assist with setting coastal management plans.

5.7.1 Baseline situation in The Bahamas

Although a number of institutions (such as Bahamas National Trust and The Nature Conservancy) undertake habitat monitoring studies, these are varied in nature, spatial scale and quality. Furthermore, there is a great need to link the habitat information in with natural capital of The Bahamas and contributions to the coastal zone.

5.7.2 Proposed studies

The use of multi-spectral satellite images approach exploits the fact that different wavelengths of light are attenuated by water to differing degrees and with the newest generation of satellites this technology can be used to map bathymetry in water depth down to 25-30 meters under optimal conditions. In order to optimize the identification of the habitats and other ecosystems the remote sensing should be combined with other inputs from ecology assessments such as initial desk studies and complemented with ground investigation surveys to ensure that the main habitats have been correctly classified and prioritising value according to biodiversity value (e.g. IUCN Red List).

It is therefore proposed that the habitat monitoring study is to be undertaken in five tasks stages:

- Task 1: Specification of key parameters and acquisition of images;

- Task 2: Production of the habitat monitoring plan;
- Task 3: Desk study and Consultation;
- Task 4: Mapping; and,
- Task 5: Habitat assessments and maps review.

Task 1: Should include specification of the parameters to be considered in the remote sensing analyses and the acquisition of the images. It is important that the biodiversity and GIS specialists work collaboratively at this stage in order to identify the most appropriate remote sensing package to provide initial imagery so that the correct level of habitats and ecosystems mapping is applied. b. It is suggested recent advances in satellite imagery can be utilized to assist on this project, including:

- the WorldView-2 from DigitalGlobe which is the first commercial high-resolution satellite to provide 1.84 m resolution multi-spectral imagery, plus a Coastal Blue detector focused increasing the depth penetration of the technology.
- EOMAP provides satellite-based high resolution water quality and shallow water bathymetry & sea floor mapping services. EOMAP has multidisciplinary team consists of physicists, mathematicians, geoinformation scientists, geographers, geo-ecologists and multi-national experts from Germany, Russia, Australia, Singapore and USA.

From using the above techniques, satellite derived bathymetry (in circa 2m grids) can be produced for shallow water areas, enabling 1 m contour lines to be produced for each Family Island area. From this, associated habitat maps can be produced on demand from the same input data.

Task 2: Should focus on the elaboration of the monitoring plan. This should include the identification of data collection for the habitat assessment, frequency, collection and processing methodologies and costs to implement the plan.

Task 3: Should be executed simultaneously with Task 1, 2 and 4. The desk study will focus on gathering biodiversity information with local authorities, government organizations, civil society, research centres and universities, including reviewing information from available national and international sources to assist in understanding the distribution of potential threatened, endemic/restricted-range (listed on the IUCN Red List), migratory or protected habitats and species.

Task 4: Will ensure accurate mapping parameters are clearly defined. The accuracy of the mapping depends on local terrain and localised climate conditions. In cases with optimal water quality and visibility (e.g. no suspended sediment and calm water), vertical accuracies better than 1 m or 10% of the depth can be achieved. Positional accuracy is within 5 m (CE90%) according to DigitalGlobe specifications and can be further improved using ground control data. The level of resolution to be expected from this approach is therefore 2m resolution for each bathymetric grid file using depth contour lines with 1m interval spacing. Once the Task 3 datasets has been produced an Ecological Constraints Map showing all designations and habitat types of biodiversity value can be developed supported by desk study assessments.

Task 5: Using the desk study information and the maps produced on Tasks 3 and 4 a ground investigation should be undertaken to ensure the habitats have been correctly classified and prioritised according to biodiversity value.

5.7.3 Outputs

Identification of location and extension of the habitats is required for the purpose of aiding coastal protection design and management. The benefit of habitat monitoring using remote sensing can assist a variety of applications such as ecosystem service modelling and vulnerability risk assessments (e.g. storm surge, flooding). This will also assist in marine navigation, construction of harbours, pipelines and other critical infrastructure in the coastal zone or shallow off-shore areas of The Bahamas, as necessary. The outputs will be presented as the following deliverables:

- Seafloor habitat (ESRI polygon shapefile) including attributes;
- Metadata (XML); and
- Map(s) (PDF).

5.7.4 Indicative program and costs

Table 5.16: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
Component A baseline studies	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
A6 Habitat Monitoring Study	X	X	X	X						

Table 5.17: Estimated costs

Activity	Estimated cost (USD)
Task 1 Specification of key parameters and Acquisition of images,	75,000
Task 2 Production of the habitat monitoring plan;	45,000
Task 3 Desk study and Consultation	18,000
Task 4 Mapping	25,000
Task 5 Habitat Assessments and maps review	25,000
TOTAL	

Table 5.18: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Imagery acquisition	10	30,000	41,000
1b Specification of key parameters	18		19,800
2a Identification of the location of data collection	10		16,500
2b Methodologies definition	8		22,000
3a Desk based habitat assessment	15		16,500
4a Mapping	20		22,000
5a Ground habitat confirmation assessment	15		16,500
5b Maps review	8		8,800
TOTAL			**163,100**
15% Risk			**188,000**

5.8 Summary and recommendations

From Section 2.4, Tables 2.15 and 2.16 summarise the program for execution and estimated costs for the proposed Component A.

Table 5.19: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
Activity	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
A1 Oceanographic data collection study	X	X	X	X						
A2 Beach Monitoring Program	X	X	X	X	X					
A3 Coastal Infrastructure Asset Inventory	X	X								
A4 Sediment Resource Study	X	X								
A5 Coastal Management Information System	X	X	X	X	X					
A6 Habitat Monitoring Study	X	X	X	X						

Table 5.20: Estimated costs

Activity	Estimated cost (USD)
Oceanographic surveys	235,000
Beach monitoring assessment	220,000
Asset condition survey	250,000
Sediment study	340,000
Information Planning Platform development	1,221,000
Bathymetry and coastal habitat extent mapping	188,000
Total for Component A	**2,454,000**

6 Component B: Coastal Protection Interventions

6.1 Overview

This Section summarises the approach and method taken to select Pilot Sites and engineering designs, and summarises the outcomes. Specific information regarding the proposed resulting investment at the Pilot Sites is collated within Project Data Sheets which can be found in Appendix D. The work summarised in this Section is related to Component B as outlined with Section 4 of this Report.

6.1.1 Overview of approach/method

The following Sections describe the method and outcomes of Task 2 of this Project which was to develop the potential investment program for coastal engineering under an ICZM Program. The outline methodology of this Task was to undertake:

- selection and screening of a list of Pilot Sites with the TAC;
- assessment of each Pilot Site for key risks and benefits to justify investment within the area;
- screening of a long list of options for each final Pilot Site selected to reduce to a short list of options; and
- a multi-criteria analysis (MCA) on the short list of options to recommend the potential engineering solutions for each Pilot Site and filling out Project Data Sheets.

Each of these elements has been described in further details in the Sections below.

6.2 Selection and Screening of Pilot Sites

An initial selection of Pilot Sites was undertaken in the First Interim Report, which assessed 10 Pilot Sites initially and screened these on a number of criteria agreed with the TAC to reduce down to 6 Pilot Sites. A summary of this process is provided in Table 6.1 and further detail is provided in the First Interim Report[70].

[70] Mott MacDonald (2016) Bahamas ICZM Program First Interim Report

Table 6.1: A list of the various sites assessed and the final Pilot Sites scoped in

Site	Defined as Pilot Site within Component 2 Project?	Reason for not defining as a Pilot Site
Abaco – Treasure Cay Public Beach	Yes	
Eleuthera – Glass Window Bridge	Yes	
Long Island - Central	Yes	
New Providence – Potters Cay to Arawak Cay	Yes	
New Providence – Bonefish Pond National Park	Yes	
New Providence – West Bay Street	No	This area provides a lot of useful information however as a Pilot Site really consists of more than one site. The Potters Cay to Arawak Cay part of the site is being taken forward as a specific site to be looked at. However it is to be noted that there are many lessons learnt from along this site and consideration of these areas will be useful for looking at coastal protection options.
Grand Bahama – Causeway connecting Thomas Town and McLeans Town	Yes	
Long Island – South	No	It was decided that one example from Long Island would be taken through as a Pilot Site and that although this site includes the harbour the central site includes key vulnerable areas of the road network in addition to the airport. It is likely that the recommendations from the central site will be applicable across the island.
Abaco – Gillam Bay	No	The problems at Gillam Bay appear to be very similar to those at Treasure Cay. Therefore Treasure Cay has been chosen as a site with higher value risk to residential and commercial properties in addition to the Treasure Cay Road. However it is likely that the recommendations from Treasure Cay will be applicable to this site.
Andros – London Creek	No	This is a similar example as the Grand Bahama causeway site. The Grand Bahama site was flagged as a higher Pilot Site by the Bahamas National Trust regarding both the vulnerability of the communities and the potential environmental impact on the mangrove systems.

6.3 Assessment of each Pilot Site for key risks and benefits

The Pilot Sites which were scoped in through the initial screening exercise (Table 6.1) were assessed for the key risks and benefits, initially as a high level exercise considering a Do Nothing baseline (summarised below) and later in more detail (summarised in the Project Data Sheets presented in Appendix D).

6.3.1 Do Nothing Baseline

To carry out an initial consideration of the key benefits and therefore justification for an investment program at the Pilot Sites, an exercise was undertaken to consider the 'Do Nothing' baseline. The 'Do Nothing' baseline aims to look at what might be at risk if no coastal protection works or improvements are undertaken in the future (i.e. the existing defences collapse or if no works are implemented). At this stage this was done as a high level qualitative assessment, however at a later stage these elements can be quantified within a cost benefit assessment. The work required to do this is considered as part of the design of the ex-ante socioeconomic assessment (Section 9).

The results from the qualitative assessment of the 'Do Nothing' baseline are summarised in Table 6.3. The categories of key risks that have been assessed were chosen by combining the TAC criteria given for the Pilot Sites with a consideration for economic, social and environmental impacts which is required to provide a risk-resilient solution. The definition of the risk categories used in Table 6.3 are presented below in Table 6.2:

Table 6.2: Definitions of risk categories used to undertake a high level assessment of the Do Nothing Scenario

Category	High Risk	Medium Risk	Low Risk
Residential and Commercial Properties	>150 residential and commercial properties at risk from coastal hazards	20-150 residential and commercial properties at risk from coastal hazards	<20 residential and commercial properties at risk from coastal hazards
Other Infrastructure	A major highway or infrastructure which serves over 100 residential or commercial properties at risk from coastal hazards	A minor highway and/or sewerage and water infrastructure serves >100 residential or commercial properties at risk from coastal hazards	Only very minor roads in the area at risk from coastal hazards
Tourism	A key location in The Bahamas for tourism which could be adversely affected by the impacts of coastal hazards	A small amount of tourism which could be adversely affected by the impacts of coastal hazards or a key area for tourism that will only be slightly affected by the impacts of coastal hazards	Very little tourism impacts (either because site does not attract many tourists or because the impacts will not adversely impact tourism)
Environmental Impact Opportunities	Nationally or internationally important habitats and species at risk from impacts of coastal hazards	Habitats or species which are not identified as being nationally or internationally important at risk from impacts of coastal hazards	Very little environmental impact
Social Impacts	>150 residential properties will be affected in terms of jobs, economy and/or recreation	20-150 residential properties will be affected in terms of jobs, economy and/or recreation	<20 residential properties will be affected in terms of jobs, economy and/or recreation
Sustainability	Under a Do Nothing Scenario, the changes over time will significantly increase the impacts from coastal hazards.	Under a Do Nothing Scenario, the changes over time may increase the impacts from coastal hazards	Under a Do Nothing Scenario, the changes over time are not likely to increase the impacts from coastal hazards

Table 6.3: Key assets at risk if no works are implemented at the different Pilot Sites

Pilot Sites	Residential and commercial properties	Other infrastructure	Tourism	Environment impacts/ opportunities	Social impacts	Sustainability
Abaco – Treasure Cay Public Beach	High Risk – Approximately 30 privately owned properties behind the public beach and over 300 properties (residential and commercial) in the Treasure Cay area.	Medium Risk – Treasure Cay Road runs parallel to the beach and is likely to be increasingly impacted by sand movement as the beach retreats. There are a number of water and sewage assets serving the area in addition to power and telecommunication infrastructure.	High Risk – This is a key area for tourism with large resorts (including Island Dreams Rentals, Bahama Beach Club, Hotel Abaco and Papa's Beach House. Reduction in beach levels could be a big issue for the tourism industry in this area.	Low Risk – The natural "rolling back" of the beach and dune system is being restricted by developments along this stretch of coastline. Any potential management options need to carefully consider wider impacts on sediment movement.	Medium Risk – There are many cafes, bars and shops in the area and many of the residents rely on tourism income. Therefore the impacts to tourism equally will impact the wider community.	High Risk – There is a very important need here to consider the wider long term sustainability of sediment movement, sediment supply and beach erosion. It will be important to consider management options that do not restrict sediment movement to other areas of the coastline and that do not need large amounts of future maintenance (e.g. sediment nourishment/ recycling).
Eleuthera – Glass Window Bridge	Low Risk – This location does not specifically protect any residential or commercial properties from coastal erosion or flooding.	High Risk – The Queens Highway is a critical link for communities (at least 200 properties in the near area) on the island and this bridge is required for connection of the northern part of the island with the rest of the island.	Medium Risk – The bridge provides an important connection between tourist sites and the airport. The bridge has a long history and is a feature on the island. This aspect of the bridge could be enhanced.	Low Risk – Very little risk associated.	High Risk – The communities within this area (up to 200 properties rely on the bridge as a connection between the north and central areas of the island for tourism, communication, supplies etc. This is a very important link for the local community.	High Risk – There have been a number of different structures built to enable to connection in this area. It is sited at a vulnerable area which is open to large waves and storms from the east. Due to the importance of the infrastructure, it is key that any solution carefully considers design standards and options which reduce risk of it being impacted in the future.
Long Island - Central	High Risk – Approximately 200 residential and commercial properties are a risk from flooding, storms and storm surges.	High Risk – The main highway connecting the north and south of the island is at risk of flooding – particularly in a few specific high risk areas. The airport is at risk from flooding and storm surges. Key infrastructure including water and sewerage, power and telecommunications are	Medium Risk – Key tourism activities on the island include diving and fishing. Impacts of flooding on infrastructure impacts these tourist activities.	High Risk – Impacts of storm surges and flooding on the vegetation and native species through saltwater intrusion. This also includes several agricultural crops that are grown on the island and livestock.	High Risk – The impacts of flooding on the community here, which rely on the connectivity throughout the island for supplies including water supplies is a key risk. The local community have adapted in many ways to the ongoing threat of flooding however this impacts the wider community that live	High Risk – A key risk for this area is the potential increasing risks of flooding and storm surges. An important recognition needs to be around design standards and where small changes (such as material for the roofs) can increase the overall resilience of a structure. However, further to this consideration is required for whether it is sustainable in all

Pilot Sites	Residential and commercial properties	Other infrastructure	Tourism	Environment impacts/ opportunities	Social impacts	Sustainability
		at risk from storm surges.			here.	areas to continue to re-build/provide protection.
New Providence – Potters Cay to Arawak Cay	High Risk – Nassau has a population of 246,329 and key commercial properties including Government Departments are at risk from the coastal zone.	High Risk – A lot of key infrastructure including water and sewerage, key road links, and Arawak Cay Port.	High Risk – There are three cruise ship terminals in this study area which generate a large number of tourists. Many of the commercial properties within the area rely on tourism as the main income. This is a key area for tourism.	Low Risk – There are limited environmental impacts and opportunities in this section – it is largely developed land.	High Risk – The capital of Nassau contains approximately 80% of the Country's population and has a population of 246,329. This is a critical frontage for many of the country's key infrastructure, economic activities and tourist activities. Should this frontage become more vulnerable to coastal hazards, there could be a large impact on the overall resilience of the capital city.	High Risk – Adaptation of current structures and activities to the potential impact of climate change needs to be carefully considered here. In particular, activities such as the ongoing re-distribution of sand along the frontage are likely to become unsustainable in the future. Management options will need to carefully consider the future maintenance burden.
New Providence – Bonefish Pond National Park	Medium Risk – The mangroves at Bonefish Pond will provide increased storm and flood protection to around 50 residential properties.	Low Risk – There is little other infrastructure in the area.	Medium Risk – There is some limited tourism to the National Parks and therefore degradation of the area could reduce tourism.	High Risk – Invasive species and potential impacts of climate change pose risk to important nationally significant habitats.	Medium Risk – There is some good interaction with local community groups such as the Young Explorers at the National Park in addition to school visits often being held here.	Medium Risk – It is currently unknown whether the system will naturally respond and adapt to climate change or whether intervention and management will be required. Certainly management of invasive species is required to enable to system to accrete and respond to sea level rise.
Grand Bahama – Causeway connecting Thomas Town and McLeans Town	Medium Risk – The health of the mangrove creek system is linked in with the overall protection to 30 residential properties within the area.	High Risk – The causeway is a key element of infrastructure in this area which connects the communities to the east of the island. This causeway is at risk of damage.	Medium Risk – Potential impact on tourism as it is impacting the health of a National Park.	High Risk – The mangrove creek system is being adversely impacted by the construction of the causeway – this is a high pilot for the BNT.	Medium Risk – The communities within this area rely on the causeway as a connection between the east and west areas. This is a very important link for the local community (around 30 residential properties) however the community further rely on the health of the mangrove system.	High Risk – Integrating the consideration of impacts on the ecological services provided by the mangrove creek systems, with the need for hard engineering designs, is an integral aspect of developing risk-resilient, sustainable management.

Following this initial exercise, further consideration of Bonefish Pond National Park was undertaken as this was a site with only one high risk benefit highlighted. It was considered that the works required which would also be economically justifiable would need to be of a small scale and therefore it is unlikely to form a major part of the investment Program under Task 2. However, it is acknowledged that this is a key National Park area within The Bahamas and the assessment of impacts of future climate change should be undertaken as well as setting up ongoing maintenance plans. Under Component C, it has been recommended that a Shoreline Management Plan for New Providence is undertaken (Section 7 of this Report) and this would include a review of the National Park areas and recommend implementation plan of maintenance and climate change adaptation with further consideration of funding for these.

Therefore this Pilot Site has not been discussed further within this Section.

6.4 Screening of Long Listed Options

Owing to the complex nature of the coastline of The Bahamas, the Pilot Sites present a variety of challenges and a variety of potential engineering solutions will be required for management of these sites. To enable the consideration of range of engineering solutions, a long list of coastal protection interventions was considered for each Pilot Site. This includes consideration of a wide range of innovative techniques which are not typically found in The Bahamas but are thought to be potentially applicable at some of the sites.

The long list of options was derived from:

- Review of coastal management in Bahamas (see Appendix C and Section 4);
- Assessment of international best practice (see Appendix C);
- Experience of Senior Engineers and Coastal Managers as key experts within the Project Team; and
- Liaising with local engineering firms within The Bahamas.

This list included consideration of:

Coastal Protection Options

- Beach enhancement and management
- Sea walls / linear defences
- Offshore breakwaters attached or detached
- Eco-Reefs
- Wrecks to reefs
- Geotextile / geo-fabric solutions
- Stepped Revetments / beach access techniques
- Protected walkways / boardwalks
- Flood walls
- Reclamation changes / reconfigurations
- Do Nothing
- New harbour / port configurations
- Causeways and new transport links

Non-Coastal Protection Options

- Urban landscape enhancement and accessibility improvements
- Eco-tourism access and facilities.
- Hinterland transport and planning strategy
- Drainage and integrated sewerage changes
- Re-location of population / community / assets
- Highway / asset modifications to increase resilience and resistance.
- Wave / tidal / wind power linked to new management structures.

- New bridges;
- Local beach management and recycling;
- Managed large scale sand engines; and
- Planting regimes/ invasive species removal.

To ensure that screening out of the long list of options included key stakeholder buy in and consideration of implications from a wide variety of disciplines (engineers, ecologists, coastal processes, hydrology), the long list was presented in the Key Stakeholder Workshop in New Providence in February 2016.

Through consideration of this long list, it was identified that:

- some options provide a potential solution to coastal management and protection at that Pilot Site;
- some options are not applicable/would not be likely to work at a particular Pilot Site; and
- some options are likely to be applicable, but only as supporting works to other solutions (for example they can offer enhancement but will not provide a solution to the problem).

The results are presented in the table below which uses the following key:

KEY:	Option shortlisted as main option	Option not shortlisted	Option shortlisted as supporting option

Table 6.4: Results from Workshop Session on Long Listed Options

	Site 1 – Treasure Cay	Site 2 – Glass Window Bridge	Site 3 – Central Long Island	Site 4 - Nassau	Site 5 – East Grand Bahama
Coastal protection options					
Beach enhancement and management					
Sea walls / linear defences					
Offshore breakwaters attached or detached					
Eco-Reefs					
Wrecks to reefs					
Geo textile / geo fabric solutions					
Stepped Revetments / beach access techniques					
Protected walkways / boardwalks					
Flood walls					
Reclamation changes / reconfigurations					
Do Nothing					
New harbour / port configurations					

	Site 1 – Treasure Cay	Site 2 – Glass Window Bridge	Site 3 – Central Long Island	Site 4 - Nassau	Site 5 – East Grand Bahama
Causeways and new transport links					
New bridges					
Local beach management and recycling					
Managed large scale sand engines					
Planting regimes/ invasive species removal					
Non Coastal Protection Options					
Urban landscape enhancement and accessibility improvements					
Eco-tourism access and facilities.					
Hinterland transport and planning strategy					
Drainage and integrated sewerage changes					
Re-location of population / community / assets					
Highway / asset modifications to increase resilience and resistance.					
Wave / tidal / wind power linked to new management structures.					

6.5 Undertaking Multi-Criteria Analysis to recommend the potential engineering solutions

Following the shortlisting of options, the Pilot Sites and coastal management interventions were considered in more detail to allow a recommendation around the potential solutions which may provide best overall approach. The information from this has been summarised in the form of Project Data Sheets which are attached in Appendix D.

As part of the Project Data Sheets, a specific intervention has been recommended, although it is noted this has been undertaken based on the knowledge and data currently available and may change as strategies and further data collection is undertaken at these sites. This has enabled approximate investment figures to be produced. These interventions have been selected through undertaking a MCA on each site. The methodology for this is presented below in Section 6.5.1 and the results are presented in the Project Data Sheets (Appendix D).

6.5.1 Multi-Criteria Analysis method

The MCA method of evaluating options has the potential to capture a wide range of impacts that may not be readily valued in monetary terms, especially those relating to social and environmental issues within the context of risk-resilient IZCM. MCA aims to establish preferences between options by reference to a clear set of specified objectives and associated criteria for assessing the extent to which these objectives have been (or could be) achieved by various options. Two of the key advantages of MCA are that it can allow stakeholder involvement and provide transparency to the decisions being made at all levels of appraisal.

As introduced in the First Interim Report the justification for policies, guidance and regulations to control coastal development in any defined boundary or "zone" must consider categories that envelope the geographic and sectoral scope for ICZM. The set of impact categories and definitions included in the MCA-based method has therefore applied these same categories and augmented them with others, as presented in Table 6.5. These categories are given a semi-quantitative 'score' assessment by Key Experts which has been described in Table 6.5. i.e. Key Experts assess the impacts in a qualitative manner, which is then attributed a number for a scale between low and high for comparative purposes. This scoring is considered appropriate for the MCA as it provides a relative scoring of the options against each other i.e. whether one option is more favourable over another.

Table 6.5: Each of the categories used to assess options for intervention at the Pilot Sites encompass the geographic and sectoral scope of ICZM.

Category	Description of impact	Scoring
Technical Risk		**Total score between 0 (no risk) and 12 (high risk)**
Coastal Processes	Existing coastal processes such as waves and currents, hydrological flow, sediment transport and accretion/erosion rates.	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Cost	Economic resources.	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Buildability	Obstacles that could cause error, delays and cost overruns during Project development and construction.	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Sustainability	Overarching impact on interconnecting ecology, economics, politics and culture.	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Environmental Risk		**Total score between 0 (no risk) and 12 (high risk)**
Habitats/Wildlife	Important habitats and wildlife within the area of the development as well as along adjacent shorelines	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Fisheries	Fishing grounds and natural mooring areas used by fishermen (coastal or wetland)	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Water Quality	Water quality from surface water run-off, sewage outfalls and industrial discharges	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3

Category	Description of impact	Scoring
Visual Appearance	Views of existing natural environment, interruption of views along the river or shoreline and loss of 'window to the water' views	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Social Risk		**Total score between 0 (no risk) and 9 (high risk)**
Public Safety	Public access and egress along the coastline	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Recreation	Recreation and amenity values.	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Cultural Heritage	Sites of cultural heritage interest, historic landscapes and riverine or coastal community livelihoods.	No Risk = 0, Low Risk = 1, Medium Risk = 2, High Risk = 3
Opportunities		**Total score between 0 (highest opportunities) and 12 (no opportunities)**
Economic Opportunities	Opportunities to bring economic growth – through tourism or enhancing industry	Highest opportunities = 0, No opportunities = 4
Environmental Opportunities	Opportunities to increase biodiversity through increasing ecology/habitat diversity	Highest opportunities = 0, No opportunities = 4
Social Opportunities	Opportunities to increase access/ social mobilisation etc	Highest opportunities = 0, No opportunities = 4
Overall effectiveness as a coastal protection structure		**Completely effective = 0, Not effective = 5**

The shortlisted options and scores against the different criteria are presented in the Project Data Sheets (Appendix D). The total score is a combination of the scores for each criteria; however weighting is applied to some criteria to reflect their relative importance. The highest weighting has been applied to the 'overall effectiveness' criterion, as this is the key aim of the investment and where the majority of the benefits and justification for the investment will be derived from. If there are multiple options which provide effective coastal protection then the options which have lower scores for opportunities and lower scores for environmental, social and technical risks will be favoured.

Following the weighting of the scoring, this provides a total score out of 10 for each short listed option.

A breakdown in the weighting that has been applied is:

- Technical Risk – 1/6th of the total technical risk score giving a maximum score of 2
- Environmental Risk – 1/12th of the total environmental risk score giving a maximum score of 1
- Social Risk – 1/9th of the total social risk score giving a maximum score if 1
- Opportunities – 1/12th of the opportunities score giving a maximum score of 1
- Overall effectiveness – 100% of the overall effectiveness score giving a maximum score of 5

6.6 Project Data Sheets

The costs and timelines for the studies, as well as the baseline and justification for the sites, have been included in detail in the Project Data Sheets (Appendix D) and are summarised below.

Table 6.6: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
Pilot Site	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Treasure Cay, Abaco					X	X	X	X	X	X
Glass Window Bridge, Eleuthera				X	X	X	X	X		
Deadman's Cay to Mangrove Bush Settlement, Long Island				X	X	X	X	X	X	
Central Nassau, New Providence				X	X	X	X	X	X	X
East Grand Bahama				X	X	X	X	X		

Table 6.7: Estimated costs

Pilot Site	Estimated cost (USD)
Treasure Cay, Abaco	3,830,000
Glass Window Bridge, Eleuthera	5,750,000
Deadman's Cay to Mangrove Bush Settlement, Long Island	7,665,000
Central Nassau, New Providence	26,165,000
East Grand Bahama	4,335,000
Total for Component B	**47,745,000**

6.7 Summary and recommendations

It is recommended that the coastal investment program forms Component B of the proposed initial ICZM Program (Section 4 of this Report). Details regarding the project sites have been included within the Project Data Sheets (Appendix D). However at all sites initial studies are required prior to construction and details of the initial studies and the work required to undertake them are presented in ToRs in Appendix F. These initial studies have all been proposed to start not until Year 2 (please see Table 6.6) as they will utilise baseline information that is being carried out under Component A.

7 Component C: Institutional Strengthening and Capacity Building

7.1 Recommendations and Findings

Based on observations of current disparate and uncoordinated ICZM practices, the roles and functions of key institutions undertaking ICZM-related activities need to be better formalized by statute, thereby providing clarity and legal authority to undertake relevant activities. In light of this, initial recommendations are of general relevance to all agencies assessed except as otherwise indicated.

Appendix L addresses in more detail the institutional and capacity building related observations derived from project related baseline assessments involving key stakeholder engagement assessments. The assessment presented in Appendix L suggests a pathway of future institutional arrangements which could enable a more coordinated and strengthened approach to ICZM implementation. The finalization of these initial recommendations is subject to feedback from the TAC and other agencies assessed herein. Once finalized, they will inform the design of a ToR to support improved ICZM institutional strengthening and capacity building in The Bahamas.

The Technical Capacity Assessment[71] related work undertaken by CCS (as part of Component 1) has derived four "Strategies" to help with the implementation of an ICZM capacity building plan to address the capacity challenges described in the Draft ICZM Policy Framework. These challenges are barriers that must be overcome if The Bahamas is to move forward with the development of an ICZM policy and program. The cross-cutting challenges have been identified below and have been addressed by the proposed capacity building strategies as shown. The four specific Strategies are as follows:

- Strategy 1: To promote awareness of the need to establish a comprehensive capacity building mechanism for coastal practitioners among decision makers.
- Strategy 2: To develop and implement a training and capacity building program for coastal zone practitioners
- Strategy 3: Provide technical support for coastal zone practitioners.
- Strategy 4: Develop a sustainable funding mechanism for capacity development.

The following text is elaborated in more detail within Appendix L and represents the key observations and findings of the institutional strengthening and capacity building aspects of the study.

7.1.1 Governance and organization

Establish a focal entity for coordinating and developing ICZM and develop enabling laws where necessary. Enhance the role of the Ministry of Environment and Housing (MoEH) in implementing ICZM and review the Planning and Subdivision Act 2015 (in the absence of the forma Draft Environmental Planning and Protection Bill – 2015) which give statutory authority to the Ministry of Works and Urban Development (MoWUD) to undertake critical coastal protection works. This point is discussed in further detail below under future institutional arrangements.

[71] CCS and SEV Consulting (2016) Third Interim Report: Technical Capacity Assessment

Increase collaboration with local government. Greater consideration should be given to providing clear SOPs and/or guidance to all 32 District Administrators in The Bahamas to help the production of standardized Family Island Plans that embrace risk resilient ICZM principles. Improve also the awareness at the Central Government level on the role and functions of Family Island Administrators as it relates to their potential to support Central Government agencies outside of New Providence. Undertake capacity needs assessments at the Family Island level to outline and address related challenges and enhance their potential to provide the required support and integrate risk resilience ICZM principles. Enable formal local government representation within a newly formed National ICZM Steering Committee.

7.1.2 Planning and programming

Prioritize the development of strategic plans at the Ministry or Departmental /Agency level. These should align with the existing policy frameworks and in particular with the National ICZM Policy Framework (being drafted) and especially Vision 2040 drafted by Office of the Prime Minister (OPM). Strategic plans should further filter into sector planning mechanisms and be developed in collaboration with agencies under the same Ministry or Department to ensure harmonization. Strategic plans should also address technical capacity issues by identifying needs and providing for training programs to promote professional development, including with respect to risk resilient ICZM.

Standardize procedures for public consultation. Establish a formal procedure for public consultation within agencies which clearly outline opportunities for public participation and add uniformity and transparency to the process. This should build on the provisions set out within the Planning and Subdivision Act 2015.

Expand civil society networks to facilitate greater inclusion into ICZM development through a new "Coastal Forum" initiative. There are a vast number of civil society groups that are active in or impacted by coastal and marine related activities such as Bahamas National Trust (BNT), The Nature Conservancy (TNC) etc. In this context, the proposed National ICZM Steering Committee (as a future "Coastal and Maritime Forum") should help to offer new opportunities for participation by the wider stakeholder community. An assessment of how this should be set up should be a primary and early task (year 1) for the PEU. It is therefore important that concerted efforts be made to ensure that all interested stakeholders including civil society, special interest groups and the private sector, are made aware of, understand and are engaged in the development of an ICZM framework going forward.

Establish mechanisms to enhance science-based decision-making. An enhanced role of the BAMSI and BEST, in supporting marine and coastal research efforts, should be considered to compliment future efforts that the College of the Bahamas (CoB) may provide regarding tertiary education courses. The research capabilities of individual agencies also should be addressed and ultimately research should feed into future adaptive management efforts that may be linked to new formalized Key Performance Indicators (KPIs) that may be set.

Comprehensively identify the potential entry points for mainstreaming ICZM into the functions and responsibilities of agencies. Assess the functions, activities, plans and programs of agencies to identify

opportunities for integration of ICZM. A mainstreaming “step by step” process could be set out for each key Ministry to embrace as part of their Strategy Plan production (see above). This work should not be lost and in fact should represent the institutional and capacity development approach for ensuring climate resilience is mainstreamed into the development planning process for The Bahamas.

7.1.3 Resource management

Address the human resources needs of agencies. Findings of the human resource capacity needs assessment (undertaken by CCS as part of this institutional needs assessment process) suggest that ICZM related experience is very low in all Ministries and departments. What is now needed is to determine how human resources should be reallocated (within and across Ministries) to improve efficiency, such as through the adoption of Information Communication Technology (ICT), or through greater internal planning so that staff responsibilities align with targeted outcomes (or KPI’s as stated above) and that more focus is also given to leadership and management training in tandem with ICZM training). Efforts to minimize the use of consultancy services should be pursued except where necessary for specialized works, in which case ensure that adequate provisions are made for staff training.

Training on all aspects of ICZM and CCA should be standardised and quality checked for content and message. This way, the same logo, approach and potentially delivery team could be used in the future, which demonstrates continuity and comfort to all trainees that a progressive training plan is being developed for The Bahamas. Should this be adopted using the CoB in some capacity or another, this approach should also help the long term training and capacity development plans for the next generation of Bahamians on ICZM and climate change related studies. A “training clearing house” (through CoB) could help to ensure sequencing of the training message is undertaken in a chronological way.

Integrate greater use of ICT in activities. Evaluate the ICT needs for the agencies particularly for its ability to support efficient data management. Increasing efficiency of staff functions should also be a priority. Reallocate human resources where possible away from time-consuming manual processes.

7.1.4 Internal controls

Prioritize the development of systems for enhanced data and information storage, access and sharing. Develop, in tandem with BNGIS Centre, a government-wide data access policy to streamline how data and information are shared among agencies with an aim to overcoming existing barriers to data and information sharing in the public sector. A policy should outline the principles upon which data and information sharing is based, including the need to increase access and improve efficiency. It should also establish procedures and rules governing how the policy will be implemented. All such procedures and mechanisms established in the policy should align with the Bahamian Freedom of Information Act (2015) and other existing legislation providing for information access.

Implement monitoring and evaluation activities within agencies. Performance indicators for ICZM and CCA should be integrated into future monitoring and evaluation frameworks.

Explore innovative funding opportunities. Consider the greater utilization of Private-Public Partnerships as a source of private sector funding.

7.2 Future institutional arrangements

7.2.1 Short term arrangements

Based on the Institutional Assessment (Appendix L), and an assessment of the function and requirements of a PEU (Section 10), it is recommended that a "standalone" PEU is set up within the Ministry of Works and Urban Development (MoWUD) and should be granted authority from the IDB (with support from the Ministry of Finance) to undertake this role for the implementation of the loan package. The existing actions, resources, structure and remit of the key Departments of MoWUD (notably Department of Physical Planning (DPP) and Department of Public Works (DPW)) align closely with the requirements for program implementation and make this agency the logical place to drive implementation. This is required as no existing Ministry/institution is able to demonstrate the necessary functionality to drive forward ICZM, nor is there any Ministry that could easily embrace an additional function within its existing framework and mandate to take forward ICZM. Necessary additional resources and capabilities will need to be brought into the PEU from MoEH/ CoB/ MAMR/ MoTA etc.) to ensure it has the full capacity necessary to oversee program implementation.

The PEU will report to the proposed Cabinet-appointed ICZM Steering Committee as well as the IDB regarding its implementation of the funded program. For clarity, reasons that the MoWUD are proposed to "house" the PEU are as follows:

- Membership currently exists within the TAC from DPP/DPW.
- The MoWUD has extensive experience in project funding, procurement and implementation. Although the proposed loan funded program would be administered by the Ministry of Finance, it is noteworthy that any loan will be executed through the wider Ministry. The MoWUD has extensive experience implementing loan funded programs and is supported by the OPM which functions as a Program Management Office for the Ministry.
- The DPP has previously been approved as an implementing agency for similar projects and therefore already has established mechanisms for project funding, financing and implementation.
- MoWUD has Planning and Designs, Research, engineers and Project Management divisions which would support the IDB program, removing the need to recreate these – instead only strengthening would be required.
- Currently the MoWUD is one of few agencies that has GOBH approval to implement a program that is comprehensively geared towards coastal management.

It is critical that consideration be given to the potential for linkages between the MoEH in the exercise of its PEU functions. In this context, opportunities for the MoWUD to provide technical support and enhance information sharing between agencies should be strongly capitalized on. All externally financed public investment projects targeted around The Bahamas should be undertaken in collaboration with MoWUD, MoEH and OPM as appropriate.

7.2.2 Long term arrangements

Undoubtedly, there are a number of key legislative and institutional reforms that need to occur in The Bahamas to be able to set the platform for an effective ICZM program. These are likely to be long term and are proposed as follows. First and foremost, there needs to be an overall environmental management framework within which the proposed ICZM Framework can become embedded. This environmental management framework should also include a comprehensive national physical development (land and sea use management) plan to help guide the sustainable use of land and marine resources across the Bahamian archipelago. The framework also needs to seek to incorporate key elements of the global Sustainable Development Goals (SDGs) that the GOBH has committed to implement by 2030 on behalf of the Bahamian people whom they serve. The GOBH will also need to regular report on progress of implementation of the SDGs to the global platform established by the United Nations.

In the longer term (post 2021), should the proposed Draft Environmental Planning and Protection Bill (2015) come into full force as a formal Act this entity can be formally appointed by the Minister as a standing committee established under the enabling provisions of the Act. Its responsibilities shall include advising and making recommendations on the development of codes and standards (SOPs) relating to ICZM. Its location under the Act would ensure close collaboration with the OPM, MAMR and MoWUD, and streamline risk resilient ICZM integration into development and spatial planning across all of the Family Islands.

7.3 Summary of Recommendations

From the institutional and framework review and analysis undertaken, the key recommendations have been assessed and several studies are proposed to address the recommendations. These studies are proposed to form Component C of the proposed ICZM Program. This would include:

- C1 Technical Support to the Project Execution Unit;
- C2 Legislative and Regulatory Review and Institutional Amendments;
- C3 Standard Operating Procedures and Guidance Manuals for ICZM Delivery;
- C4 Shoreline Management Plans;
- C5 Knowledge Transfer and Capacity Development;
- C6 Study for the Facilitation of Private Finance in the Implementation of Coastal Management Interventions.

Each of the above is addressed in specific detail in Section 7.4. Table 7.1 summarises under which sub-components the recommendations from the institutional analysis will be addressed.

Table 7.1: Table to demonstrate the assessment of the key recommendations against the proposed activities for ICZM implementation.

	C1 Technical Support to the PEU	C2 Legislative / Regulatory Amendments	C3 Standard Operating Procedures and Guidance Manuals for ICZM Delivery	C4 Shoreline Management Plans	C5 Knowledge Transfer and Capacity Development	C6 Study for Facilitation of Private Finance
Establish a focal entity for coordinating and developing ICZM and develop enabling laws where necessary.						
Increase collaboration with local government.						
Prioritize the development of strategic plans at the Ministry or Departmental /Agency level.						
Standardize procedures for public consultation.						
Expand civil society networks to facilitate greater inclusion into ICZM development through a new “Coastal Forum” initiative.						
Establish mechanisms to enhance science-based decision-making.						
Comprehensively identify the potential entry points for mainstreaming ICZM into the functions and responsibilities of agencies.						
Address the human resources needs of agencies.						
Training on all aspects of ICZM and CC should be standardised and quality checked for content and message.						
Integrate greater use of ICT in activities.		Covered under proposed Component A (See Section 2 of this Report)				
Prioritize the development of systems for enhanced data and information storage, access and sharing.		Covered under proposed Component A (See Section 2 of this Report)				
Implement monitoring and evaluation activities within agencies.						
Explore innovative funding opportunities.						

7.4 Proposed Component C Activities for the ICZM Loan

The general objective of Component C is to establish the strategic direction for risk-resilient ICZM in The Bahamas, including the creation of new Island Plans, guidelines, enabling legislation, policies and regulatory controls in tandem with improving the institutional capacity and cost recovery arrangements required for long term financial sustainability of the actions and investments carried out at both national and local levels.

The expected outcome is to provide the support necessary for The Bahamas to embark on the implementation of risk-resilient ICZM through incorporating and mainstreaming the principles of ICZM, CCA and Ecosystem-Based Adaptation (EBA).

Component C includes a number of sub-activities linked to (i) providing technical support to the proposed PEU (namely MoWUD plus key stakeholder groups as required) (ii) legislative and regulatory amendments and update; (iii) the preparation of standard operating procedures, engineering guidelines, planning tools and support plans to help support the private and public sectors to better enforce and design for risk-resilient ICZM and CCA around The Bahamas; (iv) providing planning support to produce ICZM components of at least 2 Island Plans as required under the Planning and Subdivision Act (2015); (v) knowledge transfer, institutional capacity building and education including stakeholder communication and education plus training on enforcement for Island planners/inspectors and technical support and training in risk modelling and assessment, data management and use of risk evaluation tools; and (vi) development of a cost recovery mechanism for ICZM delivery.

The following six key activities are developed in more detail below. Separate ToRs to support delivery of each activity are presented in Appendix G.

7.5 C1: Technical Support to the Project Execution Unit

Institutional arrangements are established and sustained through the PEU function delivered by the the MoWUD that is set up to help deliver risk-resilient ICZM in the short term (duration of the IDB Loan) with clear guidance as to the long term transitional arrangements for ICZM in The Bahamas beyond the IDB support period. To ensure that the PEU can effectively implement the requirements of the proposed Program, there is a requirement to provide technical guidance and communication strategies. Through discussion with key stakeholders in The Bahamas, lessons learnt from other studies indicated that having clear and effective management is one of the most important tools to having a successful implementation and achieving the expect results and outcomes.

Technical support to the PEU will be critical to ensure effective implementation of the IDB loan.

7.5.1 Baseline

There is currently no PEU in place for the ICZM Program in The Bahamas. The institutional assessment has proposed that the PEU sits within the MoWUD. Feedback from stakeholders on previous projects have stressed that the success of a project is often associated with a strong technical group, PEU or Project Manager.

7.5.2 Proposed Studies

The key objectives of the Study would be to:

1. Prepare a Strategic Action Plan for the PEU to deliver ICZM in The Bahamas;
2. Prepare a Risk-Resilient Operations Manual for future institutional compliance between Ministries;
3. Prepare a Policy for Information Sharing amongst key strategic partners that is co-developed between the MoEH and proposed ICZM Steering Committee; and
4. Design and Implement a Communications Strategy and Action Plan on Risk resilient ICZM.

The key tasks of the study would be to:

Task 1.1: Preparation of a Strategic Action Plan for delivery of risk-resilient ICZM

The primary objective of this task is to technically support the delivery of risk-resilient ICZM in The Bahamas to help manage the IDB funds for the Program throughout its 5 year duration. This may involve a thorough revisit of existing institutional work procedures to better understand and advise on future strategic actions with respect to human resources, operating strategies and delivery of the functions under separate mandates (as appropriate), identifying critical success factors as well as shortcomings (e.g.: resources, program strategies, governance structure, staff skills, and/or the relationship with its constituent institutions/agencies/units).

A ten year Strategic Action Plan for risk-resilient ICZM in The Bahamas shall be designed including requirements for the establishment and running of the future ICZM Steering Committee to incorporate new national priorities as set out in The Bahamas Vision 2040 document. It shall include goals and objectives, expected outcomes, and a detailed roadmap for enabling the PEU and strategic partners to take the identified actions. Support shall be provided to help build Ecosystem Services (ES) into the Strategic Action Plan and (ii) Community climate-risk reduction proposals which may be designed to seek to prioritize ES-based approach interventions. A Workshop shall be designed to present the draft Strategic Action Plan to the PEU and key strategic partners in order to obtain input and refine the document.

Task 1.2: Internal (non-public) Risk-Resilient ICZM Communications Manual.

The Communication Manual is to be utilized by the PEU staff to support the intra- and inter- agency communications and co-ordination necessary to deliver the Program in the near term and beyond. The primary objective of this task is to prepare an operations and communications manual for the PEU and key

supporting Ministry staffs which will address and recognize the role of the PEU post-IDB project i.e. incorporating CCA into its day-to-day operations.

7.5.3 Outputs

A clear PEU function is established and maintained within the MoWUD with transition mechanisms agreed and set up after IDB loan funds cease and a clear "ICZM road map" is produced and implemented for The Bahamas in line with the draft ICZM Policy Framework for The Bahamas (as defined during Component 1).

7.5.4 Indicative Program and Costs

Table 7.2: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
C1: Technical Support to the PEU	X	X	X	X						

Table 7.3: Estimated Costs

Activity	Estimated cost (USD)
Preparation of a Strategic Action Plan	100,000.00
Internal Communications Manual	50,000.00
TOTAL	**150,000.00**

Table 7.4: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Workshop with PEU	10	5000	16,000
1b Review of current existing institutional work procedures	15		16,500
1c Design a ten year Strategic Action Plan	35		38,500
1d Presentation of the Strategic Action Plan	10	5000	16,000
2a Review current internal GOBH communications	10		11,000
2b Prepare operations and communications manual	30		33,000
TOTAL			**131,000**
15% Risk			**150,000**

7.6 C2: Legislative and Regulatory Review and Institutional Amendments

There is a requirement to update existing appropriate planning and environmental legislation to better embrace the delivery of risk-resilient ICZM in both The Bahamas and from this, to have new regulations prepared to provide the legal basis under which the nominated institution (as defined by the PEU) could carry out its functions to effectively manage the resources of the coastal zone while incorporating DRM and CCA.

Findings of the human resource capacity needs assessment (Appendix L) suggest that ICZM related experience is very low in all Ministries and departments. What is now needed is to determine how human resources should be reallocated (within and across Ministries) to improve efficiency, such as through the adoption of ICT, or through greater internal planning so that staff responsibilities align with targeted outcomes (or KPI's) and that more focus is also given to leadership and management training in tandem with ICZM training.

Development of environmental legislation will be fundamental for the implementation and ongoing monitoring of risk-resilient ICZM in The Bahamas.

7.6.1 Baseline

Moving ICZM forward on the political agenda will require a champion and environmental legislation. There are a number of departments that do play a role in delivering specific sectoral aspects of ICZM though these often relate to traditional governance techniques that favour a sectoral approach to management. Due to the lack of formal environmental legislation in The Bahamas, enforcing development control on the coast is a key challenge. It maybe suggested that the Ministry of Environment and Housing (MoEH) could prove (in time) the natural location for delivering an ICZM policy, though this will require a clear mandate for environmental planning and protection. This "environmental regulatory vacuum" represents a key challenge in the way of driving the initiative required to take ICZM forward.

7.6.2 Proposed studies

The following tasks are proposed:

Amendment to existing planning and environmental legislation and the preparation of supporting risk-resilient ICZM Regulations

The revision of any legislation shall be undertaken in tandem with C4 Shoreline Management Plans and the preparation of regulations of this contract, to ensure consistency with these documents. An initial task shall involve the need to confer with the legal departments of Ministries or the Ministry of the Attorney General for steps in the legislative process. Additionally, the revision shall also include the review of existing legal framework and laws to ensure some consistency with the new Shoreline Management Plans identified for update (as part of the Planning and Subdivision Act 2015). Institutional opportunities and challenges should also be highlighted. The key sub-tasks shall include:

1. Review the limits of the seaward and landward boundaries of the coastal zone for The Bahamas as defined by the Component 1 team in 2016:
2. Prepare draft order delimiting the coastal zone and convene a workshop with key strategic partners for comment.
3. The Final Draft Order shall incorporate the comments obtained in Workshop to be submitted to the Minister for approval in accordance the prescribed process set out in the most appropriate legislative act (to be determined).
4. Review relevant international and regional agreements and legal instruments to which The Bahamas are signatory to, that may require amendments to existing national legislation in order to incorporate CCA into risk-resilient ICZM supporting legislation;
5. On the basis of the above prepare a draft policy paper detailing required updates and amendments to legal instruments and regulations, as appropriate. Present the policy paper to the strategic partners for comments and feedback at a consultation session.

7.6.3 Output

Relevant legislation/ legislative amendments (updated to reflect the principles of risk-resilient ICZM, CCA and sustainable development around The Bahamas) is drafted and submitted to Cabinet. Legislative amendments shall incorporate the protection of coastal ecosystem processes and functions that are necessary to support valued benefits (tourism, coastal protection services from coral reefs) and in line with environmental international agreements as well to amend legislation to incorporate ecosystem services.

7.6.4 Indicative Program and Costs

Table 7.5: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
C2: Legislative / Regulatory Amendments		X	X	X	X					

Table 7.6: Estimated costs

Activity	Estimated cost (USD)
Assessment of the coastal zone	103,000.00
Amendments to existing planning and environment legislation	122,000.00
TOTAL	**225,000.00**

Table 7.7: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Review boundaries of the coastal zone	15		16,500
1b Prepare Draft Order	35		38,500
1c Workshop on Draft Order	12	5000	18,200
1d Final Draft Order	15		16,500
2a Review relevant agreements and legal instruments	20		22,000
2b Prepare draft policy paper	52		57,200
2c Present draft policy paper	20	5000	27,000
TOTAL			**195,900**
15% Risk			**225,000**

7.7 C3: Standard Operating Procedures and Guidance Manuals for ICZM Delivery

As part of implementing risk-resilient coastal management, coastal protection structures need to be designed appropriately with consideration of future climate change (including sea level rise, increases in frequency and severity of storminess, changes in ocean chemistry etc.). Where structures are not designed or constructed to sufficient standards, they are likely to become damaged early on and need repairing, increasing the cost of maintaining or replacing the structure. There is also a higher risk of failure during a storm event. Therefore not only will increasing awareness and understanding of appropriate design guidance reduce risk to people, property and environments behind the structures, but also likely reduce long term maintenance spend.

Furthermore, all future infrastructure development and land use planning (including conservation and habitat protection) should be defined as Coastal Management Areas (CMAs) of islands within The Bahamas and ensure they comply and are clearly defined within Island Plans (as set by the Planning and Subdivision Act 2015). Future implementation plans should adhere with endorsed guidelines, codes and planning advisories as set by GOBH and which embrace and reflect latest climate predictions on the coast.

To enable effective implementation of best practice and sustainable solutions for coastal management planning, update to and new guidance documents are required.

7.7.1 Baseline

The feedback from consultation with the MoWUD has suggested that there is currently a lack of guidance in design of coastal structures, particularly when taking into account climate change scenarios. There are a limited number of strategic planning documents or “tools” around The Bahamas that help integrate risk-resilient ICZM. Guidance documents, including existing draft building codes, for example, pay no reference to coastal infrastructure per se, nor do they take into consideration latest climate predictions for (for example) rainfall or sea level rise in the region. There is therefore a need to either update or produce a

new series of guide manuals to help enforce and implement new risk-resilient ICZM regulations as to be defined within the separate Shoreline Management Plans proposed in (subcomponent C4).

7.7.2 Proposed Studies

The key objectives of the Study would be to:

1. Preparation of a workable Operations Manual for future delivery of risk-resilient ICZM
2. Preparation of the ICZM Regulations including updates to current / future Building Codes.
3. Preparation of support guide manuals on coastal engineering, coastal setback, delivery ecosystem service “added value” etc.

Key sub-tasks will include a review of any existing Operation and Technical Guidance Manuals within the context of the existing operations and procedures of the PEU and supporting Ministries/Departments; a review all relevant documents relating to administrative communications and sustainable operations currently in place; convene a workshop with staff at all levels of the PEU to obtain their perspectives on their planned expanded roles and the changes that will be required to facilitate this expansion and the need to have proper operational procedures documented within the Operations Manual.

A Draft Operations Manual for the PEU shall then be prepared to include (but not be limited to) agreed expanded roles and responsibilities, the incorporation of SMART indicators; programing procedures; organizational charts; job descriptions; personnel performance indicators etc. for various institutional levels within the PEU. The Draft Operations Manual shall be designed as a business process review of the PEU (including coordination with its partners) which would serve as the basis for consolidating and strengthening internal PEU procedures

This work is needed to help guide MoWUD to help provide clear advice to planners and engineers for all national consultants and new developers on how to design, construct and monitor coastal protection schemes within The Bahamas in the future. It also will help provide community training and also government capacity building training needs on how to maintain defence and to (where appropriate) retrofit existing schemes to become more "climate resilient”.

Planning guidelines will provide:

- Qualifying explanation to the requirements of the EIA and land use planning regulations.
- Performance standards to be set for coastal protection structures.

Engineering guidelines will cover:

- The design criteria for coastal protection structures.
- The material specifications to be used in the build of coastal protection structures.

Guidelines for the monitoring, maintenance and evaluation of coastal protection structures will aim to strengthen data capture and management as well as vulnerability/risk assessments.

7.7.3 Outputs

- Building code updated to embrace latest climate predictions on rainfall intensity and sea level rise.
- Coastal engineering manual produced and included within all future development permit requirements for adherence.
- Habitat monitoring and rehabilitation (mangroves, sea grass, and coral reef) manual produced and included within all future development permit requirements for adherence.
- Coastal planning "manual" produced to help developers with issues such as land purchase, setback and rehabilitation of lands produced and included within all future development permit requirements for adherence.

7.7.4 Indicative Program and Costs

Table 7.8: Calendar of execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
C3: Standard Operating Procedures and Guidance Manuals for ICZM Delivery				X	X	X	X	X		

Table 7.9: Estimated costs

Activity	Estimated cost (USD)
Evaluate existing practices	90,000.00
Recommend appropriate approaches	171,000.00
Produce SOP and Design Guidance	127,000.00
Stakeholder Consultation	62.000.00
TOTAL	**450,000.00**

Table 7.10: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Evaluation of existing design practice	10		11,000
1b Evaluation of existing planning process with GOBH	10		11,000
1c Evaluation of existing ecosystem based adaptation	12		13,200
1d Review international guidance	10		11,000
1e Recommend basic data requirements for planning and design	25	5000	32,500
2a Recommend updates to building codes taking into account climate change	35		38,500
2b Recommend approaches to coastal planning	35		38,500
2c Recommend approaches to ecosystem based adaptation	35		38,500
2d Recommend approaches to coastal protection design	30		33,000
3a Standard Operating Procedure Manual	50		55,000
3b Design Guidance	50		55,000
4a. Stakeholder workshops	20	5000	27,000
4b. Presentation and training on manuals	20	5000	27,000
TOTAL			**391,200**
15% Risk			**450,000**

7.8 C4: Shoreline Management Plans

The key objective of the Shoreline Management Plans would be to ensure that the principles of ICZM are being implemented through actions and policy regulations “on the ground” through adherence to Island Plans produced specifically for New Providence and Long Island as directed by the Planning and Subdivision Act (2015) within The Bahamas. This will involve the production of two separate fully endorsed and Cabinet approved Shoreline Management Plans for New Providence and Long Island. (NB: The land use planning process is set to change within the Planning & Subdivision Act (2015) through guidance is not yet in place).

Given the current lack of knowledge base and capacity to undertake hazard risk assessments, the GOBH’s ability to systematically manage coastal risk with climate change is limited[72]. There are common specific challenges in delivering ICZM in New Providence and the Family Islands. These can be summarised as:

- Lack of connection between the various Authorities responsible for individual activities resulting in poor or absent coordination and national oversight for the management and utilisation of the coastal zone;
- A spatial and temporal overlap of human activities and their objectives, causing conflicts (user-user and user-ecosystem);
- Impacts from one (or more) activities adversely affecting other users of the coastal zone;

[72] Mott MacDonald (2016) Design and Feasibility Analysis of Risk Resilience ICZM First Interim Report

- Lack of consideration of the cumulative effects of multiple activities on the coastal zone and other users;
- A lack of connection between coastal activities and the resource use and communities that are dependent on them; and
- Lack of protection of biologically and ecologically sensitive coastal habitats and areas.

Assessment of these key issues needs to be undertaken within island-wide plans to ensure the approach to ICZM is consistent throughout the islands and any works undertaken are coordinated to provide an overall risk-resilient approach.

7.8.1 Baseline

There are no examples of an island wide strategy/plan which integrates climate change adaptation and ICZM. However, new planning legislation approved in 2010 (Planning and Subdivisions Act updated in 2015) now includes provision for land use planning, environmental management and the protection of natural resources for New Providence and the Family Islands. This includes the provision of infrastructure and services to the built environment that address the issues of the coastal zone vulnerability and sensitivity to habitat protection, and the establishment of a Town Planning Committee to support this. The Act stipulates that land use plans shall be prepared for each island of The Bahamas and be available for public viewing. The Department of Physical Planning is tasked with creating a comprehensive sustainable plan that balances economic growth, meets the needs of communities and conserves biodiversity of various ecosystems.

There is a significant opportunity to tie Shoreline Management Plans in with activities being carried out during implementation of the Planning and Subdivisions Act.

7.8.2 Proposed Studies

It is proposed that in the long term, each Family Island, in addition to New Providence, should have a Shoreline Management Plan which ties into the Planning and Subdivision Act. Initial studies proposed here include undertaking two of these plans, one for New Providence and one for Long Island. These sites have been selected to provide exemplar Shoreline Management Plans which can then be used to develop Shoreline Management Plans for other Family Islands. New Providence and Long Island have been chosen as exemplar islands due to:

- Significant amount of data available (New Providence has the highest concentration of centrally collated data and Long Island has recent data that has been collated post Hurricane Joaquin) and therefore will be able to commence before the completion of Component A (baseline surveys);
- The contrasting environments and objectives for both sites. This will provide a range of receptors, pathways and outcomes to be explored during development of the Shoreline Management Plans which can then be applied to other sites; and
- New Providence has been identified by the TAC and the GOBH as a key priority due to its high population density and importance for the national economy.

The key aim of the Shoreline Management Plans is to provide the shared knowledge base and analytical capacity to support stakeholder interaction, planning and decision making for integrated coastal risk management and climate adaptation. In other words, the Shoreline Management Plans should be a forward planning document to enable climate risk management in the coastal zone.

Sub-objectives are:

- to quantify and model hazard risk for the Islands using an objective method that will represent a scientific and numerical basis to inform sector-specific risk management practices and policy, including those in disaster risk reduction, and risk transfer;
- to inform the decisions and development of more effective risk financing options;
- to will build on previous work conducted by the GOBH and to provide a comprehensive analysis and description of coastal hazards and management proposals for the entire coastal zone of New Providence and Long Island; and
- to propose long term management policies for the coastal zone of New Providence and Long Island and an action plan to facilitate future studies.

7.8.3 Outputs

Two Cabinet approved Shoreline Management Plans that are produced for New Providence and Long Island and that have been produced through demonstrable participatory processes that have assessed and embraced valued Ecosystem Services (tourism, fisheries, coastal protection etc.) to help inform ICZM plans and targeted actions.

7.8.4 Indicative Program and Costs

Table 7.11: Execution calendar

	Year 1		Year 2		Year 3		Year 4		Year 5	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
C4: Shoreline Management Plans			X	X	X	X				

Table 7.12: Estimated Costs

Activity	Estimated cost (USD)
Data Review	78,000.00
Hazard Assessment	100,000.00
Vulnerability Assessment	95,000.00
Risk Assessment	88,000.00
Habitat Process Study	88,000.00
Option Development	76,000.00
Shoreline Management Plan	75,000.00
TOTAL	**600,000.00**

Table 7.13: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Review recent studies	10		11,000
1b Review available data	10	8000	19,000
1c Identify any data gaps and propose studies required	15		16,500
1d Define Shoreline Management Units	10		11,000
1e Determine overall objectives	10		11,000
2a Consideration of hazards	35		38,500
2b Hazard mapping	10	5000	16,000
2c Hazard Assessment Report	30		33,000
3a Describe social variables	10		11,000
3b Assess damages and opportunities	30		33,000
3c Compile information in GIS	15		16,500
3d Preparation of Vulnerability Maps and Report	20		22,000
4a Compute risks	30		33,000
4b Prepare Hazard Risk Assessment Report	30		33,000
4c Risk maps in GIS	10		11,000
5a Determine baseline	20	5000	27,000
5b Undertake SEA	45		49,500
6a Determine range of options, score and leading options	30		33,000
6b Economic assessment	10		11,000
6c Implementation Plan	10		11,000
6d Financial implementation	10		11,000
7a Produce the Shoreline Management Plan	30		33,000
7b Stakeholder consultation	25	5000	32,500
TOTAL			**523,500**
15% Risk			**600,000**

7.9 C5: Knowledge Transfer and Capacity Development

The main outcome of this activity shall be having trained and better educated staff of the PEU and local stakeholder groups on risk-resilient issues and aspects as defined throughout the ICZM Program. The training will be carried out in specific administrative, technical, systems and operations, institutional and enforcement areas, in order that core PEU staff are able to meet the expanded mandate resulting from the Program (in topics such as incorporating CCA into the day-to-day operations).

A parallel outcome shall be the design and implementation of a public education and awareness campaign that describes the activities for wide publication of the updated plan. This campaign will elaborate various methods, such as media coverage, a brochure, education material, awareness campaigns based on an analysis of target audiences.

Training of staff is required to enhance the skills and capacity of the GOBH to effectively implement ICZM.

7.9.1 Baseline

Scientific research and best practices are not often integrated into decision-making. Most agencies do not have assigned research functions or planning mechanisms that enables scientific knowledge or best practice to form the basis of decision-making. In examples where recent knowledge has informed planning, this occurred dominantly through the implementation of activities to respond to international commitments, or has taken place in collaboration with a regional focal point or international organization. In some cases, it was noted that adapting management techniques to respond to science and best practices is not well received by senior management who prefer to retain traditional management techniques.

The lack of human and financial resources currently restricts the ability of agencies to effectively achieve their mandate. Human resource challenges stem not only from in-house technical capacity and numbers, but also inefficiencies in the management of staff to maximize output. Such inefficiencies are noted as being mainly as a result of outdated and bureaucratic processes for retaining and promoting staff, lack of training opportunities and limited integration of ICT into the workplace. A contributing challenge is the unavailability of funds to address the above concerns.

7.9.2 Proposed Studies

The key objectives of the work would be to:

- Train staff of the PEU, key GOBH public sector workers, local government, community based organizations and private sector organizations on enforcement for coastal zone inspectors and technical support and training in risk modelling and assessment, data management; use of risk evaluation tools;
- Implement CCA Sensitization and Training Plan for the all Strategic Partners.

- Initiate new programs including stakeholder communication and education (involving sensitization in CCA and ICZM through the implementation of a communication strategy and public education and awareness campaign).

The key tasks shall include the following:

1. Training of Staff of PEU, MoEH/MoWUD and other key GOBH bodies
2. CCA Sensitization and Training Plan for key Strategic Partners and local groups.
3. Preparation of a Training program on Information Sharing between Key Strategic Partners

7.9.3 Outputs

Project knowledge and lessons learned shared nationally and internationally through the following minimum number of activities:

- One analytical paper documenting key lessons learned, including the current and potential role of women/vulnerable communities in implementing risk-resilient ICZM, with recommendations for integrating CCA and EBA principles.
- One regional conference on risk-resilient ICZM for the northern Caribbean region.
- At least 8 field visits to project demonstration sites by target and non-target communities in across BH to promote cross community learning on new innovative techniques and monitoring approaches.
- Project knowledge and lessons learned disseminated through at least 2 national websites (The Bahamas) and 2 international ICZM platforms (or portals).

The training to include ES assessment concepts to build ES into formal decisions and ensure decision support tools provide a framework for integrated analysis of the diverse concepts and ES tradeoffs associated with different scenarios. This has been defined as a key activity under several of the studies proposed under Component B. Adaptive management techniques shall also be inculcated into the process to systematically test the efficacy of methods for mapping, assessing, and valuing ecosystem services (Component 1) and other variables to improve the tools and provide feedback on the effectiveness of alternative institutional structures, managed approaches and policies.

7.9.4 Indicative Program and Costs

Table 7.14: Calendar of Execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
C5 :Knowledge Transfer and Capacity Development	X	X	X	X	X	X	X	X	X	X

Table 7.15: Estimated costs

Activity	Estimated cost (USD)
Training of staff of PEU and GOBH	270,000.00
CCA Training Program	100,000.00
Preparation of Information Sharing Program	56,000.00
TOTAL	**425,000.00**

Table 7.16: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a Prepare Training Needs Assessment Report	25		27,500
1b Training Programs	60	2000	86,000
1c Identify technical visits	10		11,000
1d Quarterly evaluations	100		110,000
2a Training for technical personnel	35	10000	48,500
2b Sensitization for managerial staff	30	5000	38,000
3a Propose training program	25		27,500
3b Present training program	15	5000	21,500
TOTAL			**370,000**
15% Risk			**425,000**

7.10 C6: Cost Recovery Strategies for Risk-Resilient ICZM

In order to provide a sustainable long term coastal management process, the financing of the Program following the implementation of the IDB loan needs to be considered. Without effective maintenance budgets, monitoring budgets and ongoing opportunities for capital works, the initial studies undertaken as part of the IDB loan will not gain enough traction to drive CCA in coastal management in The Bahamas. The coastal zone in The Bahamas has a very wide range of uses and interacts with private developers, ports, tourist resorts and key infrastructure. This means that there is a wide range of potential to utilize this diversity to help fund the overall ICZM Program.

Ensuring the long term financial stability is critical to enabling implementation of ICZM in The Bahamas.

7.10.1 Proposed Studies

The Primary of objectives of this Study are:

- To identify ways of facilitating sustainable private sector participation in financing the implementation of Coastal Management Interventions; and,
- To identify ways of facilitating the recovery or offsetting of Coastal Management Interventions investment costs from direct or indirect beneficiaries of such interventions.

Secondary objectives of this Study include:

- To assess current GOBH policies and the existing institutional and legal framework to ascertain the viability of:
  - private sector participation in financing the implementation of Coastal Management Interventions, and
  - recovery or offsetting of CMIs investment costs from direct or indirect beneficiaries of such interventions,
- To assess GOBH's internal stakeholders institutional capability and capacity to plan, structure, procure and manage privately financed CMIs and make recommendations in relation to any required changes for improvement;
- To develop standardised evaluation methodologies and criteria for the assessment of the suitability for private finance of different types of CMSs (in terms of size, scope, complexity and duration);
- The identification of procurement options for different types of CMIs and the development of evaluation methodologies and criteria for the assessment of such procurement options; and,
- The development of standardised 'Cost / Benefit' and Value for Money' evaluation models that facilitate informed decision making in relation to the optimum finance structuring and procurement strategy of CMIs.

The key tasks shall include the following:

1. Initial consultation and diagnostic assessment
2. Identification and assessment project finance models
3. Development of the Assessment Guidelines Framework for Coastal Management Interventions
4. Implementation plan and training

7.10.2 Outputs

The main outcome of this activity shall be the implementation of a comprehensive set of options and measures by which the cost for providing coastal infrastructure can be recovered for interventions and projects identified for The Bahamas. The information from this study will feed into the Shoreline Management Plans and Strategies which will look at implementation plans and how this could be funded.

7.10.3 Indicative Program and Costs

Table 7.17: Calendar of Execution

	Year 1		Year 2		Year 3		Year 4		Year 5	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
C6: Cost Recovery Strategies for Risk-Resilient ICZM			X	X	X	X				

Table 7.18: Estimated costs

Activity	Estimated cost (USD)
Initial consultation and diagnostic assessment	50,000
Identification and assessment project finance models	30,000
Development of the Assessment Guidelines Framework	107,000
Implementation plan and training	88,000
TOTAL	**275,000**

Table 7.19: Breakdown in costs

Task	Man-days	Expenses	Total Cost (USD)
1a and 1b Information gathering	10		11,000
1c Stakeholder assessment	10		11,000
1d and 1e Review framework and practices	10		11,000
1f Consultation	5	5000	10,500
2a Identify best practice	5		5,500
2b and 2c Evaluate finance models and present finding	15	5000	21,500
3a Guidelines for assessment of financial suitability	25		27,500
3b Guidelines for procurement	25		27,500
3c Guidelines for value for money	20		22,000
3d Presentation of guidelines	10	5000	16,000
4a Capacity and capability recommendations	25		27,500
4b and 4c Implementation plan and presentation	45		49,500
TOTAL			**240,500**
15% Risk			**275,000**

8 Environmental and Social Viability of The Program

8.1 Overview

As part of this process, a Strategic Environmental Analysis of the overall phased investment package, including an assessment of the policies, regulations, institutional coordination mechanisms and procedures in places has been undertaken to ensure the viability of the Program during the course of its execution, potential impacts and preventive and mitigation measures. Furthermore an environmental analysis of the potential direct, indirect and cumulative impacts of the specific works and activities proposed for the public investment packages has been undertaken as required by national legislation and the IDB's Environmental and Social Safeguards Policy, as well as the selection and costing of preventative and mitigation measures. This Report presents a summary of this work and the results, and the details of this analysis are presented in Appendix H.

8.2 Potential strategic impacts of the ICZM Program

The proposed Program has a number of positive and negative impacts at the strategic Program level.

Positive impacts

There are several significant positive benefits of implementing ICZM within The Bahamas. The coastal zone of The Bahamas is intrinsically linked with many aspects of the local and international economy, social wellbeing, culture, ecosystem providers and environment of The Bahamas.

The Program implements a strong ecosystem services focus. This will help to mainstream the ecosystem services school of thought as a key planning and optioneering process. In particular, the work to be completed under Component C will develop guidelines and best practice examples of this. This will enable a revolution to occur in the way structures are planned and executed by the Ministry of Works and Urban Development to consider wider benefits, enable longer term sustainable and more innovative solutions.

A priority list of ICZM issues within The Bahamas has been developed by the TAC and Component 1 consultants CCS[73]. Specific environmental issues have been identified and the proposed Program aims to provide assessment of these issues. Table 8.1 summarises these issues and the positive impacts the Program will have against the issues highlighted.

[73] CCS Second Interim Report

Table 8.1: Impact of Program against the Priority ICZM Environmental and Social issues.

Priority ICZM Environmental/Social Issue[74]	Impact of Program
Coastal erosion and flooding	Reduction in risk of erosion and flooding to infrastructure and properties.
Coastal and marine pollution/ waste management	Clearer lines of responsibility will be drawn, linking in with the National Maritime Policy. Strategies will highlight risk areas and critical sewerage infrastructure will be better protected. Better management of water quality will improve tourism, ecosystem services, habitats and species.
Management of ports and shipping routes	Legislation and guidance around construction will combine with the NMP to increase awareness of best practice for design and build of structures such as quay walls.
Illegal and unregulated activities	Component C will look to increase the legislative power of specific institutions, potentially though specific ICZM legislation, which will provide increased power to control unregulated activities.
Competing interests for limited space	Island wide plans will assess strategic areas for development, land use conflict issues and ownership issues to devise areas that can be used for development and areas which should not be.
Lack of coastal zone management and legislation	Component C will build upon existing legislation to improve and increase.
Stalled national implementation of ICZM legislation	Stakeholder engagement, both public, government and private stakeholders, will feature throughout all components to facilitate and ensure buy-in on a national scale. Outreach educational activities will play a role within the Program and should have some level of involvement with citizen scientists, dive community, dive show owners, resort managers etc.
Decline in fisheries	The Program will be looking to protect and enhance coral reefs which act as key feeding sources for fish and mangroves which provide nursery areas for fish. Furthermore, legislative work under Component C will work to make clear the links between ICZM and the National Maritime Policy and where the legislation will sit to protect fishery stocks.
Public rights of access	Landownership and public access to beaches and the coastline will be an important aspect of the plans developed under Component C in addition to being looked at in more detail under strategies conducted under Component B. Furthermore, when selecting likely pilot site engineering solutions, social impacts and opportunities were considered in selecting the likely preferred option.
Control of management of invasive species	Issues with invasive species covers a range of topics, from the impact of Casuarina trees on erosion to the impact of the Lionfish on coral health. Island level plans are needed to provide an overall strategy to dealing with the species, and standard operating procedures and design guidance will advise on dealing with invasive species interacting with coastal protection elements.

Climate resilience, climate change adaptation and disaster risk management

Overall the Program will look at mainstreaming CCA and disaster risk management activities by:

- Strengthening and building in resilience into coastal areas inclusive of key ecosystem services providing habitats such as mangrove areas and sea grass meadows along with coral reef systems;
- Mainstreaming CCA within key environmental legislation;

[74] CCS Second Interim Report

- Engraining the importance of a good scientific basis to policy and management decisions through the use of Shoreline Management Plans to set out implementation plans over 50 years;
- Expansion and enhancement of the national baseline data required for effective climate and risk-resilient adaptation management and coastal protection design; and
- Development in the capacity of GOBH and key stakeholder institutions in their ability to carry out CCA and disaster risk management activities.

Positive social impacts

The interventions that have been proposed at the five Pilot Sites within the Program have been assessed on a number of criteria, with core consideration of social impacts. There are many opportunities, particularly in the more populous areas such as Nassau, to provide enhanced amenities and access to beaches and the water front.

Furthermore, through the development of monitoring programs, and design of different frontages, there is opportunity to involve small businesses within The Bahamas and provide a positive contribution to the economy.

Small businesses will also benefit from the increased tourism that could be an outcome of some of the Pilot Sites. An example of this is the small businesses that exist on Junkanoo Beach, Nassau. If overall connectivity and beach amenity was improved it is likely that a larger area of Junkanoo Beach could benefit from increased tourism, right down to the fish fry area by Arawak Cay.

Negative Impacts

Although an increase in tourism at Pilot Sites generates a positive impact in terms of economic viability and social impacts, this could also increase the pressure on the environment. Cruise vessels in developed areas could have high pressure impacts in terms of cumulative and in combination impacts due to high usage and anthropogenic influences. This could negatively impact ecology as well as water quality. Furthermore, increased tourist usage of beaches could cause an increases in issues such as littering and pollution which would also negatively impact marine and coastal ecology. The impact of increase in tourism needs to be managed through sustainable tourism initiatives and increase in management of areas through organisations such as the BPP&PBA.

Impacts on the marine and intertidal habitats and flora are largely associated with the temporary and permanent habitat loss/degradation resulting from the construction of each specific activity for each pilot site.

It is also worth noting that depending on the individual pilot site sedimentation will have a negative impact. Many ecosystems benefit from sediment transport and deposition, whether directly or indirectly. Sediment builds aquatic habitats for spawning and benthic organisms. It is also responsible for providing nutrients to

aquatic plants, as well vegetation in nearshore ecosystems such as floodplains and marshes. Without sediment deposition, coastal zones can become eroded or non-existent.

Construction of additional coastal protection structures could have a large number of negative impacts through the construction on the environment. The construction projects need to be carefully controlled and each project should have a mitigation plan regarding potential impacts of construction.

8.3 Potential impacts of the infrastructure investments

Further to assessing the overall positive and negative impacts of the Program, this Project has also considered the specific potential impacts of the coastal protection works which are proposed at five Pilot Sites under Component B and mitigation measures required. This is summarised in Table 8.2 which considers not just the initial studies proposed, but the potential construction and operation impacts in addition to cumulative impacts at the sites.

Table 8.2 Environmental and Social Management Plan for the Pilot Site interventions

Coastal Infrastructure Project	Negative Impact	Mitigation Measure	Output	Responsible Agency	Time Frame	Costs (US$)
Site 1: Eleuthera: Glass Window Bridge						
	Construction Impacts					
	Road closure.	Plan construction to close only one lane at a time. Early stakeholder engagement to inform community.	Provisions and diversions in place to reduce disruption to local community.	Ministry of Works and Urban Development.	Years 3 to 4 (throughout construction).	$100,000 (traffic control and stakeholder engagement)
	Water pollution which could affect marine flora and fauna.	Contractor to have pollution control and spill kits in place to reduce risk. Specific management plans for the site looking at proximity to the coastal environment and sensitive receptors or habitats.	No large pollution incident to occur on site.	Ministry of Works and Urban Development.	Years 3 to 4 (throughout construction).	$10,000
	Noise and vibration disturbance (particularly during demolition).	Implement best construction practice including limiting working hours to reduce disturbance in the morning and evening. Use of passive acoustic monitoring techniques should be considered.	Reduction in complaints from the local community and visitors.	Ministry of Works and Urban Development.	Years 3 to 4 (throughout construction).	N/A
	Operational Impacts					
	Run-off and drainage problems could require closure of the road.	During design ensure the drainage design is appropriate to cope with rainfall events up to 1in100 year standard of protection.	No road closure under a 1in100 year storm event or less due to flooding.	Ministry of Works and Urban Development.	Years 1 to 2 (during detailed design).	$25,000
Site 2: Abaco: Treasure Cay						
	Construction Impacts					
	Beach closure.	If possible plan construction in phases so that the entire beach is not closed at the same time. Early stakeholder engagement to warn businesses and local community.	Reduced impact to residents.	Public Parks and Public Beaches Authority.	Years 3 to 4 (throughout construction).	$25,000 (stakeholder engagement)
	Increase in suspended sediment.	At design stage undertake some sediment modelling to assess water quality and potential impacts during construction. During construction use specified construction techniques as recommended by the designer following the modelling.	Reduced increase in suspended sediment during construction causing minimum impact on marine life.	Ministry of Works and Urban Development.	Year 2 (optioneering) and Years 3 to 4 (construction) .	$40,000 (modelling)
	Potential impact or need to remove trees currently on	During design undertake survey of trees on beach and amend design where possible.	Minimal impacts to trees and re-planting	ICZM Project Execution Unit	Year 2 (detailed	$5,000 (survey and design)

Coastal Infrastructure Project	Negative Impact	Mitigation Measure	Output	Responsible Agency	Time Frame	Costs (US$)
	the beach.	Include re-planting of trees to mitigate any loss.	undertaken where required.	(Office of the Prime Minister).	design).	$5,000 (replanting)
	Disturbance from acoustic noise and vibration.	Implement best construction practice including limiting working hours to reduce disturbance in the morning and evening. Use of passive acoustic monitoring techniques should be considered.	Reduction in complaints from the local community and visitors.	Ministry of Works and Urban Development.	Years 3 to 4 (throughout construction).	N/A
	Operation and Maintenance					
	Increased attractiveness may add increased pressure by increased visitor numbers.	During production of Strategy assess the current capacity of the area and recommend sustainable tourism practices and mitigation measures.	Recommendations for sustainable tourism practices to minimise impact of visitors.	ICZM Project Execution Unit (Office of the Prime Minister).	Year 2 (during Strategy).	$10,000
	Potential for colonisation of new structures by invasive species.	An invasive species plan to form part of the Strategy to assess the potential and amend design if required.	Minimal risk of colonisation of structures by invasive species.	BEST	Year 2 (during Strategy).	$30,000
	Sustainability of maintaining the beach material.	Optioneering study to include at least 2D modelling of beach evolution around potential structures to look at maintenance requirements. Maintenance manual to be produced as part of the optioneering study.	Structures designed and constructed to provide effective sediment control. Future maintenance plan set up to review and implement maintenance where required.	ICZM Project Execution Unit (Office of the Prime Minister).	Years 2 to 3 (optioneering study).	$70,000
	Impacts on the rest of the beaches to the southeast of the public beach.	Optioneering study to include at least 2D modelling of beach evolution along the entire coast to ensure no adverse impacts.	No adverse impacts on beaches further down the coast.	BEST (modelling), PPPB Authority (future monitoring).	Years 2 to 3 (optioneering study).	N/A – same modelling as costed for above.
	Cumulative Impacts					
	Combination of project with the beaches privately owned by the hotels.	Early engagement throughout the project to look for both areas of opportunities and conflicts.	Maximises opportunities and minimal conflicts.	ICZM Project Execution Unit (Office of the Prime Minister).	Years 1 to 4 (throughout Study)	$30,000
Site 3:Long Island: Central Long Island						
	Construction					
	Disruption of the road and airport.	Ensure that the airport is able to continue business as usual throughout construction and plan construction so that diversions are put in	Ongoing operation of the airport and diversions in place for the road to	Ministry of Works and Urban Development.	Years 3 to 4 (throughout construction).	N/A – included in construction costs

Coastal Infrastructure Project	Negative Impact	Mitigation Measure	Output	Responsible Agency	Time Frame	Costs (US$)
		place where the construction interacts with the road.	ensure passage along the island is still possible.			
	Disturbance from acoustic noise and vibration (aerial and underwater).	Implement best construction practice including limiting working hours to reduce disturbance in the morning and evening. If needed for areas near water line or in water use of a PAM technician passive acoustic monitor re pilling activities etc.	Reduction in complaints from the local community and visitors and minimise risk of impacts to marine organisms.	Ministry of Works and Urban Development and BEST.	Years 3 to 4 (throughout construction).	N/A
	Potential for increased suspended sediment in water courses.	During construction use sediment traps or blankets when working next to water courses to reduce amount of suspended sediment being released. Consider use of sediment sensors with alarms. This should be dealt with by the contractor in a Dredge Management Plan with details of the particular type of dredge timing etc.	Minimum impacts to water quality during construction.	Ministry of Works and Urban Development.	Years 3 to 4 (throughout construction).	N/A – included in construction costs
	Operation and Maintenance					
	Improved drainage has potential to impact mangrove areas through fresh water inundation.	During the Strategy undertake drainage modelling to assess potential impact on the mangroves and amend design as required.	Minimal impact to mangrove health following construction.	ICZM Project Execution Unit (Office of the Prime Minister).	Years 1 to 2 (Strategy).	$15,000
	Cumulative Impacts					
	Coordination with ad-hoc and private works carried out following damage from Hurricane Joaquin in 2015.	During Strategy undertake a detailed condition assessment and topographic survey to identify all the works, alongside stakeholder engagement. Build and integrate into the design.	Maximised opportunities by coordinating design.	ICZM Project Execution Unit (Office of the Prime Minister).	Years 1 to 2 (Strategy).	$150,000
Site 4: New Providence: North Nassau Frontage						
	Design					
	Increased the time to carry out Strategy and therefore intervention – ongoing coastal risk to the area.	Ensure that the timeframe of the study is known and understood within the ICZM program. Nassau has been identified as a priority location and therefore should be progressed as soon as possible. Ensure clear deadlines and timeframes for consultants undertaking the Strategy and optioneering studies.	Early engagement onto the Nassau Frontage project and completion of project in required timescales.	ICZM Project Execution Unit (Office of the Prime Minister).	Years 1 to 3 (Strategy through to detailed design).	N/A
	Construction					

Coastal Infrastructure Project	Negative Impact	Mitigation Measure	Output	Responsible Agency	Time Frame	Costs (US$)
	Impact traffic through the construction footprint as well as noise and vibration.	Plan construction so that diversions are put in place where the construction interacts with the road and early interaction with stakeholders regarding any potential changes in the road layout. Use of passive acoustic monitoring techniques should be considered.	Minimal disruption to traffic in downtown Nassau.	Ministry of Works and Urban Development.	Years 4 to 5 (throughout construction).	N/A – included in construction costs
	Impact on the use of the beach/tourist facilities.	If possible plan construction in phases so that the entire beach is not closed at the same time. Early stakeholder engagement to warn businesses and local community and work to time construction works so they do not coincide with important events such as the carnival.	Reduced impact to residents.	Public Parks and Public Beaches Authority.	Years 4 to 5 (throughout construction).	$40,000 (stakeholder engagement)
	Impacts on navigation of boats.	Contractor to undertake a traffic management plan prior to starting construction and to include marine traffic within the traffic management plan.	Minimal impact to navigation and alternative routes put in place where required.	The Ministry of Environment and Housing, Port Department.	Year 4 (at start of construction).	$10,000
	Impacts on marine ecology and birds.	Contractor to have pollution control and spill kits in place to reduce risk.	No large pollution incident to occur on site.	Ministry of Works and Urban Development.	Years 4 to 5 (throughout construction).	$10,000
	Operation and Maintenance					
	Increased visitor numbers to Junkanoo beach could increase pollution risk.	During production of Strategy assess the current capacity of the area and recommend sustainable tourism practices and mitigation measures.	Recommendations for sustainable tourism practices to minimise impact of visitors.	ICZM Project Execution Unit (Office of the Prime Minister).	Year 2 (during Strategy).	$10,000
	Potential for colonisation of new structures by invasive species.	An invasive species plan to form part of the Strategy to assess the potential and amend design if required.	Minimal risk of colonisation of structures by invasive species.	The Ministry of Environment and Housing, BEST.	Year 2 (during Strategy).	$30,000
	Cumulative Impacts					
	Combined with the plans under the Sustainable City Vision for Nassau.	During the Strategy plan out the implementation plan with close coordination with other initiatives within Nassau. Plan construction so that works do not directly coincide with other initiative which would increase disruption to downtown Nassau.	Construction does not coincide with any other major constructions works, unless opportunities can be gained through combining projects and reducing construction timeline for Nassau as a whole	ICZM Project Execution Unit (Office of the Prime Minister).	Year 2 (during Strategy).	$20,000 (coordination of timeframes and engagement with other initiatives)

Coastal Infrastructure Project	Negative Impact	Mitigation Measure	Output	Responsible Agency	Time Frame	Costs (US$)
			.			
Site 5: East Grand Bahama						
	Design					
	Conflicts and strained relationships between interested parties around key focus and objectives.	Early stakeholder engagement and ensure that the different parties form part of the development and consultation process for the optioneering and detailed design processes.	Minimised conflicts between different parties and an agreed set of objectives.	ICZM Project Execution Unit (Office of the Prime Minister).	Year 2 (optioneering) .	$45,000
	Construction					
	Acoustic noise, vibration and traffic from construction vehicles.	Implement best construction practice including limiting working hours to reduce disturbance in the morning and evening. Use of passive acoustic monitoring techniques should be considered. If needed for areas near water line or in water use of a PAM technician passive acoustic monitor re pilling activities etc.	Reduction in complaints from the local community and visitors and minimise risk of impacts to marine organisms.	Ministry of Works and Urban Development and BEST.	Years 3 to 4 (throughout construction).	N/A
	Increased suspended sediments in the water column as well displacement of local and coastal marine species.	During construction use sediment traps or blankets when working next to water courses to reduce amount of suspended sediment being released. Consider use of sediment sensors with alarms. This should be dealt with by the contractor in a Dredge Management Plan with details of the particular type of dredge timing etc.	Minimum impacts to water quality during construction.	Ministry of Works and Urban Development.	Years 3 to 4 (throughout construction).	N/A – included in construction costs
	Operation and maintenance					
	Impact of increased flows/increased salinity on mangrove ecology.	Control sediment flows to reduce sedimentation in the water column such as use of water quality sensors and sediment traps. Monitor fish kills throughout and post construction.	No significant change in fish kills following construction.	BEST, Ministry of Environment and Housing.	Years 4 to 10.	N/A – included in construction costs

9 Economic Justification of The Program

Although not presented as part of the ToR for this Project under Component 2, for the proposed Program, an ex-ante socioeconomic assessment will be required for presentation to the Inter-American Development Bank (IDB) Board of Directors. By its nature, the ex-ante socioeconomic assessment is a high level assessment that allows an understanding of the socioeconomic benefits of schemes and the overall Program based on existing data and analyses. One of the functions of the ex-ante socioeconomic assessment is to provide guidance for the development of the economic analysis component that will be implemented as part of the Program.

The overall aim is to use existing data and studies to develop the best available estimates of the costs and benefits if the Program is to be implemented according to the methods and description presented in this Report.

The economic analysis should attempt to measure the economic returns relating to the overall proposed Program as well as on the individual scheme level. At a Program level, it is considered that the economic benefits of Components A and C are interrelated, and therefore it is recommended that the benefits are not divided between these Components. It is suggested Component B is undertaken separately initially as the relative benefits for the different Pilot Sites are almost independent and should one or two not be undertaken it will be clear what the benefits of the Program still are. These should then feed into the overall Program assessment. Therefore there are two tasks proposed for the ex-ante socioeconomic assessment:

1. Socioeconomic benefits of undertaking coastal protection works at each proposed Pilot Site (x5) relating to flooding and erosion of assets and transport; and
2. Socioeconomic benefits of the whole Program – calculating additional benefits (from tourism and social benefits) of Component A and C and addition to the benefits calculated under 1).

There are a wide range of benefits that could be considered, however the focus will be on the following:

- Residential and commercial property and infrastructure (incl water, electricity, gas, sewerage) damage from coastal erosion;
- Residential and commercial property and infrastructure (incl water, electricity, gas, sewerage) damage from storm surges and flooding;
- Transport benefits (e.g. from reduction in time roads are closed/damaged);
- Tourism benefits to the national economy; and
- Social benefits from increased beach use benefits to Bahamian residents.

The ToR presented in Appendix I details the method which should be undertaken for the ex-ante socioeconomic assessment.

10 Inter-institutional coordination

10.1 The roles and functions of a Project Execution Unit

The critical function of a Project Execution Unit (PEU) is to ensure dedicated human and institutional resources to manage the implementation of externally financed public investment programs. The establishment of the PEU function can also be an important institutional mechanism to ensure that staff time and effort are focused on implementation of the specific projects, thereby avoiding overburdening existing agency staff with additional responsibilities. The arrangement poses benefits not only in terms of increasing efficiency through improved time management, but also enables the supplementation of existing workforce capacity through the hiring of additional and qualified staff to execute the project requirements. PEUs are also expected to undertake key responsibilities to support effective and transparent program management. Therefore, specific functions will include annual project and activity planning, management and supervision of program implementation, financial management, procurement, and monitoring, evaluation and reporting.

10.2 Implementing the PEU

Overall, ICZM is an iterative process that will require careful and considered delivery, particularly as its development is still in its embryonic stage in the Bahamas. To this end, the overall ICZM effort requires a range of flexible and interchangeable core functions which are broadly categorised as follows:

- Policy development and mainstreaming: This includes the formulation of ICZM-related policies, codes and standards, and the coordination of initiatives to integrate such policies across a range of sectors and ministries. It also includes all aspects of project implementation, including project monitoring and evaluation.
- Implementation: This includes technical delivery and support in areas such as physical planning and development (national and local government delivery), natural resource management, economic development activities, and coastal protection and related infrastructural works.
- Information management: This involves research and the collection and storage of scientific information and data, monitoring and evaluation, data analysis and the provision of policy advice based on these findings.

A PEU that can support and drive all these ICZM functions is required for the successful implementation of a successful loan program. However, given that one overall objective of a proposed IDB-funded project is to strengthen the ICZM capacity of the government as well as other ICZM stakeholders, aspects of the PEU's functions must ultimately be embedded in the institutions of the state in a sustainable manner beyond the lifetime of the funded project.

10.3 Recommendation

Based on the above discussion of the function and requirements of a PEU, it is recommended that a "standalone" PEU is set up within the Ministry of Works and Urban Development (MoWUD) and should be granted authority from the IDB (with support from the Ministry of Finance) to undertake this role for the implementation of the loan package. The existing actions, resources, structure and remit of the key Departments of MoWUD (notably DPP and DPW) align closely with the requirements for program

implementation and make this agency the logical place to drive implementation. This is required as no existing Ministry/institution is able to demonstrate the necessary functionality to drive forward ICZM, nor is there any Ministry that could easily embrace an additional function within its existing framework and mandate to take forward ICZM. Necessary additional resources and capabilities will need to be brought into the PEU from MoEH/CoB/MAMR/MoTA etc) to ensure it has the full capacity necessary to oversee program implementation.

The PEU will report to the proposed Cabinet-appointed ICZM Steering Committee as well as the IDB regarding its implementation of the funded program. For clarity, reasons that the MoWUD are proposed to "house" the PEU are as follows:

1. Membership currently exists within the TAC from DPP/DPW.
2. The MoWUD has extensive experience in project funding, procurement and implementation. Although the proposed loan funded program would be administered by the Ministry of Finance, it is noteworthy that any loan will be executed through the wider Ministry. The MoWUD has extensive experience implementing loan funded programs and is supported by the OPM which functions as a Program Management Office for the Ministry.
3. The DPP has previously been approved as an implementing agency for similar projects and therefore already has established mechanisms for project funding, financing and implementation.
4. MoWUD has Planning and Designs, Research, Engineering and Project Management divisions which would support the IDB program, removing the need to recreate these – instead only strengthening would be required.
5. Currently the MoWUD is one of few agencies that has GOBH approval to implement a program that is comprehensively geared towards coastal management.

It is critical that consideration be given to the potential for linkages between the MOEH and the OPM, in the exercise of its PEU functions. In this context, opportunities for the MoWUD to provide technical support and enhance information sharing between agencies should be strongly capitalized on. All externally financed public investment projects targeted around The Bahamas should be undertaken in collaboration with MoWUD, MoEH and OPM as appropriate.

The PEU responsibilities will need to continue to cultivate strong ties with Local Government on Family Islands by ensuring their representation on island specific coastal protection projects. Within the proposed IDB ICZM project, upon selection of priority or pilot areas for coastal protection works (for example), the PEU should identify and collaborate with the relevant Family Island planners and Councils on future implementation. Therefore, the PEU should not duplicate capacity within local areas but rather provide opportunities to build capacity of existing personnel through participation on execution on coastal works.

Data collection will also be supported by embedding a GIS/information specialist within the MoWUD, thereby further supporting its PEU responsibilities. Until the National GIS project for The Bahamas is fully operational (through BNGIS), the PEU will undertake the functions of facilitating the sharing and use of data with respect to coastal and marine activities collected by the project and other agencies of government. The capacity of the BEST Commission should be enhanced with respect to the collection and management of such data.

The PEU should consider the engagement of three professional positions with the following focus. They shall need to work in collaboration with other stakeholders as required. The proposed positions are as follows:

1. Program Manager: This position will be head of the Secretariat and responsible for preparation of ICZM program plans and management reports.
2. Socio-Economist: This position will be responsible for ICZM program monitoring & evaluation and the analysis of GOBH datasets/ information to track coastal issues.
3. Coastal Planner: This position will be responsible for the assessment and design of adaptation measures including disaster response plans for coastal communities.

In addition, one Administrative Staff may be engaged to assist with PEU operations.

11 Stakeholder Consultation

11.1 Overview

The design and implementation of coastal infrastructure and the development of adaptation measures that improve resilience to climate change and natural disasters in The Bahamas is generally supported by key stakeholders and councillors who have provided important influences in the development of the Program.

Mott MacDonald believe that local stakeholders, Government and quasi-governmental organisations have a deep understanding of local processes, use, needs and requirements of the coastal environment. Our key objectives for working with local stakeholders and organisations (governmental and non-governmental) include:

1) To work with local stakeholders to understand the key issues of ICZM and Climate Change Adaptation (CCA).

The Project Team has aimed to harness knowledge from the local stakeholders contributing to the shaping of the Program. The Project Team has aimed to ensure that a wider range of stakeholders all sections of the community can contribute to the Program development from an early stage. The views and opinions of the local stakeholders have been considered throughout the process to ensure that the Program is supported and is specific to The Bahamas.

2) To help the key stakeholders understand the extent of the climatic change risk.

In addition to using the knowledge from the local stakeholders to help influence the Program development, the Project Team also considered it an important process to inform the stakeholders and help them understand the level of risk posed by future sea level rise, storm surge and hurricanes to their properties/land/businesses. This realization may further encourage support and involvement of organisation in implementation of ICZM in The Bahamas.

3) To ensure that the function of the implementation of coastal infrastructure and the development of adaptation measures meets all requirements from stakeholders.

The Bahamas' coastal environment supports multiple ecosystem functions and therefore multiple stakeholders. The optioneering process for the Pilot Sites considered the impact of each stakeholder. Consultation early on was critical to understanding and incorporating these requirements into the optioneering. This further sets the precedence for engagement in optioneering processes going forward in the program.

11.2 Methods of Stakeholder Engagement

Stakeholders are defined as anyone who has an interest in the Program and therefore covers both members of the public and organisations such government ministries, quasi government organisations (such as: BAMSI) and non-for profit organisation (Bahamas National Trust). Throughout the process, the methods of engagement the Project Team focused on included:

- TAC meetings;
- Multi-Criteria Stakeholder Workshop;
- Online questionnaires;
- One to one meetings ;
- Institutional assessment focus groups; and
- Public engagement undertaken under Component 1.

These various methods have been presented in further detail within the Stakeholder Engagement Report presented in Appendix J.

12 Results Matrix

12.1 Project Objective

The objective of this Program is to initiate the long-term integrated management process of The Bahamas' coastal resources. The specific purpose is to establish the national coordination and planning process for the preparation of an Integrated Coastal Zone Management planning framework for the country. It is aimed at building resilience to coastal hazards (including those associated with climate change) through enhanced conservation and management of the coastal zone. The program consists of the following Components: (1) Diagnostic Studies and Information Management; (2) Coastal Protection Interventions; and (3) Institutional Strengthening and Capacity Development.

12.2 Project Outcomes

The key outcomes related to this objective are:

- the completion of diagnostic surveys and development of information management;
- implementation of initial engineering pilot projects; and
- an ICZM "Unit" within the GOBH that has successfully guided the process of developing a national-level ICZM Policy Framework for The Bahamas, and that has the capacity to coordinate the future implementation of ICZM.

Table 12.1: Expected Impacts

Indicators	Unit	Baseline		Goals		Means of verification	Observations
		Value	Year	Value	Year		
EXPECTED IMPACT							
Impact 1: Increase in risk management performance for The Bahamas as measured by the Risk Management Index (RMI)1							
Indicator 1.1 : Increase Bahamas Risk Management Index (RMI) over the duration of the project (https://www.imf.org/external/np/seminars/eng/2013/caribbean/pdf/thebahamas.pdf)	RMI	29.76	2010	34	2020	**Source and year of baseline**: **Means of verification**:	**Comment:** RMI looks at indicators related to the risk management performance of the country which reflects organizational capacity and actions to address disaster risk. RMI total has four components: risk identification (RI), risk reduction (RR), disaster management (DM) and governability and financial protection (FP)

Impact 2: Reduced risk to coastal communities for all Family Islands around The Bahamas							
Indicator 2.1: Increased national/local technical and institutional capacity to address climate change risks in coastal areas through adaptation interventions including Ecosystem Based Assessments	Baseline values to be determined during the baseline assessment		2017		2020	**Source and year of baseline**: tbd **Means of verification**: tbd	**Comment:** Each targeted institution (MoWUD/MoEH/MAMR/MoWUD/MoTA) has progressed by a minimum of 1 step in their capacity score assessment framework. A scoring methodology needs to be adopted. The scoring is based on four criteria expressed as questions (these criteria will be further validated at inception phase): 1. Are there institutional arrangements in place to address climate change in coastal areas? 2. Are those arrangements based on clear and strong mandate? 3. Are those arrangements supported by adequate budget allocations? 4. Do those arrangements include broad stakeholder participation across relevant, ICZM related sectors? Each question must be answered with an assessment and score for the extent to which the associated criterion has been met: not at all (= 0), partially (= 1) or to a large extent/ completely (= 2). An overall score is calculated, with a maximum score of 10 given five criteria 5. Will the disaster/ climate risk assessments conducted under Component 2 increase technical capacity to address climate change?
Impact 3: Increased saving to The Bahamas arising from improved phasing of schemes and monitoring and maintenance							
Indicator 3.1: Reduced spend over the whole life of a scheme (50 years) compared to the current baseline scenario.	Benefit cost ratio over whole life of the scheme (50 years).	Baseline benefit cost ratio to be assessed in optioneering studies	2017	Benefit cost ratio of scheme to be above 1.0 and greater than the baseline	2020	Optioneering studies to provide economic assessment including assessment of benefit cost ratio.	Schemes are often implemented earlier than may actually be required to maintain the necessary standard of service, because there is insufficient high quality data available to enable the scheme designer to proceed with sufficient confidence, that standards will be maintained. Furthermore required ongoing maintenance will reduce the deterioration of condition of structures and reduce the need to replace them.

Table 12.2: Expected Results (all three Components)

Expected Results	Unit	Baseline		Intermediate		Goals		Means of verification	Observations
		Value	Year	Value	Year	Value	Year		
EXPECTED RESULT (COMPONENT A – DIAGNOSTIC STUDIES AND INFORMATION MANAGEMENT)									
Result 1: Enhanced knowledge and information effectively used to inform risk resilient ICZM policy decision making through a fully functioning information system									
Indicator 1.1	Number of new ICZM metrics being consistently measured and outcome data shared through the Coastal Management Information System (CMIS).	No nationally focused ICZM diagnostic surveys exist to address coastal hydrodynamics, shoreline asset condition or natural habitat heath	2016	50% of diagnostic studies completed	2018	100% of diagnostic studies completed	2020	Project Execution Unit formal bi-annual progress reports. .	The overall Program (three components) has been structured in a way that many studies in Components B and C rely on completion of the Component A studies.
Indicator 1.2	Establishment of a data storage and access system for risk-resilient ICZM parameters	An initial GIS library and policy which is Cabinet approved has/ is being developed by BNGIS Centre but this does not hold all the information required for The Program and has no specific tools developed within it to aid risk-resilient ICZM.	2016	Additional data collated into GIS.	2018	Management Information System set up which sets out coastal management tools.	2021	CMIS in place, populated and being actively used by ICZM agencies and NGOs. ICZM National Steering Committee formal bi-annual progress reports	The CMIS should develop on and be informed by the existing work and policies in place through the BNGIS Centre.

EXPECTED RESULT (COMPONENT B – COASTAL PROTECTION INTERVENTIONS)									
Result 2: Enhanced capacity of coastal communities on Pilot Project Islands to adapt to dynamic climate-related threats through implementation of practical coastal adaptation measures specifically tailored to the needs of stakeholders within each relevant Family Island									
Indicator 2.1	Number of pilot project interventions successfully constructed.	No specific risk resilient ICZM interventions are intentionally constructed in the Bahamas to provide ecosystem services to beneficiaries.	2016	2 pilot project interventions successfully constructed	2019	5 pilot project interventions successfully constructed	2021	Annual Budget Report PEU [75]Biannual reports	Pilot projects are proposed for Nassau frontage, East Grand Bahama, Long Island, Eleuthera and Abaco.
Indicator 2.2:	Amount of funding allocated from the MoWUD budget for climate adaptation interventions on the coast.	The current spend allotted nationally for coastal protection/asset maintenance budget within MoWUD is not defined apart from other assets.	2016	A clearly defined maintenance and capital spend budget requirements within the MoWUD.	2020	Acceptance and agreement by Ministry of Finance and Cabinet on MoWUD project budget for coastal protection.	2021	Annual Budget Report	Financial provisions are reflected in the national budget, public sector asset management plans, and National Development Plan (Vision 2040) to address climate change risk management in coastal areas.
Indicator 2.3:	Number of Family Island councils/Dept of Local Govt and local community groups/officials trained on low cost, community-based options for risk resilient ICZM	No Family Island Administrators are trained on low cost, community-based options for risk resilient ICZM	2016	At least 2 Family Island Administrators and 5 local community groups are trained on low cost, community-based options for risk resilient ICZM	2018	At least 4 Family Island Administrators and circa 8 local community groups are trained on low cost, community-based options for risk resilient ICZM	2021	A project replication strategy is developed and disseminated to senior government planners in key Ministries (e.g., MoEH/ MAMR/ MoWUD/ MoTA/ NGOs etc.).	The results of all coastal protection pilot projects are analyzed and used to the formulation of a government-endorsed replication program

[75] PEU structure and content is yet to be determined

EXPECTED RESULT (COMPONENT C – INSTITUTIONAL STREGTHENING AND CAPACITY BUILDING)									
Result 3: Enhanced regulation and capacity of public administrations, Family Island Administrators, communities and NGOs, with policy support to plan for and respond to climate change related risks in coastal areas									
Indicator 3.1:	Number of sectors (covering national and Family Island administrative areas across The Bahamas) who are able to comply with and integrate ICZM policies within sectoral Strategy Plans	No Bahamian sector (Ministry/Department) can demonstrate total compliance with all 8 ICZM international principles.	2016	3 Bahamian sectors (Ministry/Department) able to demonstrate total compliance with all 8 ICZM international principles.	2018	6 Bahamian sectors (Ministry/Department) able to demonstrate total compliance with all 8 ICZM international principles	2021	Updated Sector Strategy Plans	Mainstreaming ICZM principles need to be inculcated into sector development plans with "easy to implement" actions to ensure this indicator is attained.
Indicator 3.2	Updated environmental regulation	No formal environmental protection regulation/law in place to help support ICZM delivery in The Bahamas	2016	Draft Environmental Protection and Planning Bill is updated with ICZM Policy Framework compliance clauses etc.	2018	Environmental Protection and Planning Act is promulgated and passed with ICZM Policy Framework compliance clauses included etc.	2021	Updated Environmental Protection and Planning Bill into a Cabinet passed Act	Review and Update to the mandate of the proposed National ICZM Steering Committee to enhance its coordination powers (in light of the updated EPPD Act) and improvement to its role to monitor and evaluate progress of the Bahamian ICZM Policy Framework.

Table 12.3: Expected Products (all three Components)

Products	Estimated Cost (US$)	Unit	Baseline	2017 Year 1	Year 2	Year 3	Year 4	2021 Year 5	Final Goal	Means of verification
Component A: Diagnostic studies and information management										
Indicator 1.1: Number of water level monitoring stations with ongoing collation of data within a GIS information system.	235,000	Water Level Monitoring Stations	1	1	5	5	5	5	5	**Source and year of baseline**: Information from Department of Meteorology, 2016 **Means of verification:** PEU Biannual reports **Comments:** Current location at Settlement Point. Exact number to be set up to be determined

										through initial modelling.
Indicator 1.2: Number of key risk beaches with ongoing annual monitoring activities stored in a GIS system.	220,000	% of key risk beaches identified in initial risk assessment study	0	0	50	100	100	100	100	**Source and year of baseline**: Ministry of Works and Urban Development, 2016 **Means of verification:** PEU Biannual reports **Comments:** Key risk beaches around The Bahamas to be identified as part of an initial study.
Indicator 1.3: Length of vulnerable coastline key assets recorded under a condition assessment within GIS system – location and condition both recorded.	250,000	% length of overall key risk shoreline length identified in initial study	0	100	100	100	100	100	100	**Source and year of baseline**: Ministry of Works and Urban Development, 2016 **Means of verification:** PEU Biannual reports **Comments:** Key risk shoreline stretch around The Bahamas to be identified as part of an initial study.
Indicator 1.4: Increased understanding of sediment processes and drivers though undertaking of a sediment process study.	340,000	Number of studies with national coverage	0	0	1	1	1	1	1	**Source and year of baseline**: Feasibility Assessment for Risk-Resilient ICZM in The Bahamas – Final Report – 2016. **Means of verification:** PEU Biannual reports
Indicator 1.5 : Coverage of coastal zone that has aerial and topographic information and coordinated details regarding assets, environment, social data and climate change. This is all coordinated within a Coastal Management Information System (CMIS)	546,000	% of coastal zone.	0	50	100	100	100	100	100	**Source and year of baseline**: BNGIS Centre, 2016. **Means of verification:** Annual statistics recorded within the CMIS on coastal defence condition. **Comments:** Outputs shall facilitate the work that is being undertaken by BNGIS Centre as part of the Bahamas Spatial Data Infrastructure Act 2014.

Indicator 1.6: A Coastal Management Information System which provides coordinated and innovative coastal management tools.	330,000	Number of systems	0	0	0	1	1	1	1	**Source and year of baseline**: BNGIS Centre, 2016. **Means of verification:** Annual reports by BNGIS Centre.
Component B: Coastal Protection Interventions										
Indicator 2.1: **Number of Pilot Interventions completed to expected specifications**	47,745,000	Constructed interventions at 5 locations	0	1	2	3	4	5	5	**Source and year of baseline**: Feasibility Assessment for Risk-Resilient ICZM in The Bahamas – Final Report – 2016. **Means of verification:** PEU Biannual reports **Comments:** Sites as defined within the Feasibiity Study report on on New Providence, Long Island, Eleuthera and East Grand Bahama
Indicator 2.2: **Number of pilot areas with improved ecosystem services introduced as part of the design** *(NB: a baseline would be established in the strategies and then % improvements would be required over the years of implementation of the scheme)*	Included in costs under 2.1	Pilot Sites at East Grand Bahama, Long island, Treasure Cay	0	0	1	2	3	4	4	**Source and year of baseline**: Feasibility Assessment for Risk-Resilient ICZM in The Bahamas – Final Report – 2016. **Means of verification:** PEU Biannual reports, design reports **Comments:**
Indicator 2.3 : **Number of properties afforded improved coastal risk resilience as a result of pilot intervention**	Included in costs under 2.1	Properties	0	0	0	0	300	530	530	**Source and year of baseline**: Feasibility Assessment for Risk-Resilient ICZM in The Bahamas – Final Report and Google Maps – 2016. **Means of verification:** PEU Biannual reports **Comments:** Demonstration coastal protection projects in place, with demonstrable positive impacts on wider community objectives.

Component C: Institutional strengthening and capacity building										
Indicator 3.1: **Legislation/ legislative amendments submitted to Parliament.**	225,000	New Cabinet approved legislation Acts	No ICZM related legislation in place (Draft Environmental Protection and Planning Bill – 2015).	0	0	1	1	1	1	**Source and year of baseline**: Laws of Bahamas listing updated **Means of verification:** PEU Biannual reports
Indicator 3.2: **Number of new ICZM "Standard Operating Procedures" generated to help mainstream risk resilient ICZM to the Family Islands**	200,000	Standard Operating Procedures	No Standard Operating Procedures exist to help deliver ICZM for all Family Islands (in line with the Planning and Subdivision Act 2015)	0	1	2	4	6	6	**Source and year of baseline**: Feasibility Assessment for Risk-Resilient ICZM in The Bahamas – Final Report – 2016. **Means of verification:** PEU Biannual reports **Comments:** Vision 2040 and the strategic plans of agencies with a primary mandate for ICZM should be prioritized.
Indicator 3.3: **Production of ICZM "Guide Manuals" to help support delivery of Climate Resilient Local Development Planning Guide and Coastal Protection Manual for The Bahamas *(incl. Building and Planning Codes for Coastal Infrastructure*);**	250,000	Guide Manuals	No coastal protection construction guides/ building codes support	0	1	2	2	2	2	**Source and year of baseline**: Feasibility Assessment for Risk-Resilient ICZM in The Bahamas – Final Report – 2016. **Means of verification:** PEU Biannual reports **Comments:** Vision 2040 and the strategic plans of agencies with a primary mandate for ICZM should be prioritized.
Indicator 3.4: **Contribution to the production of two Shoreline Management Plans (embracing outputs from Indicator 3.4) for New Providence and Long Island**	600,000	Key sections for inclusion within a future multi-sectoral Island Plan focusing on ICZM issues	No ICZM "plan" established for Family Islands	0	1	1	2	2	2	**Source and year of baseline**: Feasibility Assessment for Risk-Resilient ICZM in The Bahamas – Final Report – 2016. **Means of verification:** PEU Biannual reports **Comments:** Vision 2040 and the strategic plans of agencies with a

										primary mandate for ICZM should be prioritized.
Indicator 3.5: **Number of ICZM knowledge/ skills transfer/M&E training events conducted under the ICZM investment program for government and non-governmental stakeholders**	650,000	Events (e.g. webinars, seminars, workshops, on the job training sessions)	0	2	4	6	8	10	10	**Source and year of baseline**: Feasibility Assessment for Risk-Resilient ICZM in The Bahamas – Final Report – 2016. **Means of verification:** PEU Biannual reports **Comments:** National training events conducted for relevant organizations on risk resilient ICZM must be tailored to individual organisational needs
Indicator 3.7: **Finance (cost sharing) strategy developed with the private sector embracing Technical Interface Agreements (TIAs)**	250,000	Strategy	No cost sharing finance strategy in existence.	0	0	1	1	1	1	**Source and year of baseline**: Feasibility Assessment for Risk-Resilient ICZM in The Bahamas – Final Report – 2016. **Means of verification:** PEU Biannual reports

Appendices

Appendix A. Literature Review Table

A.1 Overview

A review has been undertaken of the available technical information on coastal risks and related ecosystem services in The Bahamas in addition to regional on-going work on risk-resilient ICZM. This provides a good baseline understanding of previous projects and a platform on which to develop the feasibility analysis for a risk-resilient ICZM Program in The Bahamas.

Further to the Bahamas-specific literature review presented in Section A2, Section A3 presents regional/global literature and Section A4 presents a high level discussion/assessment of the climate change and adaptation status in The Bahamas.

A.2 Bahamas Specific Literature Review

The results and information from the literature review have been collated in Tables A1, A2 and A3. These tables have been structured to provide a summary of the literature review by:

- Listing the relevant coastal risk and ecosystem service related literature reviewed;
- Summarising the aim/information contained within the report;
- Listing of any coastal risk information collated that may prove of use in a future ICZM project;
- Listing any ecosystem services information collated that may prove of use in a future ICZM project ; and;
- Reviewing the TAC criteria for prioritising coastal protection and whether the available literature provides key relevant information relating to any of the criteria selected (which is listed below as follows):
  - 1) Geographic locations in both New Providence and the Family Islands (i.e. is there a spread of possible interventions proposed);
  - 2) Risk to natural disasters, climate change and/or seal level rise, storm surges, inundation and flooding (i.e. are vulnerable communities/assets being prioritised?);
  - 3) Beach erosion risk, improvement of public coastal access to beaches and reduction in habitat degradation (i.e. will the intervention provide added value to tourism or ecosystem services);
  - 4) Priorities for national public investment by the Ministry of Finance (i.e. are the pilot interventions of national relevance and pilot?);
  - 5) High ecosystem services value; and
  - 6) Use of green infrastructure (i.e. will the pilot interventions be replicable to other islands and potentially be an exemplar of good soft coastal engineering practice?).

Based on the definitions adopted for this report (see “Definitions and Terms” at the start of this Report), the tables have been set out to provide a “relevance” category in the final column that is associated with each literature/report reviewed. This category aims to distinguish the relevance of the literature relating to “Risk-resilient ICZM” in The Bahamas to enable the critical relevant literature to be identified. The following categorisation has been used:

- Critical – Critical literature which will form an important part of a risk-resilient ICZM Program within The Bahamas;

- Key Background Data – Contains a large amount of background data which should be fully reviewed during any assessment of risk-resilient ICZM within The Bahamas;
- Focussed Background Data – Useful background data for a specific focussed theme – will be appropriate for elements of a risk-resilient ICZM Program; and
- Limited Use – Limited applicability to a risk-resilient ICZM Program – most likely either outdated or specific for a different region.

The literature has been categorised into three separate tables for ease of reading:

- Table A1 provides a summary of the national policy related literature (split into Policies/Acts and General Reports);
- Table A2 provides a summary of the sector specific literature (split into Policies/Acts and General Reports); and
- Table A3 provides a summary of site specific literature (a geographic location etc.) (split into Policies/Acts and General Reports).

Table A.1: Review of available technical information from relevant literature – national policy related literature/reports.

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
Policies/Acts					
The Development of a National Maritime Policy for The Commonwealth of The Bahamas: A situation analysis prepared for the Bahamas Maritime Authority on behalf of the GOBH (ComSec 2013)	The Government of The Bahamas has therefore signalled its desire to formulate a National Maritime Policy, which will examine maritime resources and legal infrastructure, review and amalgamate existing policies with a view to promoting sustained economic growth and development as well as environmental preservation and conservation. This report provides an initial analysis of the current state of marine management and governance in The Bahamas, as well as a broad range of policy options for consideration by the Government. It looks at the current enabling legislation and the key features of this legislation.	No new information is provided but this document does summarise a lot of important data (climate change etc) and provides links and/or references to where this data is kept.	A discussion around the importance of ecosystem services is presented in this document. No new field gathered information is provided but this document does summarise a lot of important data and provides links and/or references to where this data is kept.	1,2,3,5,6	**Critical**
National Development Plan (Vision 2040) – covers economy, social policy, environment *(this section mentions coastal protection)* and Government Structure (currently in development)	Vision2040 will provide a roadmap for the future development of The Bahamas. The Plan will include a comprehensive policy framework that will guide Government decision making and investment over the next 25 years. Vision2040 is an initiative of the Government of The Bahamas, developed in partnership with the Inter-American Development Bank and in close cooperation with the College of The Bahamas and The Bahamas Chamber of Commerce and Employers Confederation. The Plan will be guided by extensive research, analysis and widespread public consultation aimed at addressing four main policy pillars: The Economy, Governance, Social Policy and Environment (Natural and Built). The process of developing the Plan is ongoing and includes three distinct phases: Diagnosis, A National Conversation, and Plan Development. The projected completion date of the National Development Plan is early 2016.	It is likely that the Plan will cover assessment of coastal assets within the Environment (Natural and Built) policy pillar, with provisional text stating “In The Bahamas, we value our sun, sand and sea and other natural assets”. One of the key challenges is proposed to be “Lack of integration of modern technology, GIS, ecosystem valuation, hazard planning, adaptation and mitigation services “ as well as “Complicated land tenure and registration processes “, both of which will have a large impact on coastal risk management. Furthermore, one of the key threats to infrastructure is listed as being climate change relating	Initial work highlights that the lack of integration of ecosystem valuation in management of the environment (natural and built assets) is a key challenge that needs to be addressed.	1,2,3,4,5,6	**Critical in terms of providing the platform for development planning in the country**

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
		to higher sea levels as well as severe storms and hurricanes.			
National Maritime Policy (April 2015)	The purpose of the BNMP is to establish a framework that can guide the planning and development of maritime activities in a rational and sustainable manner for the social and economic development of The Bahamas. This policy is the basis for effective coordination among all Government agencies with responsibility for maritime and ocean affairs and the harmonisation of national actions in relation to the marine resources of The Bahamas. Through the implementation of the BNMP, the Government of The Bahamas intends to facilitate economic growth through maximising the comparative advantage provided by the unique features of The Bahamas and creating a competitive and business-friendly governance, policy and planning environment for marine activities. The strategic actions included in the BNMP set out a road map for the implementation of the National Maritime Policy. These include a number of short and medium term actions designed to enhance the implementation of the policy objectives of the National Maritime Policy.	The NMP covers the nearshore and coastal environment and therefore policies and plans will directly coincide with ICZM work.	Marine ecology and ecosystem services should be a critical aspect of justifying works under the NMP.	1,2,3,4,5,6	**Critical**
BAHAMAS SPATIAL DATA INFRASTRUCTURE ACT, 2014 **http://bahamas.gov.bs/MAP PUBLICATIONS, accessed on 15/04/2016**	As a part of The Bahamas National Geographic Information Systems (BNGIS) Centre's drive to improving the delivery of public service and taking the nation to a new level of transparency by enabling geospatial data and information to the General Public, this section of the website provides users with the ability to display published maps from agencies operating under the auspices of the Ministry of The Environment as well as published maps from other governmental agencies.	Limited information at the moment but would provide a platform to develop GIS coastal risk information.	Limited information at the moment but would provide a platform to develop GIS ecosystem services/ecological information.	1,2,3,4	**Critical**
Bahamas National Climate Change Policy (2005)	The Government of The Bahamas recognizes that Global Climate Change is an environmental phenomenon with serious implications for the country, and indeed for all countries and especially for Small Island Developing States. The Government also recognizes that although The Bahamas, and other Small Island Developing States, contribute only a very	Discuss various coastal risks associated with climate change covering environmental, social, economic impacts.	Includes consideration of coastal and marine ecosystems (pg 12) in addition to water resources (pg 28) and terrestrial biodiversity (pg 23).	1,2,4,5	**Key Background Data**

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
	small amount of total greenhouse gas emissions, they face an overwhelmingly disproportionate level of risk from the impacts, due to their inherent vulnerability. Specifically, it provides an assessment of the degree of vulnerability if The Bahamas to the projected impacts of Climate Change by sectors; of the capacity for adaptation to anthropogenic climate change; and proposes strategies for anticipating and ameliorating or avoiding the negative impacts.				
National Creeks and Wetlands Restoration Initiative (2007)	Defines the specific direction the Government of The Bahamas should take to give effect to its obligations under the Ramsar Convention. Although not exclusively marine, the policy does include mangrove forests and coastal wetlands under the definition of wetlands. Hence, the policy is highly relevant to much of the shallow near shore bank areas that characterise many of the islands in the chain.	No new data contained within the Report.	No new data however relevant policy for ecosystem management.	1,2,4,5,6	Key Background Data
GOBH – Intended Nationally Determined Contribution (INDC) under the UN Framework Convention on Climate Change (2015)	The document presents The Bahamas' Intended Nationally Determined Contribution (INDC) in accordance with Decisions 1/CP.19 and 1/CP.20, of the United Nations Framework Convention on Climate Change (UNFCCC). The timeframe for implementing the INDC is from 2010-2030. No new policy or data is provided in this document but it does summarise the approach of the GOBH to climate change adaptation and mitigation.	Outlines planning, adaptation and mitigation to key climate change risks – particularly focussing on the coastal environment. No new data is provided but summarises what is currently understood.	Briefly.	1,2,4,6	Key Background Data
General Reports					
The Bahamas National Report: Integrating management of watersheds and coastal areas in small island developing states of The Caribbean (prior to 2000)	The overall objective of this project was to integrate fresh water resources and coastal water management through multi-sectoral planning and management of island ecosystems. Specifically, the project assisted participating countries in improving watershed and coastal zone management practices in support of sustainable development. This document talks about the importance of Integrated Coastal Management planning and suggests a pilot study and demonstration project to apply the methodologies and techniques to real Bahamian	No new information but highlights the importance of looking at watershed management alongside coastal risk management as it is all integrated in The Bahamas.	No new information but it does discuss ecosystem management issues.	1,2,3,5,6	Focussed Background Data

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
	situations is required. Although a date for this publication cannot be found – it is acknowledge that it is likely to have been undertaken prior to 2000. Therefore although the report has useful information, much of this may be out of date.				
Document setting out the Government 5 year investment plan and priorities (2015?)	This has been requested from the Ministry of Finance but has not yet been received by the Project Team.	Unknown.	Unknown.	1,2?,4,5?	**Focussed Background Data**
Integrated Coastal Zone Management in The Bahamas – Horley Witten Report (2002)	Sets out an initial consideration of ICZM and considers key definitions of the coastal zone. However, much of the work in this report is now outdated. A review with the GOBH should be undertaken to assess where any potential outcomes of this report were potentially implemented.	Much of the information is outdated and should be treated with caution.	Much of the information is outdated and should be treated with caution.	1,2,3,4,5,6	**Focussed Background Data**
Bahamas Country Profile (2002)	This report looks at the UN Agenda 21 chapters form the United Nations Conference on Environment and Development In Rio de Janiero in 1992. It provides a status update of the chapters with regards to: ▪ Decision-making ▪ Programs and Projects ▪ Status ▪ Capacity building, education and training ▪ Information ▪ Research and technologies ▪ Financing ▪ Cooperation It must be noted that much of this information, although useful, is likely to be out of date. A new profile is potentially required for The Bahamas.	None.	None.	1,4,6	**Limited Use**
40th Anniversary of The Bahamas proposal for The Expansion of The Protected Area System of The Commonwealth of The Bahamas	The Bahamas Gap Analysis, which is a part of the Protected Areas Master Plan, recommended that establishment of protected areas in some localities would contribute significantly, both in biodiversity coverage and in maintaining connectivity. New marine / coastal protected areas declared and improved management - since 2008, six marine protected areas have been declared in The Bahamas. The Bahamas had 758,684 hectares (2929 sq. miles) of marine	Site specific information.	Site specific information.	1,2,3,4,5,6	**Key Background Data**

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
	protected areas, which are legally defined. This accounts for 3-5% protection of The Bahamas' near shore marine environment. Under this proposal, bearing in mind the recommendations of the Gap Analysis as well as taking into consideration stakeholder consultation, existing MPA proposals and the "40 for 40" campaign, 9 new Marine Protected Areas (MPA) sites and Park Expansions are proposed.				
The Global Environment Facility (GEF) – www.thegef.org	The Global Environment Facility (GEF) is a major funding mechanism for environmental projects globally. The Bahamas receives the majority of its funds for projects concerning the environment by utilising the GEF. Recently approved projects include The Draft National Environmental Policy for the Commonwealth of the Bahamas (2005) and Strengthening Access and Benefit Sharing (ABS), Bahamas, approved in February 2016 - to create and apply the enabling conditions for fair and equitable access and effective benefit sharing.	Projects under GEF are relevant for coastal risk studies and have been discussed individually within this literature review.	Projects under GEF are relevant for ecosystem service studies and have been discussed individually within this literature review.	N/A – see individual projects	Key Background Data

Table A.2: Review of available technical information from relevant literature – sector specific literature.

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
Policies/Acts					
Abstraction Policy (currently being produced)	We have been informed that this is currently being undertaken by the GOBH but do not currently have any further information on this policy.			1,4	Focussed Background Data
General Reports					
Indicators of Disaster Risk and Risk Management: The Bahamas (2011)	In order to improve disaster risk understanding and disaster risk management performance a transparent, representative and robust System of Indicators, easily understood by public policymakers, relatively easy to update periodically and that allow cluster and comparison between countries was developed by the Institute of Environmental Studies of the National University of Colombia, Manizales. The report presents	Presents information on hazards to The Bahamas in addition to economic and infrastructure vulnerability.	Limited reference to environment risk management.	1,2,3	Key Background Data

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
	the results for The Bahamas.				
CARIBSAVE Climate Change Risk Profile for The Bahamas (2012)	Looks at the projections of temperature, precipitation, sea surface temperatures; and tropical storms and hurricanes for the Bahamas which have been used in making expert judgements on the impacts on various socio-economic sectors and natural systems, and their further implications for the tourism industry. The CARIBSAVE Partnership coordinated a field research team with members from the University of Waterloo (Canada) and the staff from the Bahamas Meteorological Service to complete detailed coastal profile surveying on the island of Eleuthera and Harbour Island.	Summarises climate change information and looks at specific impacts on Abaco and Eleuthera. Primary data were collected and analysed to: 1. Assess the vulnerability of the livelihoods of community residents in the Abacos and the surrounding Cays to climate change; and 2. Project sea level rise and storm surge impacts on beaches on the island of Eleuthera and Harbour Island.	Broadly discusses potential impact of climate change on marine and terrestrial biodiversity and fisheries.	1,2,3,5	**Key Background Data**
Hurricane Joaquin Pathfinders Task Force After Action Report (2015)	Provides a description of the response that was undertaken to Hurricane Joaquin by the Pathfinders Task Force, giving an idea of the scale of disruption that occurred.	Provides an idea of the scale of disruption from Hurricane Joaquin.	None.	1, 2	**Focussed Background Data**
Bahamas National Trust Strategic Plan (2013-2017)	5 years strategic plan outlines how BNT plan to work with local communities and GOBH, the scientific sector and international organisations to achieve their goals through the implementation of six related programs. The core program is national park and protected areas management complimented by education and outreach programs.	Limited	Good examples of MPA work and how EBA needs to be embraced in the process.	1,2,5	**Focussed Background Data**
The Bahamas Country Risk Profile (2013)	Provides and outline of the earthquake and tropical cyclone risk profile for The Bahamas. It aims to provide decision makers with a clear picture of the key risks which the country faces in order to guide national catastrophe risk management and inform decision making for both risk reduction and risk transfer.	Uses remote sensing data alongside economic and demographic statistics to generate the density and value of physical assets at risk in The Bahamas.	None.	1, 2	**Focussed Background Data**
Coasts at Risk Index (*accessed* 2016)	When it comes to the risks facing coastal nations, Caribbean countries are among the most vulnerable in the world, according to the Coasts at Risk index, which measures the risks such nations face around the world.	The Coasts at Risk Index, developed by The Nature Conservancy, the Coastal Resources Center and the United Nations	None.	2,3	**Focussed Background Data**

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
	This article presents the top 20 countries in the world in the Coasts at Risk Index.	University, assesses the risk of coastal nations exposed to natural hazards like floods, tsunamis and sea level rise, and where environmental degradation of coastal resources contributes to this risk, with two main factors: exposure and vulnerability.			
Draft Economic Assessment Report from Hurricane Joaquin – IDB	This report summarises the economic damages from across the key islands affected by Hurricane Joaquin under Social Sectors (health, education, housing and public buildings), Infrastructure Sectors (roads, airports and docks, power, telecommunications and water and sewerage) and Productive Sectors (tourism and fisheries). The estimated total damage to the affected islands is $104,788,224.	Important information around the potential impacts from Storm Surges, particularly for the Islands of Acklins, Crooked Island, Long Island, Run Cay and San Salvador.	Limited information included on environmental loss. However health and education impacts are covered in Social Sector damages.	1,2,3,4,5?	**Key Background Data**
Economy Profile (2016) - The Bahamas	The Report sheds light on how easy or difficult it is for a local entrepreneur to open and run a small to medium-size business when complying with relevant regulations. The Report presents the data for the labour market regulation indicators for The Bahamas. This report gives some background information regarding potential institutional difficulties within The Bahamas.	None.	None.	1,4	**Limited Use**
The Tsunami and Coastal Hazards Warning System for the Caribbean and Adjacent Regions (*accessed* 2016)	A presentation providing an overview of the role of UNESCO/IOC in CARIBE EWS, which aim to put a tsunami and earthquake warning system in place for the Caribbean.	Assesses seismic data availability within the Caribbean.	None.	2	**Limited Use**
Climate Change Enabling Activity (Additional Financing for Capacity Building in Priority Areas), UNDP (GEF project)	Phase II is intended to provide for the continuity of the National Climate Change Program in The Bahamas by addressing weaknesses and areas not covered by the initial efforts. In many ways this is testament to the fact that national capacity as a result of training and awareness has been enhanced to the point where the strengths and weaknesses of the initial Enabling Activity project design have been identified. The continuity of the project would focus on the further	Provides a link to climate change adaptation aspect of ICZM and coastal management.	Limited.	1, 2, 4	**Focussed Background Data**

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
	development of national capacity through, the review of technological needs, capacity building in systematic observation networks and in the area of emission factors for a small island economy.				
Assessment of Capacity Building Needs to Conserve Biological Diversity and Preparation of a Second National Report to the CBD, UNEP (2003)	Add-on funding would support the Bahamas Environment, Science and Technology (BEST) Commission, to obtain national consensus on mechanisms needed to build capacity to manage and conserve biodiversity; expand on its initial participation in the CHM; and prepare a second national report to the CBD	Limited specific coastal management assessment.	Very important for setting up the needed legislative capacity for capturing work to enhance biodiversity and other ecosystem services.	1, 5, 6	**Focussed Background Data**
Enabling Activities for the Stockholm Convention on Persistent Organic Pollutants (POPs): National Implementation Plan for The Commonwealth of The Bahamas, UNEP, 2007	The project objectives were: i. Enable the preparation of the National Implementation Plan with respect to POPs in The Bahamas; ii. Assist The Bahamas in meeting its reporting and other obligations under the Convention; iii. Strengthen The Bahamas national capacity to manage POPs specifically and chemicals generally.	Some link to the management of waste and pollution and linking with NMP.	Associate with pollution and run-off problems which is likely to be a key area of justification for works relating to assessment of ecosystem services.	3, 5	**Limited Use**
Promoting Sustainable Energy in the Bahamas, IADB, (Project completion 2014)	The general objective of the this project was to promote and support the development and implementation of sustainable energy sources in the Bahamas providing alternatives to reduce dependency on imported fossil fuels.	Limited.	Limited	2, 4	**Limited Use**
Implementing Land, Water and Ecosystem Management in The Bahamas, UNEP, (submitted in 2014, PIF approved 2016)	The expected outcomes are the development and implementation of integrated, innovative technical solutions for the maintenance of ecosystem health for East Grand Bahamas; Strengthening of national environmental monitoring and evaluation systems; Strengthening of the enabling environment in support of policy, legislative and institutional reforms and increase of capacity for sustainable natural resource management; Enhancing knowledge exchange, best practices, replication and stakeholder involvement in natural resource management.	Limited direct interaction with coastal management.	Focuses on ecosystem health and particularly East Grand Bahama (one of the pilot sites in this project) – important for any coastal protection works to combine with data and recommendations from this Report.	1, 2, 3, 5, 6	**Focussed Background Data**

Table A.3: Review of available technical information from relevant literature – site specific literature.

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
General Reports					
Social-Ecological resilience on New Providence (The Bahamas) (2011)	This report presents results from a field trip undertaken be The University of Hamburg. During this trip several interviews and site visits were undertaken on New Providence and the results were collated to provide information on the resilience of the environment and social indicators on New Providence.	None.	Discusses the importance of coral reef and mangrove ecosystems to shoreline protection however does not provide new information.	1,3,5	**Focussed Background Data**
Small Hope Bay – The Cycle of Casuarina-Induced Beach Erosion (2005)	Uses example from Small Hope Bay area of North Andros. Research looked at damage from hurricane Michelle in 2001 and the potential role of the Casuarinas in beach erosion.	Research suggests that presence of Casuarinas could potentially increase beach erosion as they trap sand that has been moved during a storm and do not allow the beach to naturally re-distribute sand and recover.	An interesting view of a potentially damaging role of the Casuarina trees.	1,2,3,6	**Focussed Background Data**
Coastal erosion around San Salvador, Bahamas: A field trip guide (2006)	Records information from a study of the coast of San Salvador, however also highlights how many of the observations can also be applied elsewhere in The Bahamas. The study concentrates on coastal erosion as the most serious aspect of coastal processes from a human perspective, and suggests that in many cases it is promoted, or even initiated, by human action. The report provides a good review of current coastal protection measures which may or may not function as well as they can.	No new data presented around coastal risk.	None.	1,3,6	**Focussed Background Data**
IDB Andros Project including the coastal vulnerability modelling (currently being undertaken)	A Project being undertaken by the IDB. Information and data for this Project has been shared with Mott MacDonald however much of the information is site specific to Andros. This information could be used as an example of developing databases for other islands.	Site specific information.	Site specific information.	1,2,5	**Focussed Background Data**
Pine Islands documents (GEF Project Document 2015)	A project which is being led by the Forestry Unit with Physical Planning, BEST and Ministry of Agriculture. Aim is to incorporate the importance of forestry and mangroves within planning. It focuses on four sites on: Abaco, Andros, New Providence and Grand Bahama.	Limited site specific reviews of coastal risk.	Yes but all site specific information – currently ongoing so much of the information and data is not currently available.	1,2,5,6	**Focussed Background Data**

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
	Within this there will be a mangrove and rehabilitation study including ground trothing of data.				
Scenario development/ modelling for the Andros Project (2015)	Scenario development has been undertaken by the Stanford Team looking at intensive to low levels of potential development and impacts of this. The preliminary modelling has been done. There currently has been a lot of information collated for Andros and therefore it could be a beneficial site to have as a pilot study – could potentially replace one of the other sites (discussed in the meeting with OPM). Ministry of Works are also involved in this project and have a lot of photos – some showing the old locations of sea walls.	Site specific information.	Site specific information.	1,2,5	**Focussed Background Data**
Inception report for Emerging Sustainable Cities Project (2015)	This is an IDB funded project being undertaken by consultants ERM with the key contact being Peter Rawlings. This project is for urban centres and is focussed on New Providence. It is looking and compiling indicators such CO2 and greenhouse gas emissions in addition to indicators such as sanitation/waste water and GDP. It will then look to bring these together and see how the urban centres score and where there are needs for improvements looking at: ▪ Mobility ▪ Sanitisation ▪ Energy ▪ Hazard Planning ▪ Housing	Some information collected on hazard planning.	None.	1,2,4	**Limited Use**
Sustainable Exuma Project (2015)	Data from the Sustainable Exuma project (recently completed) represents a valuable source of information, but for Exuma islands only. The model approach for this work (completed by Harvard Graduate School and Design) could potentially be replicated to other Family Islands.	Site specific information.	Site specific information.		**Limited Use**
Environmental Impact Assessment for The Baha Mar	The Environmental Impact Assessment (EIA) evaluates potential environmental, social, economic, cultural, and natural impacts of the proposed Baha Mar Resort	Site specific information (New Providence Island)- Environmental information,	Site specific information (New Providence Island)- Environmental information,	1,2,3,5,6	**Focussed Background Data. (valuable,**

Report/Project Name	Aim of Report/Information provided	Coastal Risk Information	Ecosystem Services Information	Information relating to the TAC Criteria	Category of Relevance
Resort Project, July 2012 - Littoral Evaluation Report Baha Mar Resort Project Cable Beach Nassau, Bahamas, March 2006	Project. The proposed project involves the renovation of the existing Radisson Cable Beach Resort and Wyndham Nassau Resort and Crystal Palace Casino properties and the development of new hotel and residential units and other facilities at the existing, developed Cable Beach site. The environmental impact analysis examines the change in impacts due to the redevelopment of existing developed areas as well as the potential impacts from the development of facilities in undeveloped areas. There is lot of information about environmental conditions and characteristics included. However their validity at presence shall be checked.	Coastal numerical model and Water quality	Coastal numerical model and Water quality		**but site limited)**
Environmental Impact Assessment for Exploratory Drilling in the Bain, Cooper, Donaldson and Eneas Blocks, Offshore The Bahamas **Bahamas Petroleum Company Plc., March 2012**	It is an Environmental Impact Assessment (EIA) which includes a lot of environment and socioeconomic information. The Blocks are located offshore The Bahamas, southwest of Andros Island adjacent to the marine border with Cuba. There are a number of sensitive coastal areas facing the Blocks including: beaches, estuaries, mangroves and protected areas. Potential project impacts and other baseline environmental and social conditions are described and assessed.	Site specific information	Site specific information	1,2,3,5	**Focussed Background Data.**

A.3 Regional scale literature review

Table A.4: Regional Scale Literature Review

Name of Regional Project	Relevance to Risk Resilient ICZM in The Bahamas
Caribbean Planning for Adaptation to Global Climate Change (CARICOM), World Bank,1997/2002. The overall objective of the proposed project is to build capacity in the CARICOM Small Island Developing States (SIDS) to develop Stage II adaptation strategies and measures, according to the United Nations Framework Convention on Climate Change (UNFCCC), the guidance issued at the Conference of Parties, and building on the outputs of the National Communications. This will be sought through support to: (i) the mainstreaming of climate change considerations into development planning and sectoral investment projects; (ii) appropriate technical and institutional response mechanisms for adaptation to global climate change; and (iii) regional climate change monitoring and modelling.	The Bahamian pilot projects was: Coral reef monitoring for climate change (Bahamas, Belize, and Jamaica). Establishment of coral reef monitoring protocols – This resulted in a significant increase in monitoring and early warning capabilities in Bahamas.
A Participatory Approach to Managing the Environment: An Input to the Inter-American Strategy for Participation (ISP), UNEP, 2000. The project aims were to build capacity within the countries of the Americas for the successful incorporation of public participation practices in sustainable development policy formulation and decision-making; to design mechanisms to improve communication and promote partnership among governments (national and local), nongovernmental organizations, community and local groups, the private sector, and academic organizations in these matters; and to provide technical assistance for exchanging information and developing methodologies for conflict resolution and consensus building.	Useful for public participation, but now very dated and staffs trained will have left office.
Caribbean Renewable Energy Development Program, UNDP, 2004. This project aimed at removing barriers to renewable energy utilisation in the Caribbean. Through specific actions to overcome policy, finance, capacity and awareness barriers it is estimated that the contribution of renewable energy sources to the region's energy balance will be significantly increased. At that time renewable energy provided less than 2% of the region's commercial electricity. It was estimated that due to the planned barrier removal activities the share of renewable energy could reach 5% by 2015. This would imply annual reductions of CO2 emissions by some 680,000 tons. Part of the GEF funding was used through non-grant instruments to remove incremental risks related to RE investments thus improving the cost-effectiveness of the GEF resource utilisation.	Minimal relevance to risk resilient ICZM in Bahamas going forward into 2017 onwards. Renewable energy not focused on as a priority topic.
Caribbean: Mainstreaming Adaptation to Climate Change (MACC), World Bank, 2003/2009. The Mainstreaming Adaptation to Climate Change (MACC) project was implemented from 2004 to 2007 by the World Bank, with funding of USD $5 million from GEF. The overall objective of the proposed project was to build capacity in the CARICOM Small Island Developing States (SIDS) to develop Stage II adaptation strategies and measures, according to the United Nations Framework Convention on Climate Change (UNFCCC) and the guidance issued at the Conference of Parties. This was sought through support to: (i) the mainstreaming of climate change considerations into development planning and sectoral investment projects; (ii) appropriate technical and institutional response mechanisms for adaptation to global climate change; and (iii) regional climate change monitoring and modelling. By the time that the project had closed, it was determined that only three countries (The Bahamas, Jamaica, and Trinidad & Tobago) out of the 12 participating countries had sufficient in-house expertise to implement the digital SLR/climate monitoring network	A coral reef monitoring pilot program was conducted in one coral reef habitat each in the Bahamas, Belize, and Jamaica. Information exchange and dissemination workshops were not conducted, diminishing the degree of take-up by other countries in the region.
Integrating Watershed and Coastal Area Management (IWCAM) in the Small Island Developing States of the Caribbean, UNEP, 2006/2011. The overall objective of the	A National Report on IWCAM for the Bahamas was prepared in

Name of Regional Project	Relevance to Risk Resilient ICZM in The Bahamas
proposed project will be to assist participating countries in improving their watershed and coastal zone management practices in support of sustainable development. The project will include the following components addressing areas of priority concern: coastal area management and biodiversity; tourism development; protection of water supplies; land based sources of pollution; climate change. Activities undertaken during the full project will include, amongst others, demonstrations in the fields of marine pollution reduction and waste management, land use, soil degradation and watershed management. Addressing water resources management and conservation under conditions of stress may include pilot projects demonstrating innovative approaches to: water storage, distribution, treatment and re-use, and to conservation of scarce resources in high demand sectors such as tourism.	2002 by ICF Consulting which set out the baseline for future ICZM strategy focus areas. Andros was selected as a demonstration island. The primary objective was to demonstrate active groundwater recharge area protection through the development of a Land and Sea Use Plan.
Building Wider Public and Private Constituencies for the GEF in Latin America and the Caribbean: Regional Promotion of Global Environment Protection through the Electronic Media, UNDP, 2001/2004. One of the key aims of this project is to increase public awareness of global environmental issues and international environmental agreements (MEAs) and to increase motivation, interest and participation of general public and Latin American & Caribbean owners of SMEs in global environment issues, and in replicating environmentally sustainable initiatives. This multi-focal project began implementation in 2001 and officially ended on 29th February 2004.	Project too old to be of direct relevance to the risk resilient ICZM project in Bahamas.
Sustainable Conservation of Globally Important Caribbean Bird Habitats: Strengthening a Regional Network for a Shared Resource, UNEP, 2003/2007.The development objective of this project was that the conservation status of globally important sites for biodiversity in the Caribbean was enhanced through strengthened local and national partnerships and increasingly aware national and international networks of public and private sector stakeholders and decision-makers. The project was aimed at enhancing cooperation, communication and consensus among biodiversity conservation stakeholders through the coordination of a strengthened network of NGO, government agency and regional institution partnerships.	BNT were the co-executors of the project for Bahamas. Notable successes included the set-up of Important Bird Areas (IBAs) in Bahamas which included significant funding from the corporate sector in the Bahamas. Focus placed on Abaco and Harrold and Wilson Ponds.
BS Regional Project for Implementing National Biosafety Frameworks in the Caribbean Sub-region - under the GEF Biosafety Program, UNEP, 2008/2011. The key aim of this project was to implement effective, operable, transparent and sustainable National Biosafety Frameworks (NBF) which cater for national and regional needs, deliver global benefits and are compliant with the Cartagena Protocol on Biosafety (CPB) in 12 Caribbean countries.	Minimal direct relevance to the focus of the current risk resilient ICZM in Bahamas going forward into 2017 onwards. Biosafety is not focused on as a priority topic.
Mitigating the Threats of Invasive Alien Species in the Insular Caribbean, UNEP, 2009/2014. Globally significant ecosystems, species and genetic diversity preserved in the Caribbean region through reduction of risk from invasive alien species.	Minimal direct relevance to the focus of the current risk resilient ICZM in Bahamas going forward into 2017 onwards. Invasive alien species are not focused on as a priority topic.
Disposal of Obsolete Pesticides including POPs, Promotion of Alternatives and Strengthening Pesticides Management in the Caribbean, FAO, 2014/2015. To promote the sound management of pesticides in the Caribbean throughout their life-cycle in ways that lead to the minimization of significant adverse effects on human health and the global environment	Minimal direct relevance to the focus of the current risk resilient ICZM in Bahamas going forward into 2017 onwards. POPs are not focused on as a priority topic.
Support to Preparation of the Third National Biosafety Reports to the Cartagena Protocol on Biosafety - GRULAC and CEE REGIONS, UNEP, 2015. To Assist GEF-Eligible Parties to the Cartagena Protocol on Biosafety to prepare and make timely submission of their Third National Reports on measures that each party has taken to implement the Protocol in line with Article 33.	Minimal direct relevance to the focus of the current risk resilient ICZM in Bahamas going forward into 2017 onwards. Biosafety is not focused on as a priority topic.
Biodiversity Data Management Capacitation in Developing Countries and Networking Biodiversity Information, UNEP, 1999. The overall objective of the Biodiversity Data Management Project was to enhance the capacity of developing countries in data and	In the Bahamas, no regional linkages were established by this project. The project did not

Name of Regional Project	Relevance to Risk Resilient ICZM in The Bahamas
biodiversity information management to support the implementation of the Convention on Biological Diversity. It conducted a national "institutional survey" which reported on the national capacity; prepared a "national plan" for the management and application of biodiversity data, developed a series of "basic guidelines" to support efficient information management; and a "resource inventory" of available methods and technologies which could be drawn upon to assist data management.	develop global linkages beyond learning to access and use the Internet for specific searches. The only global links created thus far have been between the Bahamas, UNEP and WCMC.
Biodiversity Country Studies - Phase I, UNEP, 1995. The primary objective of the Biodiversity Country Studies was to gather and analyze the data required to drive forward the process of developing national strategies, plans, or programs for the conservation and sustainable use of biological diversity and to integrate these activities with other relevant sectoral or cross-sectoral plans, programs, or policies.	Report for Bahamas was completed in 1995 and can be accessed at http://www.best.gov.bs/wp-content/uploads/2016/03/Bahamas-NAR.pdf

A.4 Climate Change Adaptation Review

This Section sets out a policy, legislative and institutional mapping and analysis to explicate on the degree to which climate change adaptation (CCA) has been genuine integrated and mainstreamed, and make recommendations for possible improvements.

The first Section undertakes a policy/legislative review:

1. Analysis of national dedicated policy/strategy on adaptation.
2. Analysis of 2nd National Communication to UNFCCC.
3. Look at the Intended Nationally Determined Contribution (INDC)
4. An examination of the degree to which sectoral policies and legislation (including all climate relevant/sensitive sectors in the Bahamas) include provision on climate change issues. (National centrally enacted sectoral policies and legislation, as well as relevant policy/legislation at a sub-national level. Main sectors are: Tourism, Financial Services, Agriculture very small sector (1-2% of GDP)
5. Analysis of the degree to which national development policies take account of an integrate climate change issues/are linked with climate change policy/strategy.
6. Where appropriate, relevant supplementary policies in the environmental sphere have been reviewed.

The second section sketches out the principal institutions that deal with CCA, and will clarify their roles and responsibility as far as possible. This information has then been taken forward as part of the Institutional Assessment Report (Appendix G).

For Part 1 a matrix has been developed that offers both a qualitative analysis (through detailed narrative gleaned from the review/analysis of the relevant documents), and a quantitative score assigned, so that the degree to which CCA has been incorporated can be quickly identified. The scores are based on the following definitional categories:

- 1- Business as Usual: Little or no evidence that climate change issues and activities (adaptation only, not mitigation) have been integrated;
- 2- Nascent: Limited evidence that climate change has been considered and integrated effectively;
- 3- Established: Clear provision for the management of climate change risks and opportunities.

Each score is informed and substantiated in the captured narrative.

Part 2 is a descriptive account of the institutional framework based on the desk research.

A.4.1 Part 1 – Policy and Regulatory Framework Review

Table A.5: Policy and Regulatory Framework Review of Climate Change Adaptation in The Bahamas

Reviewed Document	Narrative	Score Assigned
Intended Nationally Determined Contribution (INDC) Under the UNFCCC (communicated Nov. 2015)	The INDC states at the outset that it has the dual objective of adaptation and pursuit of a low-carbon pathway, and adaptation features as a stand-alone key section of the document (unlike a number of other INDCs). Whilst adaptation considerations are well integrated into the document, the sectoral policy endorsements (see pages 4-5) are rather weak for certain sectors and there is little by the way of concrete recommendations Rather a recognition that adaptation is to be integrated into sectoral policy, namely Agriculture, livestock development and Fisheries, Tourism, notably Coastal and Marine Resources and Fisheries, Energy. However, for certain sectors – Health, Financial and Insurance Sectors, Forestry, Human Settlement, Transportation and Water Resources – have better developed adaptation policy options. However, it should be noted that the INDC is indeed a high-level policy document, and a statement of intent as opposed to a detailed national climate change strategy.	3
2nd National Communication to the UNFCCC (communicated November 2015)	The 2nd national communication includes a vulnerability and adaptation assessment (V&A) report - as provided by the UNFCCC guidelines for the preparation of national communications and followed a consultative process involving key stakeholders and/or sectors; and a modelling approach using climate change and sea-level rise projections for different time horizons in the future. This indicates that adaptation planning in the national communication is likely to be robust and appropriate for the specific context of the Bahamas, and the approaches to the vulnerability and adaption assessments are well detailed in the document. Not only this, but Chapter 6 details specific steps and resources required for adaptation measures including capacity / technical resources and fiscal measures, as well as detailing specific projects – this is well thought through.	3
2005 National Environmental Management and Action Plan (NEMAP)	The NEMAP was prepared for the government (prior to the National Policy for the Adaptation to Climate Change detailed immediately below) to identify gaps and deficiencies in meeting its international environmental commitments and in addressing other environmental management issues. It was prepared to provide a baseline to evaluate the effectiveness and efficiency of its capacity development efforts to address these gaps and deficiencies, and looked at existing environmental management structure, including legislation, policies and guidelines, institutions, financial resources, human resources, information management and compliance and enforcement. It also recommended specific actions for moving forward. Specifically, it is acknowledged that climate change measures are being strengthened e.g. through the National Policy for the Adaptation to Climate Change, but is otherwise lacks any specific substantive detail on adaptation needs.	2
National Policy for the Adaptation to Climate Change (2005)	The preamble clearly states that there is a focus on adaptation, and furthermore that this is clearly linked to national development aspirations. The policy sets out in relatively good detail the vulnerability of The Bahamas to the anticipated impacts of climate change, as sub-divided by sector. It also includes as assessment of adaptation capacity, as well as recommending strategies and a coordinated response for dealing with the negative impacts of climate change. In addition, the policy examines some of the possible impacts on: coastal and marine resource and fisheries, terrestrial biodiversity resources, agriculture and forestry, human settlements and human health, water resources, the energy and transportation sector, as well as on tourism and the finance and insurance sectors. The policy provides a plan of action for addressing such impacts, and outlines issues around capacity/capability. Adaptation policy goals are clearly set	3

Reviewed Document	Narrative	Score Assigned
	out, as are specific sectoral policy directives. These are however high-level, with room for more substantive detail.	
National Energy Policy (2013)	From a general perspective, there is a clear acknowledgment of climate change issues, particularly those revolving around mitigation. For example, one of the principal policy objectives is to 'to protect the environment and mitigate climate change'. There is no specific provision on adaptation however, and indeed lack of specificity of climate change provision.	2
Forestry Act (2010) (as amended by Forestry (Amendment) Act, 2014)	There is no explicit mention of climate change in the Act, and no express mention of adaptation (or indeed mitigation).	1
Sustainable Tourism Policy (1994)	Text of policy not available online – could not be reviewed. The 2nd National Communication to the UNFCCC states '[The] Ministry of Tourism has no existing climate change policies, but it supports the national climate change policy. Priorities include conserving the natural resources of The Bahamas and making tourism thrive. Sustainable tourism guidelines exist that are provided to developers when new projects are presented to the Ministry for comment.'	N/A
The National Wetlands Policy of the Bahamas (2004)	Climate change is mentioned, but this is merely a cursory inclusion, and there is no concrete policy provision. There is no inclusion of adaptation measures.	1
Regional Framework for Achieving Development Resilient to Climate Change (2009-2015) (regional policy in conjunction with CARICOM countries)	Approved in July 2009, the Regional Framework defines CARICOM's strategic approach for coping with climate change and is guided by five strategic elements and some twenty goals designed to increase the resilience of the CARICOM Member States' social, economic and environmental systems. It provides a roadmap for action by member states and regional organisations over the period 2009-2015. Adaptation is well reflected in the document, and is explicitly linked with national development. Indeed, one of the four main strategies is to mainstream climate change adaptation strategies into the sustainable development agendas of CARICOM states. Furthermore, financing need for adaptation is identified as key issue. The document features well thought through concrete policy provision on adaptation.	3
Vision 2040 – national development plan	Still under development – not available for review.	N/A
Draft National Environmental Policy of the Commonwealth of the Bahamas	This policy does not appear to have been published as a final policy document, but is useful to look for indicative purposes. Notably the document is short at only 5 pages, and features only one mention of climate change, and no actual policy provision for adaptation.	1
National Biodiversity Strategy and Action Plan (1999)	The Plan states that plants can act as carbon sinks, and acknowledges their importance for climate change in this respect. The Plan states that there have been a number of institutions established, but this can be taken to be more of a recapitulation of current arrangements, rather than concrete policy provisions. With specific reference to adaptation, it is acknowledged that the BEST Commission have a critical coordination role to play in tackling vulnerabilities. The Plan is otherwise silent on issues of adaptation.	1
Mid-year Budget	Given that the financial services sector is important for The Bahamas, fiscal policy has been quickly reviewed to determine how climate change has been integrated; this has	N/A

Reviewed Document	Narrative	Score Assigned
Statement 2015/16	again been included for indicative purposes only as a full review of monetary and fiscal policy is beyond the purview of this exercise. There is a singular mention of climate change, but the statement is threadbare on actual detail, and simply states that 'work is ongoing'.	

A.4.2 Part 2 – Institutional Framework Review

Table A.6: Institutional Framework Review of Climate Change Adaptation in The Bahamas

Institution	Narrative	Score Assigned
The Bahamas Environment, Science & Technology (BEST) Commission	(Due to constraints posed by desk review only i.e. in the absence of primary research, it is difficult to comment with authority on the efficacy of the BEST Commission. Any comment on effectiveness is gleaned from secondary sources.) The Bahamas Environment, Science & Technology Commission also known as the BEST Commission was established in 1994. The BEST Commission manages the implementation of multilateral environmental agreements and is the focal point for such agreements. BEST Commission reviews environmental impact assessments (EIA) and environmental management plans (EMP) for development projects. The BEST Commission coordinates the review of commercial, industrial, and residential development projects under consideration by the Government of The Bahamas. The team also evaluates research permit applications for scientific investigations involving or affecting natural resources within The Bahamas. In addition, the team reviews the environmental aspects of various government infrastructure projects and responds to queries regarding the environment and environmental planning and protection. With respect to adaptation, BEST has the responsibility for awareness raising, training, and advising on legislative and institutional framework. BEST had a Board of Directors which includes representation from various Government agencies including Ministry of Tourism, Ministry of Foreign Affairs, Department of Agriculture, Department of Environmental Health Services, Department of Fisheries, Department of Physical Planning, and the Water and Sewerage Corporation. This would seem to suggest that BEST was helping to mainstream climate change adaptation considerations across the Executive. However, the attendance at these meetings was often poor due to time constraints, and the Board was not reappointed after 2002, and has involved into a body with more technical expertise, and it is not clear if BEST now plays a role in mainstreaming across different line ministries. Nevertheless, as awareness of the significance of the environment in national development has risen, the Commission has evolved in an effort to meet the challenging task of achieving sound environmental management. Importantly however, BEST does not have any regulatory autonomy, and can only advise the government.	N/A – Scoring has formed part of the Institutional Assessment Report (Appendix G).
The National Climate Change Committee	The National Climate Change Committee (or NCCC), was formed as a sub-committee of the BEST Commission, has tasked a public education and outreach subcommittee (or PEO subcommittee) with drafting and implementing a public education and outreach strategy on climate change.	As above.
National Emergency Management Agency (NEMA)	The Government of The Bahamas has a Disaster Management Committee composed of representatives from relevant Government Ministries and Departments and from the private sector. The Committee meets once a month throughout the year to discuss means to mitigate the impact of disasters, including hurricanes. Climate change is dealt with in the context of early warning systems. However, the 2nd National Communication to the UNFCCC does state that climate change should be more effectively integrated into NEMA's planning processes.	As above.

Appendix B. Data Gap Table

B.1 Overview

A review has been undertaken of the available data that is required for coastal risk management in The Bahamas in order to effectively implement a risk-resilient ICZM framework. This provides a good baseline understanding of previous projects and a platform on which to further studies. It has importantly informed the data gap analysis summarised in Section 3 of this Report and underpinned the development of Component A for the proposed risk-resilient ICZM Program.

B.2 Data Gap Review

The results and information from the data gap review have been collated in Table B1. This table has been structured to provide a summary of the data gap review by:

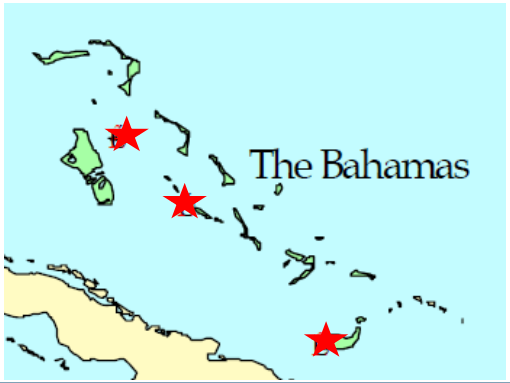
- Looking at the availability of existing data;
- Listing within which organisation any existing data is held;
- Detailing the overall spatial coverage of existing data;
- Outlining in summary where the key gaps are that need further consideration; and
- A brief summary on the importance of filling the data gaps within that category for implementation of the ICZM Program.

The data gap analysis has been categorised into five separate categories for ease of analysis:

- **Physical data:** Physical data has been categorised as data which is required to undertake risk-resilient ICZM coastal protection design of both hard and soft engineering structures. Design parameters required include topographic, bathymetric, metocean and geological data. Furthermore, base mapping photography data (incorporating aerial and satellite images) has been included in this category.
- **Asset data:** Asset data is classified for the purpose of this study as information on coastal management and coastal protection assets. This includes soft and hard engineering assets such as sea walls, revetments, offshore breakwaters, beaches and dune ridges.
- **Environmental data:** The environmental data category covers ecological data regarding key flora and fauna in the coastal zone for The Bahamas.
- **Social data:** Social data incorporates statistics and information about the population of The Bahamas living in the coastal zone.
- **Climate change data*:*** Inclusion of any future environmental and climate change data which could impact the coastal zone within The Bahamas.

Data Category		Existing data that has been looked at	Organisation that holds the data	Up to Date?	Publically Available?	National Coverage?	Good Quality?	Key Data Gaps for further consideration and importance of data for ICZM	Recommendation for ICZM
Physical Data	Topographic/ Elevation data	1999 contours and 2004 contours exist for a number of islands. However, there are inconsistencies and potential data quality issues with the 2004 contours (suggested from users of the data in The Bahamas).	Lands and Surveys Department	X	X	X	X	Without accurate topographic data, coastal protection structures cannot be to the required design criteria to withstand extreme water levels and climate change.	- Update the datum used for coastal protection management. - Look at use of remote sensing data to build topographic data in the short term for selected islands, and in the longer term on a national scale. - Collate data in one place for planning and management purposes.
		Shattuck datum – this is the reference point for elevations in The Bahamas and is located on Cable Beach, New Providence. However, the 'mean sea level' is constantly changing and therefore the reference point is changing (and is now approx. 2-3ft lower than it should be). This has led to the situation that in existing data sets there is no one consistent reference to mean sea level making designs very difficult.	Ministry of Works and Urban Development / Department of Meteorology	X	√	√	√		
		Recent LIDAR data (May 2015) is apparent for parts of the country (Andros only) as identified by USGS. Flight coverage is on land only and does not appear to cross the shoreline into the nearshore zone at any place in Andros (see image below) 	USGS - (http://glight.gsfc.nasa.gov/ext/maps/index.html)	√	√	X	√		
	Bathymetry	High level bathymetry is available from the admiralty charts.	Admiralty Charts - UKHO	√	√	√	√	It appears there are no nationally owned/coordinated data sets with a high resolution (<1km). Understanding of the bathymetry is not only required for the design of coastal near-shore and offshore structures but also to inform the modelling of the nearshore environment. This is required	- Look at using remote sensing data to determine a national scale bathymetry dataset. - Detailed bathymetry will still be required for specific engineering interventions at specific sites. - Collate data in one place
		Specific bathymetry is likely to be available, specifically around port areas or areas of structural development.	Private ports such as Freeport	?	X	X	?		
		BNGIS Centre have been put in contact with a group in Switzerland who may hold some bathymetry data for The Bahamas but this is ongoing work and it is unclear yet whether this exists.	Unknown – contact is through BNGIS Centre	?	?	?	?		

		Bathymetric data from 2014 on a 1km scale available from General Bathymetric Chart of the Oceans (GEBCO).	GEBCO	√	√	√	√	to increase understanding of processes driving climate change.	for planning and management purposes.
	Sediment Data	There are a number of scientists who come to the Bahamas to undertake sediment studies and some of them have been coming for a number of years.	The Bahamas National Trust has some of this data as do the BEST Commission.	√	√	X	√	It is understood that a national program/sediment study does not exist and one would help to understand sand/sediment movement and transport around the islands. Beaches and dune systems are some of the most important natural defences to coastal erosion and flooding. It is important to therefore have an understanding of the drivers to changes in sediment transport and supply.	- A study should be undertaken to provide a national understanding and summary of sediment supply, movement and deposition within The Bahamas. - Collate data in one place for planning and management purposes.
	Wave data	The Bahamas looked at gathering wave information through wave buoys a couple of decades ago but this was not a successful campaign.	N/A	N/A	N/A	N/A	N/A	There is limited data available. The Met Office has indicated that it would be useful to have wave buoys where the information can be accessed remotely. Details of the wave environment around The Bahamas are required to inform nearshore modelling and derive parameters for design to ensure the sustainability of resilience of designs of coastal protection structures.	- An Oceanographic Study undertaken to determine where wave buoys could be located and the methods/equipment to use to avoid issues from previous attempts. - Collate data in one place for planning and management purposes.
	Current data	Current data is held by NOAA from studies undertaken in the 1990s.	NOAA	X	?	?	?	We have not yet been able to get hold of this data to review the quality/coverage however there is no recent data available. Current data is required to inform sediment modelling and to inform coastal protection designs. Current data will inform sediment studies (see section above on sediment data).	- Look for opportunities to collect current data using same equipment collecting wave data. - Collate data in one place for planning and management purposes.
	Sea level data	A number of units were put on different islands to record data on water levels, however all but one have been destroyed/moved by storms and hurricanes. The one on Grand Bahama at Settlement Point still exists and is owned by the US government. This has about 15 years of data.	GOBH – Department of Meteorology	√	√	X	√	The Bahamas is missing an integrated, historic water level record. There are some historic data sets outside of the Settlement Point tide gauge, however it is often unknown by stakeholders who owns the data and how to get hold of the data. Sea level data is critical and underpins an understanding of average and extreme water levels which enables coastal protection structures to be produced to specific guidelines and return period events. This further underpins the	- An Oceanographic Study undertaken to determine where tidal gauges could be located and the methods/equipment to use to avoid issues from previous attempts. - Collate data in one place for planning and management purposes.
		The GOBH did not download any data from the previous units as it was all sent to the University of Hawaii. The University of Hawaii may therefore have some of the data still however it is likely to be short term and intermittent.	University of Hawaii - potentially	X	X	X	?		
		CPACC installed three gauges to look at water level	CPACC	X	?	√	X		

		monitoring (see below). This was part of a project funded by: GEF, World Bank, NOAA and Organization of American States. 						process of providing solutions which are most effective in relation to climate change.	
	Storm/ hurricane/ surge data	The BEST Commission have been undertaking a study, led by Keith Phillippe, looking at pre and post hurricane remote sensing/GIS data to see whether they can see the damage that has been caused including inundation of sea water. They have been using secondary data sets (such as USGS and FSA – Federal Space Agency in Russia) to create a BEST dataset. Temporal studies however are difficult at this scale due to a limited number of data sets and often a high enough resolution is not available.	BEST Commission	√	N/A	√	?	There could potentially be some data held by NEMA or elsewhere but this data appears to be held by various different organisations or tied up in reports. In design of coastal protection engineering, and during assessment of coastal hazard risks, understanding is needed regarding the most likely extreme events and the processes that drive these. Historic data can help determine probabilities of these events which in turn allows for the calculation of overall risk.	- Collate data in one place for planning and management purposes.
		The Bahamas National GIS (BNGIS) Centre is undertaking a study to look at the local scale of storm damage from Hurricane Joaquin in the Southern Islands. Storm surge inundation maps exist for Crooked Island, Acklins, Cat Island and Long Island.	BNGIS Centre	√	√	X	√		
		Hurricane Joaquin post hurricane reports including assessments of the damages incurred as well as data regarding the track of the hurricane, winds and surges experienced.	NEMA (though reports produced by a number of organisations).	√	√	√	√		
	Base mapping data – buildings, roads and land use	Infrastructure data bases within a GIS outlining streets and buildings. They are only visual tools which contain the outline of the buildings and no attributes. The information is spatially variable.	Lands and Surveys Department	√	X	X	X	Base mapping data is very spatially irregular and mainly focusses on New Providence and Southern Islands impacted by Hurricane Joaquin. The base mapping data that does exist largely only exists as a visual tool and does not hold information within the attribute layers and	- The base mapping and availability to use this as a tool for planning and management activities needs to be developed. - As part of a longer term goal and as part of the
		Land use plans - hard copy only – detailing broad land use of the islands. Only available from early 1990s.	Lands and Surveys Department	X	?	?	?		

		More detailed mapping of buildings and roads has recently been completed for the Southern Islands affected by Hurricane Joaquin including Long Island, Cat Island, Crooked Island, Acklins, Rum Cay, San Salvador Island, Exuma. Shapefiles exist outlining topographic features.	BNGIS Centre	√	√	X	?	can be unreliable. Base mapping information is required to inform Coastal Strategy Planning – particularly in The Bahamas where land use and land ownership is one of the key issues identified to ICZM planning.	Island Plans to be produced under the Planning and Subdivisions Act (2015) updated land use plans should be created within GIS.
	Coastline / Marine boundaries	A shapefile layer is held by BNGIS Centre which provides an outline of the coastline for The Bahamas. However this is taken from images of The Bahamas and therefore is likely to refer to a number of tidal extents.	BNGIS Centre	√	√	√	X	There is need for a common defined coastline boundary to be defined. Establishment of an accurate and consistent boundary for the coastline is integral for defining legislation and framework limits. Development of this could be undertaken in tandem with development of topographic data.	- As part of developing the baseline mapping and tools for coastal management, an updated coastline needs to be delimited and agreed upon nationally. - Collate data in one place for planning and management purposes.
		TNC have developed a coastline for The Bahamas.	The Nature Conservancy	√	√	√	?		
		BNGIS Centre has been involved in a Commonwealth desktop study to define the marine limits and maritime waters for The Bahamas – this is available in GIS vector formats.	BNGIS Centre	√	√	√	√		
	Waterbodies	A shapefile layer is held by BNGIS Centre which outlines the freshwater and coastal water bodies.	BNGIS Centre	√	√	√	√	Interaction between inland waterbodies and flooding under extreme events is an important consideration, particularly when climate change scenarios are introduced.	- Collate data in one place for planning and management purposes.
	Aerial photography	A range of aerial photography exists for specific islands, however the date, quality and coverage is islands specific. -2010 imagery exists for New Providence, however is of poor quality and is not accurate. -2007 imagery is available for Abaco. -Andros 1985 Aerial Photograph Index Map from flight lines Flight Lines 4 & 5, 10, 11, 12, 13, 14, & 15. – Historic photographs are available for determining coastline/land use change.	BNGIS Centre	X	√	X	X	There is a lack of up to date, good quality aerial photography for the majority of The Bahamas. Aerial photography is not only a useful tool for base mapping but can be used to track shoreline change of time, identify land use and habitat extents and to identify damage following storm surges or hurricanes.	- Collate up to date aerial photography in the short term for selected islands, and in the longer term on a national scale. - Collate data in one place for planning and management purposes.
	Satellite imagery	Open source satellite imagery is available from Google/Bing Maps/Landsat. However this can vary in quality and it is hard to get temporal consistency for a national coverage. - LANDSAT (1970s – present), 30m resolution - ASTER (2002 – 2011), 15m resolution - Rapideye for Andros Island (2009), 5m resolution - Hi resultion (<5m) for selected areas including	LANDSAT, ASTER, Rapideye, Quickbird, IKONOS and others.	√/X	√/X	√/X	√/X	There is a lack of coordination between satellite data and central repository for the data. BNGIS are currently working on collating this data. Satellite imagery is not only a useful tool for base mapping but can be used to track shoreline change of time, identify land use and habitat extents and to	- Satellite imagery to be used in combination with specific survey data to inform studies such as habitat monitoring.

		IKONOS (4m colour), Quickbird (2.5m colour) and Worldview-2 (2m colour).						identify damage following storm surges or hurricanes. Satellite imagery can be a cost effective way of getting data for large areas.	
		Satellite imagery has recently been obtained as part of the post hurricane Joaquin work for some of the Southern Islands through NEMA – including Long Island, Cat Island, Crooked Island, Acklins, Rum Cay, San Salvador Island, Exuma.	NEMA	√	√	√	√		
		Imagery is being sought for Andros/New Providence to help support the Pine Islands GEF project.	Forestry Department	√	X	√	?		
Asset Data	Coastal structures – location and condition	The Ministry of Works and Urban Development have an excel spreadsheet with a list of the structural assets, however this is in development and does not include coastal protection/defence assets. Asset data is not spatial. It has been indicated that the Civils department started a similar process 4-5 years ago however this was potentially shelved and not sure what state this is in.	Ministry of Works and Urban Development	√	X	X	X	The asset data does not exist in a spatial format. Furthermore the asset data does not cover all of the coastal defence/protection structures. It is fundamental that the location and condition of coastal protection structures are understood and recorded for effective ICZM implementation, preferably in a GIS environment for most effective management. This allows planning of capital and maintenance spends to make coastal management as economically sustainable as possible.	- A coastal structures condition survey is required. - Long term- ongoing update and monitoring of structures is required. - Information on location, type and condition of coastal protection structures is required within GIS. - Collate data in one place for planning and management purposes.
		Locations of Docks on some Family Islands are available as GPS measured points.	BNGIS Centre	√	√	X	√		
	Beach profile/ condition data	None is currently known to exist however it is likely that some private developments may undertake their own monitoring in specific locations.	Private developments potentially – unknown.	?	X	X	?	The Ministry of Works and Urban Development confirmed that the GOBH do not currently undertake and beach profile monitoring or beach condition assessments. Beach and dune systems are an important aspect of The Bahamas' natural defence to coastal erosion and flooding, in addition to providing economic services related to tourism and social services relating to recreation. It is important therefore that they are regarded fundamentally as assets for similar reasons as outlined above for coastal structures.	- A beach monitoring survey is required. - Long term- ongoing update and monitoring of beaches is required. - Collate data in one place for planning and management purposes.
		Historic changes in shoreline has been assessed on the Andros Project using aerial images (see above for data availability)	Inter-American Development Bank	√	X	X	√		

	Sewage and Water Assets	The Water and Sewerage Company (WSC) have a GIS team who have mapped/are mapping the WSC key assets including major plants as well as pipe lines.	The Water and Sewerage Company	√	X	X	√	The mapping of assets has dominantly been undertaken for the New Providence assets in addition to areas of the larger Family Islands. The location of key assets is important for understanding the risk associated with those assets and to prioritise coastal protection works.	- Collate data in one place for planning and management purposes.
	Power and other infrastructure	Asset data is held by the individual corporations regarding the number and location of assets.	Individual corporations.	√	X	X	√	Data exists on a national scale but is not collated anywhere that is easily accessible by the Government. The location of key assets is important for understanding the risk associated with those assets and to prioritise coastal protection works.	- Collate data in one place for planning and management purposes.
Environmental data	Mangroves – extent and health	Mangrove habitats have been mapped by The Nature Conservancy using remote sensing data including IKONOS and ETM+ and are characterized by the presence of any of the four mangrove species: red mangrove (Rhizophora mangle), black mangrove (Avicennia germinans), white mangrove (Laguncularia racemosa), and buttonwood (Conocarpus erectus).	The Nature Conservancy	√	X	√	√	There is not really any data regarding the current status of mangrove health. There was some mangrove research which has been undertaken in the National Creeks and Wetlands Restoration Initiative.	- Long term habitat monitoring should be undertaken on a regular basis and changes observed. - Collate data in one place for planning and management purposes.
		The Bahamas National Trust has recently brought someone into the team to look specifically and mangrove restoration and produce a pilot listing of sites. No specific data available yet to discuss.	Bahamas National Trust	N/A	N/A	N/A	N/A		
	National Park data	Data is held by The Bahamas National Trust on National Parks covering: - Areas of the national park - Key sensitive species (flora and fauna) - Where applicable mapping of the blue holes and connections across islands has bene undertaken - Monitoring data - Maintenance plans - Zoning (part of management plan within parks)	Bahamas National Trust	√	√	√	√	National Parks are a good example of where the GOBH is looking at long term maintenance and sustainability of critical ecosystems in The Bahamas. These will need to be assessed with regards to coastal risk and climate change in island plans.	- Long term habitat monitoring should be undertaken on a regular basis and changes observed. - Collate data in one place for planning and management purposes.
	Coral reefs	Mapping of reefs has taken place by The Nature Conservancy (TNC).	The Nature Conservancy	√	X	√	√	Coral reefs are critical environments that interact and influence coastal processes. They provide extremely valuable Ecosystem Services and yet are extremely vulnerable to climate change.	- Long term habitat monitoring should be undertaken on a regular basis and changes observed.

		The Caribbean Planning for Adaptation to Climate Change (CPACC) carried out a detailed assessment of reef systems around Bahamas Under the Marine Ecosystems Services Valuation Project (ReefFix) the capacity was built in The Bahamas in the use of economic valuation methodologies that sustain the social, economic and environmental benefits of coral reefs. ReefFix is an Integrated Coastal Zone Management (ICZM) tool that works supports stakeholder analysis and socio-economic valuation with a view towards improving oversight of marine resources to meet commitments made by SIDS to increase coverage and effective management.	CPACC	X	√	√	√		- Collate data in one place for planning and management purposes.
		Classification of reefs at threat by World Resources Institute (2011)- categorises reef areas into four risk categories: Low, Medium, High and Very High. A sample from the interactive map for The Bahamas is presented below. 	World Resources Institute	√	√	√	√		
	Water quality	Information held by the Water and Sewerage Corporation – spatial data held within GIS.	The Water and Sewerage Corporation	√	X	X	√	Focus of data availability is in New Providence and Andros Islands. Development within the coastal zone can impact water quality and in turn important ecosystems as well as the tourism	- Collate data in one place for planning and management purposes.

		Measurements taken on spawning aggregations was provided by the Department of Marine Resources and verified by local community members in Andros to see how properties of the water will negatively affect nursery habitat, spawning, and reproduction.	Department of Marine Resources	√	√	X	√	industry.	
	Vegetation classifications, ecosystem services, species presence	Coverage and occurrence of key species within The Bahamas. The data is generally sporadic and led by local projects/conservation projects.	The Nature Conservancy	√/X	X	√/X	√/X	There lacks a consistent conservation dataset at the national scale – in particular species occurrence data including marine mammals and endangered species etc. The functions, services and health of the coastal zone of The Bahamas is critically linked to the health of the ecology within different environments. Management of the coastal zone needs to consider protection of aspects of these environments in the context of climate change. Furthermore, should these environments change with environmental changes, management techniques may also need to change and therefore the current baseline and processes driving change are important.	- Long term habitat monitoring should be undertaken on a regular basis and changes observed. - Collate data in one place for planning and management purposes.
		Coral reef extent and health – rapid assessment undertaken by Atlantic and Gulf Rapid Reef Assessment (AGRRA). Undertaken between 1997 and 2013. Health of reefs determined by assessment of 6 key indicators.	Atlantic and Gulf Rapid Reef Assessment (AGRRA)	X	√	√	√		
		Bahamas National Trust have a number of projects coming up over the next three years which will look at habitat mapping in GIS, ecosystem services, information on national parks, ongoing monitoring etc. No specific data available yet to discuss.	The Bahamas National Trust	N/A	N/A	N/A	N/A		
		Lobster Harvest Scenarios covering current baseline and future scenarios: business as, conservation approach to management, intensive development.	Part of Vision 2040 (Government of The Bahamas)	√	√	√	√		
		Polygon shapefiles showing geomorphic classes and then attributing with nomenclature. These units represent natural breaks in the system based on currents, larval connectivity, benthic habitat types and island/bank orientation. These data layers were compiled for a protected area gap assessment for the Bahamas. This project identified critical conservation targets and threats for these countries working with existing data layers from local governments filling data gaps.	The Nature Conservancy	X	X	√	√		

Social data	Land ownership	Land ownership data has been created by heads-up digitizing from 1:50,000m scanned vegetation and land ownership maps produced by the Department of Lands and Surveys in 1970.	The Nature Conservancy	X	X	√	X	Data is outdated. There are many complicated land ownership regulations on different Family Islands which can lead to disjointed coastal protection and inhibit ICZM.	- Under specific site optioneering the land use will need to be determined. - As part of a longer term goal and as part of the Island Plans to be produced under the Planning and Subdivisions Act (2015) updated land use plans should be created within GIS. - Collate data in one place for planning and management purposes.
	Property data (building location, size, age, definition)	Property locations are mapped for a number of Family Islands, depending where specific BNGIS Centre projects have been focussed. This includes New Providence as well as some of the Southern Islands through NEMA – including Long Island, Cat Island, Crooked Island, Acklins, Rum Cay, San Salvador Island, Exuma.	BNGIS Centre	√	X	X	X	The property data lacks attribute information behind the spatial layers (for example property type, address, etc.). Property data is required a sites highlighted for intervention to assess the risk, vulnerability and overall justification of studies.	- The base mapping and availability to use this as a tool for planning and management activities needs to be developed. - Collate data in one place for planning and management purposes.
	Population data	Population data and census data is available from the Department of Statistics of The Bahamas. Statistics also available on the population of individual settlements throughout The Bahamas. Included within this is: - Population of The Bahamas by Age - Dependency ratios and change over time - Future population estimates - Population by Island - Ethnic diversity of the population - Education profiles	Department of Statistics	√	√	√	√	Population data is required a sites highlighted for intervention to assess the risk, vulnerability and overall justification of studies.	- Specific island level and sub-island level social data will need to be developed for the optioneering of coastal interventions: + in the short term this will be undertaken for each Pilot Site. + in the long term this should be collated as part of the Island Plans to be produced under the Planning and Subdivisions Act (2015).
	Education statistics	Data and statistics on education is available through the Ministry of Education including: - Highly trained teachers - Investment in education - Actual expenditure on education - Pre-primary enrolment - Private v public school attendance	Ministry of Education	√	√	√	√	Education statistics are important to inform the baseline social indicators and therefore disaster risk management strategies that are appropriate and specific to the area.	- Specific island level and sub-island level social data will need to be developed for the optioneering of coastal interventions: + in the short term this will be undertaken for each

		- Results such as GLAT and BGCSE results - Result distribution between genders as well as subjects							Pilot Site. + in the long term this should be collated as part of the Island Plans to be produced under the Planning and Subdivisions Act (2015).
	Economic data	Economic growth rates, GDP and employment information is held by the Ministry of Finance.	Ministry of Finance, GOBH	√	√	√	√	Needs to be related to ICZM specific issues (such as potential loss from flooding etc.) to enable full justification and prioritisation of coastal protection works. Economic data is required a sites highlighted for intervention to assess the risk, vulnerability and overall justification of studies.	- In the short term - collate data in one place for planning and management purposes - In the long term this data needs to be assessed on the Island level as part of the Island Plans to be produced under the Planning and Subdivisions Act (2015).
		Economic and socio-demographic information (GDP total, population by age group and sex, consumption of all ozone-depleting substances etc.) is available the Economic Commission for Latin America and the Caribbean using CEPALSTAT.	Economic Commission for Latin America and The Caribbean	√	√	√	√		
	Economic impact from hurricanes	Damage figures in a number of different sectors including social sectors (health, education, housing and public buildings), infrastructure sectors (roads airports and docks, power, telecommunications and water and sewerage) and productive sectors (tourism and fisheries) is available from the Disaster Assessment Team, 2015 and presented in the IDB Report Assessment of the effects and impacts of Hurricane Joaquin which is currently in draft form.	NEMA / Inter-American Development Bank	√	X	X	√	Damage data is required a sites highlighted for intervention to assess the risk, vulnerability and overall justification of studies.	- Collate data in one place for planning and management purposes.
	Land resources	Land resource maps are held by the Land and Surveys department. Many of these are from the 1970s and are not available in a digital format.	Department of Land and Surveys	X	X	√	X	Up to date land resource maps are not available for the national scale of The Bahamas. There are many complicated land ownership regulations on different Family Islands which can lead to disjointed coastal protection and inhibit ICZM.	- Under specific site optioneering the land use will need to be determined. - As part of a longer term goal and as part of the Island Plans to be produced under the Planning and Subdivisions Act (2015) updated land use plans should be created within GIS. - Collate data in one place for planning and management purposes.

Climate change data	Storm surges	A storm surge atlas has been undertaken for north and northwest Bahamas but is not yet completed for the entirety of the Bahamas.	BEST Commission	√	X	X	√	The storm surge atlas has not been completed for the South Bahamas Islands. In order to assess the risks and create designs which are adaptable and sustainable in the face of climate change, potential changes that could occur in storm surges needs to be understood.	- Specific hazard mapping needs to be undertaken on an Island scale as part of Shoreline Management Plans. Could also in the long term be incorporated into Island Plans to be produced under the Planning and Subdivisions Act (2015). - Collate data in one place for planning and management purposes.
		For Andros, a GIS dataset contains a simulated hurricane model created from elevation data based on estimated storm surge heights. Elevation data was created by heads-up digitizing from 1:25,000m scanned topographic quadrangle maps produced by the Department of Lands and Surveys 1968-1975.	The Nature Conservancy	X	X	X	√		
	Modelling	Climate change modelling has been undertaken by Kathleen Sullivan Sealy and could be a valuable source of knowledge if this could be made available. However BNT suggest may be unlikely that we can get access to this data. No data has been specifically looked at.	Private ownership	N/A	N/A	N/A	N/A	No easily accessible climate change modelling is known to exist. In order to assess the risks and create designs which are adaptable and sustainable in the face of climate change, potential changes that could occur in the coastal environment needs to be understood.	- Specific hazard mapping needs to be undertaken on an Island scale as part of Shoreline Management Plans. Could also in the long term be incorporated into Island Plans to be produced under the Planning and Subdivisions Act (2015).
	Temperature rise/ Sea level rise	IPCC sea level rise data.	IPCC	√	√	√	√	Local variations unknown. In order to assess the risks and create designs which are adaptable and sustainable in the face of climate change, potential changes that could occur in water levels needs to be understood.	- Specific regional changes and predictions of sea level rise are needed in the long term. Water level data needs to be collated around The Bahamas to allow variations and trends to be understood. - Collate data in one place for planning and management purposes.
		Temperature increases for The Bahamas within the Climate Change Profile for The Bahamas	McSweeny et al (2010). UNDP Climate Change Profiles	√	√	√	√		
		Predictions made as to the impact of sea level rise in The Bahamas, indicating the extent of loss to other important industries, infrastructure, residential areas and natural habitats.	Simpson et al. (2009). An Overview of Modelling Climate Change Impacts in the Caribbean Region with contribution from the Pacific Islands	√	√	√	?		

Appendix C. Review of Coastal Management in The Bahamas

C.1 Introduction

C.1.1 Current coastal and beach management in The Bahamas

There is currently no specific coastal management unit or institution that exists within The Bahamas. The construction and maintenance of coastal protection structures is undertaken by the **Ministry of Works and Urban Development (MoWUD).** The asset information held by the structures team within the MoWUD covers all Government-owned structures however it is unlikely to cover all coastal protection structures[76]. Therefore specific coastal engineering is very limited in The Bahamas.

Much of the coastline of The Bahamas interacts with, or is owned by, private developments, namely: residential properties, hotels and ports. This makes coastal engineering practices in The Bahamas very fragmented and disjointed in many places. There are no specific guidelines relating to building structures within the coastal zone and different approaches are used by different people.

More recently, **The Bahamas Public Parks and Public Beaches Authority** (BPP&PBA) was set up in October 2014 under a specific statute[77]. It was created to assist the GoBH in fulfilling its commitment to "*establish green spaces throughout the country in order to further preserve the environment, and also to help this lead to greater employment for Bahamians, while creating a cadre of trained public officers similar to those employed with the United States Park Service*".

The functions of the BPP&PBA are to:

- control, plan, design, develop, administer, manage and maintain the public parks and public beaches designated by the authority;
- conserve the natural beauty and topographic features of public parks and public beaches;
- propagate, protect and preserve the animals, plants and other organisms within the public parks and public beaches;
- preserve objects and places of aesthetic, historical or scientific interest; to remove derelict objects from any public park or public beach or from public access to any public park or public beach;
- maintain public access to and to provide a lifeguard service at public beaches as it thinks fit; and
- maintain green verges and the facilities at public parks and public beaches.

This authority presents good opportunity for ownership over the management and control of beaches, however it does not cover beach protection structures and therefore ownership and responsibility for different aspects of coastal engineering needs to be clarified in the future.

C.1.2 Coastal Structures in The Bahamas

The following coastal structures have been seen in Bahamas on site visits and through consultation:

- Seawalls in Nassau Harbour, New Providence Island and Long Island;

[76] Ministry of Works and Urban Development (2016) *Personal communication*

[77] Bahamas Public Parks and Public Beaches Authority Act - BPP&PBA Act 2014

- Sloping Rock Revetments in New Providence;
- Coastal reclamations in Old Bahama Bay, West End, Grand Bahama;
- Concrete sloping wall at Eleuthera Glass Window Bridge approach embankments;
- Straight and Fishtail Groynes and Recharged Beach at Montagu Beach, Saunders Bay, Public Beach Treasure Cay, Gillam Bay, Abaco and Nassau, New Providence;
- Offshore breakwater at Baha Mar, New Providence;
- Concrete armoured Breakwaters at entrance to Nassau Harbour, New Providence; and
- Mangroves on the leeward side of many islands around The Bahamas.

From the understanding by the Project Team, the current structures used within The Bahamas and the general prevalence of these structures are as presented in Table C1.

Table C.1: Coastal protection structures that exist in The Bahamas and prevalence

Coastal protection asset	Low prevalence (only used in minimal locations)	Medium prevalence (used in a number of locations but not everywhere)	High prevalence (found along most of the coastline within The Bahamas)
Seawalls and Revetments			√
Breakwaters	√		
Groynes		√	
Soft alternatives (mangroves, dunes and coral reefs)			√

C.2 Review of Coastal Structures in The Bahamas

The major typical types of coastal structures are first briefly described and the review of the existing relevant types of structures in Bahamas follows.

C.2.1 Seawalls and Revetments

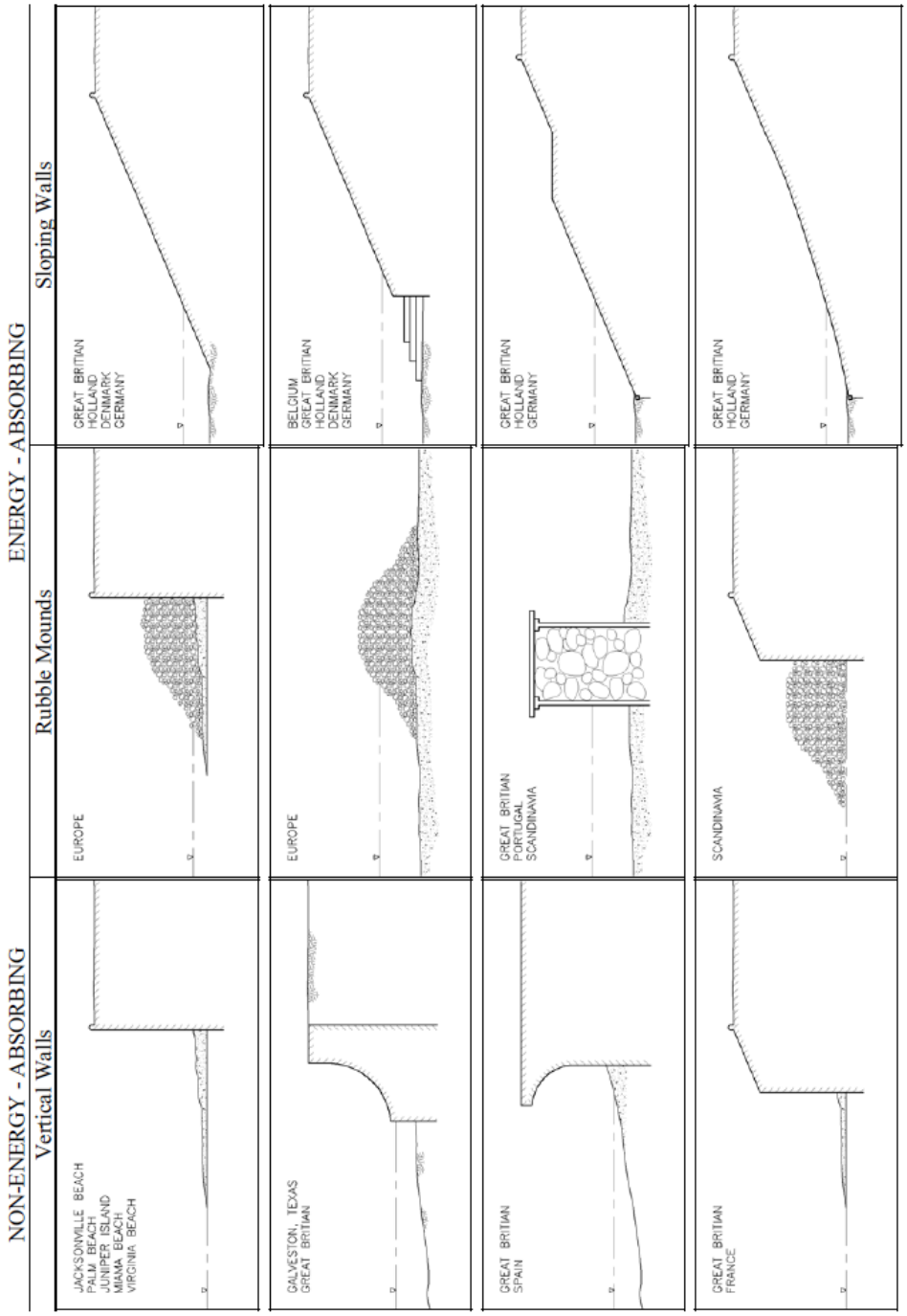
C.2.1.1 Brief overview of design, function and use

Seawalls are designed to prevent inland flooding from major storm events. When vertical, they are characterised non-wave energy absorbing, whilst with a sloping surface or rubble mound, they absorb part of the incident wave energy. The front face may also be curved or stepped to deflect wave run-up. Typical damage modes for seawalls include: toe scour leading to undermining; overtopping and flanking; rotational slide along a slip-surface below and shoreward of the seawall; and corrosion of any steel reinforcement. Typical types of seawalls are presented in Figure C1. Seawalls may be:

Concrete seawall: a typically massive, concrete structure with its weight providing stability against sliding forces and overturning moments.

Dikes: typically earth structures (dams) that keep elevated water levels from flooding interior lowlands. The key functional element in their design is the crest elevation to minimize the overtopping from storm surge and wave run-up.

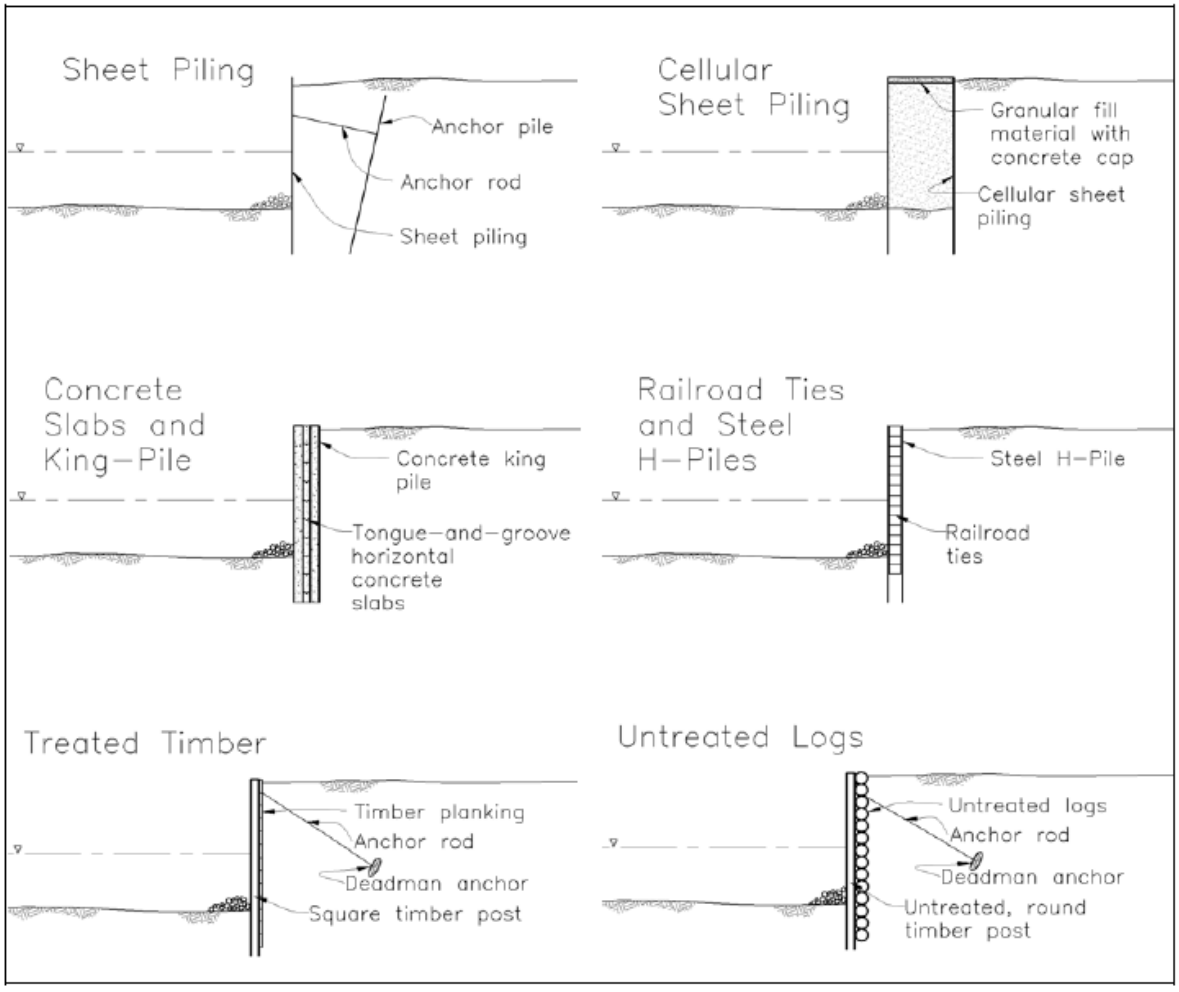
Figure C.1: Different types of seawalls and dikes



Source: by Pilarczyk (1990), extracted from CEM (2008)

Bulkheads: vertical retaining walls to hold or prevent soil from sliding seaward. Their main purpose is therefore to reduce erosion of land and loss of material to the sea and secondarily to protect the land from wave attack. The strength of a bulkhead to protect against wave attack is provided almost solely by the fill, and if this material is lost, the bulkhead has no practical mechanism to adequately protect against waves. Therefore, two critical elements of a good bulkhead design that prevent or limit loss of backfill are: return walls at the alongshore ends of the structure to prevent high water from washing material away from behind the structure; and geotextiles to allow water but not fines to flow through the structure. Drainage of water through, behind, or laterally away from the structure is important to relieve pore pressure from excessive rainfall or overtopping. Drainage can be provided by drilling weep holes in the structure face to allow water to seep out. Typical types of bulkheads are presented in Figure C2.

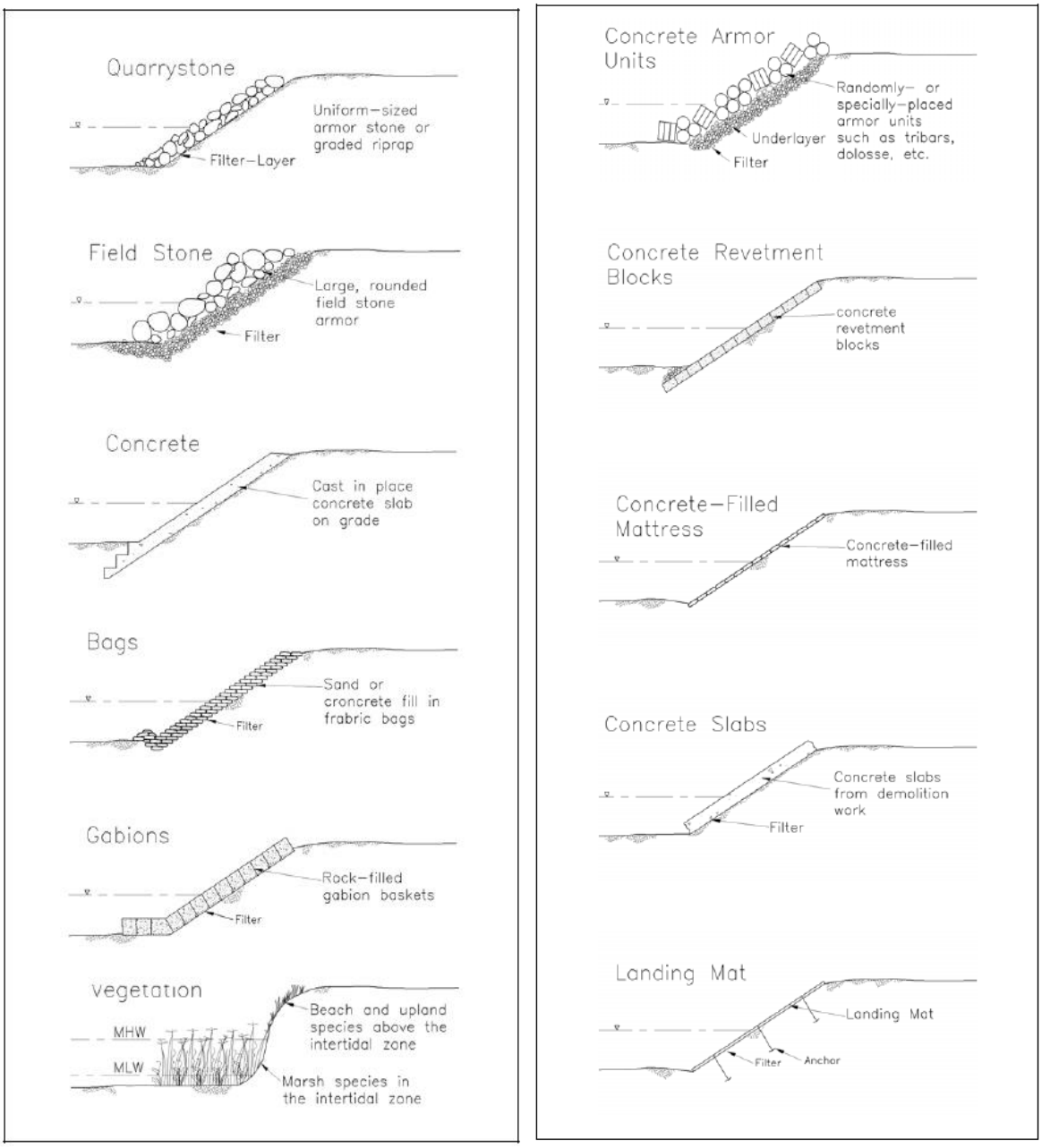
Figure C.2: Typical bulkhead types



Source: CEM, 2008

Revetments: considered a cover placed directly on an existing slope, embankment or dike to provide protection against waves. Revetments consist of a stable armour layer, a filter or underlayer, and a toe protection. The filter and underlayer support the armour, yet allow for passage of water through the structure. Toe protection prevents scouring and provides support for all the layer materials previously mentioned. If the toe fails, the entire revetment can collapse. Figure C3 summarizes a wide range of designs and materials employed for a revetment (CEM, 2008). Armouring may be either flexible or rigid. The armour's roughness, slope and crest elevation influence the effectiveness of revetments to withstand and absorb some part of the incident wave energy. The functional design of coastal armouring structures involves calculations of wave run-up, wave overtopping, wave transmission, and reflection. These technical factors together with economic, environmental, social, and aesthetic aspects all contribute to determine the crest elevation of the structure.

Figure C.3: Revetment alternatives



Source: CEM, 2008

C.2.1.2 Risks associated with structures

In general, in heavily built up areas where 'hold the line' strategy is adopted, seawalls are considered appropriate only if they are properly designed for the exposure conditions the defence would be subjected to during its design life.

The concrete walls if designed to comply with the current guidelines and standards would provide a robust and secure defence with little maintenance over a long design life between 50 to 100 years. However, such structures are not favoured in locations where there exist good sandy and shingle amenity beaches which attract tourists such as along the various islands of the Bahamas. Due to its wave reflective nature, concrete seawalls tend to accelerate beach erosion and undermining of the wall foundation. If non wave absorbing, seawalls may give rise to greater wave run-up/overtopping and consequential flooding (especially if adequate drainage is not provided) and sometimes damages of i.e. roads, buildings.

C.2.1.3 Seawalls and Revetments in The Bahamas

In Bahamas the low land levels play an important role in designing coastal structures.

Although very high concrete walls would be required to withstand the high waves in Bahamas, these are considered obtrusive, unattractive and not environmentally sympathetic with the surroundings. Figure C4 shows examples of different types of sea walls in Bahamas, in New Providence and Long Island.

Figure C.4: Damages that have occurred to sea walls in New Providence and Long Island

Source: Mott MacDonald, 2016

Seawalls in Nassau Harbour are mainly concrete vertical walls with precast concrete block crest wall installed with gaps in between the blocks to provide drainage for the wave overtopping water (see Figure 6 left). It was noted by the Ministry of Works and Urban Development that during the mid-2000s a review of sea wall designs suggested that they should have this “turret” type shape to allow flood water from overtopping and storms to quickly drain and therefore allow a speedy recovery of roads.

The vertical seawalls, in places, are fronted by sloping rock revetments. The photo in Figure 6, left shows such a type of structure, however with a poor performance especially regarding the stability of the unconventional materials used for the armouring.

In Long Island central, a coursed masonry blockwork seawall protects the main highway that connects Deadman’s Cay settlement and Mangrove Bush settlement (see Figure 6 bottom left). Private owners of properties have also built dry stone and/or mortared masonry walls to protect against flooding.

Masonry seawalls are considered appropriate in exposed sea conditions only if designed as gravity walls with appropriate strip foundations of sufficient depth to allow for any projected future erosion of the foreshore and also where appropriate the provision of additional scour protection in front. Such walls are

generally designed as retaining walls with fill at the back with minimal free standing height so as to provide the necessary stability against overturning and sliding. Masonry walls are relatively more expensive than concrete walls as they are labour intensive and require skilled masons and also require maintenance in the form of re-mortar and pressure pointing of the joints and the filling of voids formed due to loss of masonry.

Sloping rock and concrete **revetment** structures have been provided in the Bahamas as coastal structures:

- to the exposed coastal earth embankments and slopes supporting roads and structures
- to the coastal reclamations to facilitate hotel and recreational developments
- along the existing vertical seawalls as fronting structures to mitigate wave overtopping /flooding and provide protection to the wall foundation.

Figure C5 shows a wide rock armoured revetment with a smooth slope in front of a vertical low wall.

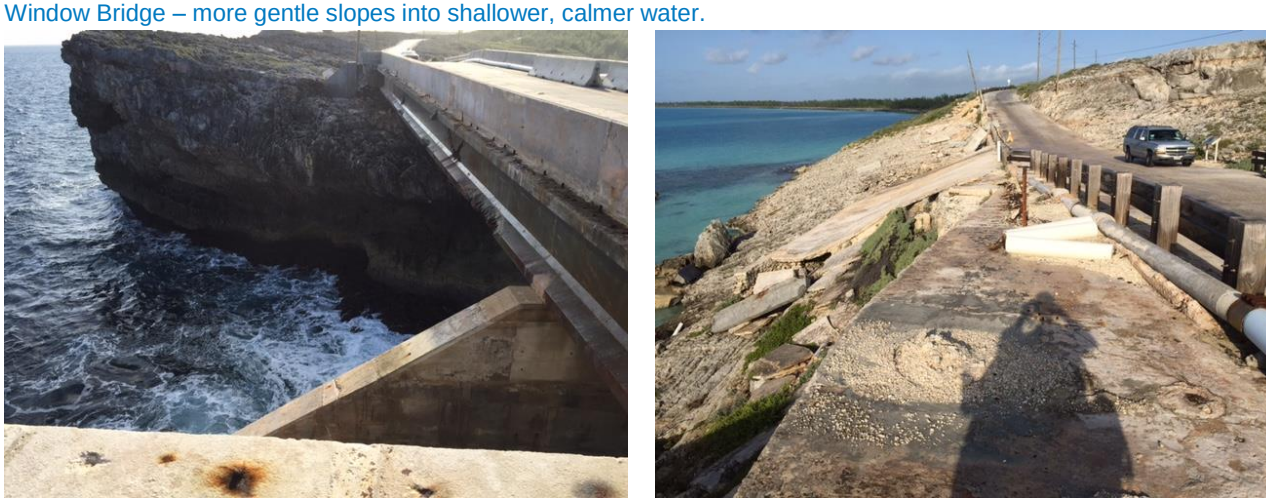
Such structures, if designed appropriately, may dissipate a significant part of the incident wave energy but most commonly they do not retain a beach in front of them and obstruct the access to the sea. They are considered easy to construct and maintain using local equipment. However, the location of a source of rock material of adequate and durable quality in the region or abroad together with the relative costs should be considered during design.

Figure C.5: Rock revetment off West Bay Street, New Providence

Source: Mott MacDonald, 2016

The sloping faces of highway earth embankments and approaches to the Eleuthera Glass Bridge have been faced with in-situ concrete sloping wall (see Figure C6).

Figure C.6: Left: East side of the Glass Window Bridge – steep cliffs into deeper water. Right: West side of the Glass Window Bridge – more gentle slopes into shallower, calmer water.



Source: Mott MacDonald, 2016

Large areas of this concrete sloping wall- protection have been extensively damaged and require rehabilitation. The design and performance of concrete sloping wall is dependent on the storm exposure condition and being a non-flexible structure would require very substantial and robust construction using reinforced concrete and adequate toe support to the slope. The concrete wall slab shall be designed to be supported on ground beneath with concrete bulkheads provided at intervals to compartmentalise the structure and provide increased stability. In view of the rigid nature of the structure, its application is limited to rocky slopes where the concrete apron slope can be anchored into the underlying rock. Where the slope is formed of earth bund, a more flexible rock armoured revetment cover is preferred.

C.2.2 Breakwaters

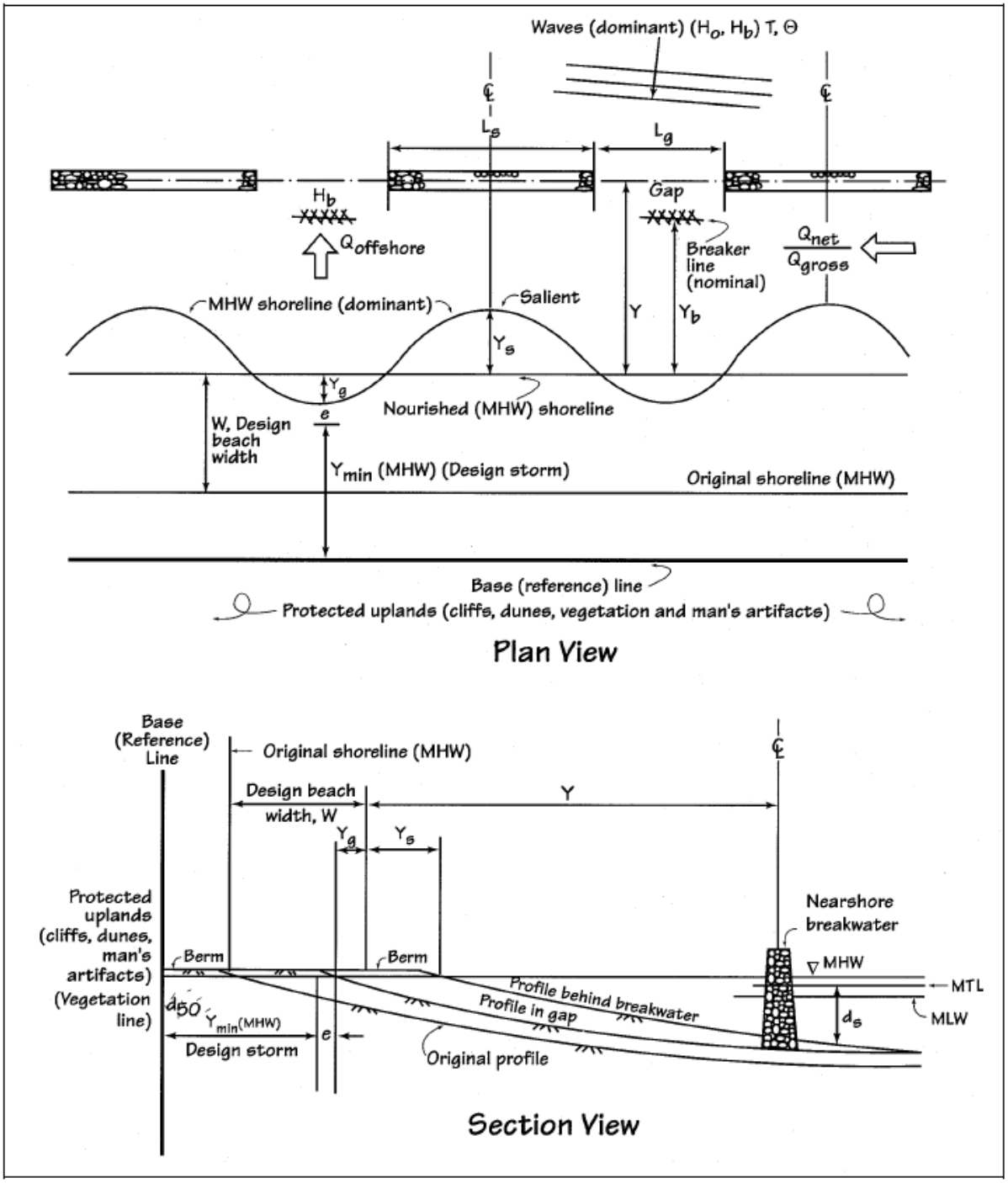
C.2.2.1 Brief overview of design, function and use

Breakwaters can be built for shore protection or for the protection of a harbour basin. They take the form of a rubble mound structure armoured with rock or proprietary concrete units or sand fill geo-bags depending on the intensity of the wave exposure.

Coastal breakwaters are designed offshore around the surf zone almost parallel to the coastline and most commonly detached to provide shore protection. The primary function of such structures is to reduce the amount of wave energy in their lee with the waves diffracting around the end of the structure and thus initiate sediment deposition at the shoreline through the modification of the inshore currents. They are similar to natural bars, reefs or nearshore islands that dissipate wave energy. The reduction in wave energy slows the littoral drift, produces sediment deposition and a salient (or in extreme cases, a tombolo) feature in the sheltered area behind the breakwater. Some longshore sediment transport may continue along the coast behind the breakwater (however, not in the case of tombolo formations). During significant storms the

erosion of the salient behind the breakwater is limited due to the provided protection, whilst the exposed gap area can be eroded with sediment moving offshore. Breakwater height, length, wave transmission characteristics and distance from the coast contribute to its effective performance to provide a minimum beach width. These structures can be water penetrating emergent or submerged depending on the tidal range and the extent of wave transmission over and through the structure that would be appropriate to provide the necessary protection without the loss of beach amenity with the latter structure being preferred in areas which are environmentally sensitive. Figure C7 is extracted from CEM (2008). It shows the key design parameters.

Figure C.7: Key design parameters for system of breakwaters



Source: CEM, 2008

Offshore conventional breakwaters

Conventional Breakwater is a statistically stable structure built most commonly offshore for the purpose of forming an artificial harbour basin which is protected from the effect of the waves so as to provide safe berthing of vessels. The majority of the breakwaters are built with natural rock or concrete units or a combination of the two, depending on the size and intensity of the waves it is subject to during its design life.

The breakwater is typically formed with a core of quarry run material with a protective rock filter/underlayer and a coverlayer consisting of rock or concrete armour units. The availability and the price of armour rock, either locally or imported from overseas to the required weight, quality and quantity would generally determine whether the adoption of rock armour as coverlayer is viable. Although a rock is preferred as an environmentally acceptable material for armouring of coastal structures such as revetments and coastal protection breakwaters, the use of rock would be limited in sea conditions, up to significant wave height of 3.0m. The median weight of rock required to be stable under this limiting wave would be approximately 8 tonnes (T) which would correspond to a standard heavy rock grading of 6T to 10T. Sourcing rocks in excess of this grading of required quality and quantity would be limited to very few sources around the world.

A number of proprietary concrete armour units have been developed over the years and have been extensively used as coverlayer armour on breakwaters in very exposed sea conditions. The concrete units are placed in one or two layers depending on the shape and interlocking capability with the single layer units requiring very special placement to ensure full interlocking between units otherwise failure of one single unit would lead to progressive failure of the protected slope. The new generation single layer concrete units such as Accropode(s), Core-Loc patented by Sogreah, France (currently Artelia) and X-Bloc patented by Delta Marine consultants are used extensively as it is a quite attractive solution, which offers significant reduction in the quantity of concrete required when compared to two layer units. The stability coefficient of the single layer units has been enhanced by their complex shape and good interlocking during their placement and this has resulted in the reduction of the required unit's weight comparing to the two layer armour units. Since the single layer armour units require special placement, it is common practice to engage the patent holder to provide the necessary support (supplying the necessary placing grid drawings and intermittent site visits) during construction. A comparison of costs between single layer and double layer armour units suggests that the former type of unit would produce a cost saving of up to 40%. The double layer units such as Dolos, Tetrapods, Antifer Cubes, Tri Bar, are preferred in certain situations where experience has been gained by local designers and contractors from extensive use of such units in sea defence works and in cases the units are no longer under the patent of the unit developers.

Berm Breakwater

Berm breakwater is designed as a dynamically stable rock structure which is in general has a similar profile in design to conventional breakwater but built with a wide crest using lighter armouring on the crest and slope which is subjected to reshaping over time by wave action to eventually form a stable S-shape profile. It is used in places where rocks although available in large quantities, the weight of rock is small to be statistically stable against the wave condition experienced at the site. The rock shall be of durable quality

to withstand in addition to the wave impact, the abrasion that the individual rock would be subjected to by the alongshore movement material under wave induced current. Such structures are designed using industry standard empirical formulae but it is strongly recommended they are tested experimentally to assess and verify their performance. Modern approaches use berm breakwaters to provide low crest s's levels and protect against wave overtopping.

C.2.2.2 Risks associated with breakwaters

If sediment budget is not sufficient to build up the beach along the sea frontage behind the breakwaters through natural processes, then artificial beach material (most commonly sand) replenishment will be required to build up the beach.

It is recommended that both the structural and hydraulic performance of such offshore breakwaters armoured either with rocks or concrete armour units shall be tested experimentally in a physical model in a 2D wave flume and/or in a 3D wave basin (especially if the orientation and alignment of the breakwater shall be tested).

C.2.2.3 Offshore Breakwaters in The Bahamas

The main west breakwater in Nassau Harbour is located on the west side of the entrance channel and the shorter lee east breakwater at the tip of Paradise Island (Figure C8). The breakwaters are formed by a rubble mound core and armour consisting of Tribar concrete blocks. A number of breaches have occurred on both breakwaters over the years and without repairs they do not provide the same protection to the harbour basin as originally intended and this has impacted on the tranquillity of the harbour waters on the west side where the turning area is located.

Figure C.8: Breakwater in Nassau Harbour

The breakwaters require refurbishment to ensure that they provide the necessary protection to the west side of the harbour basin against storms. Any refurbishment that needs to be carried out should be in compliance with the current internationally accepted design standards and to cater for increase in sea level

and storm intensity due to the predicted short and long term climate change. The refurbishment process in general would be expected to include initially the condition and structural survey of the breakwaters including dimensional survey where appropriate and the assessment of its current standard of defence and the residual life of the structure based on a review of information on the breakwater previous design and construction accessing literature sourced from the client, the harbour authority and published papers. In addition the results of the met-ocean study would be used to develop refurbishment options and to choose a preferred option.

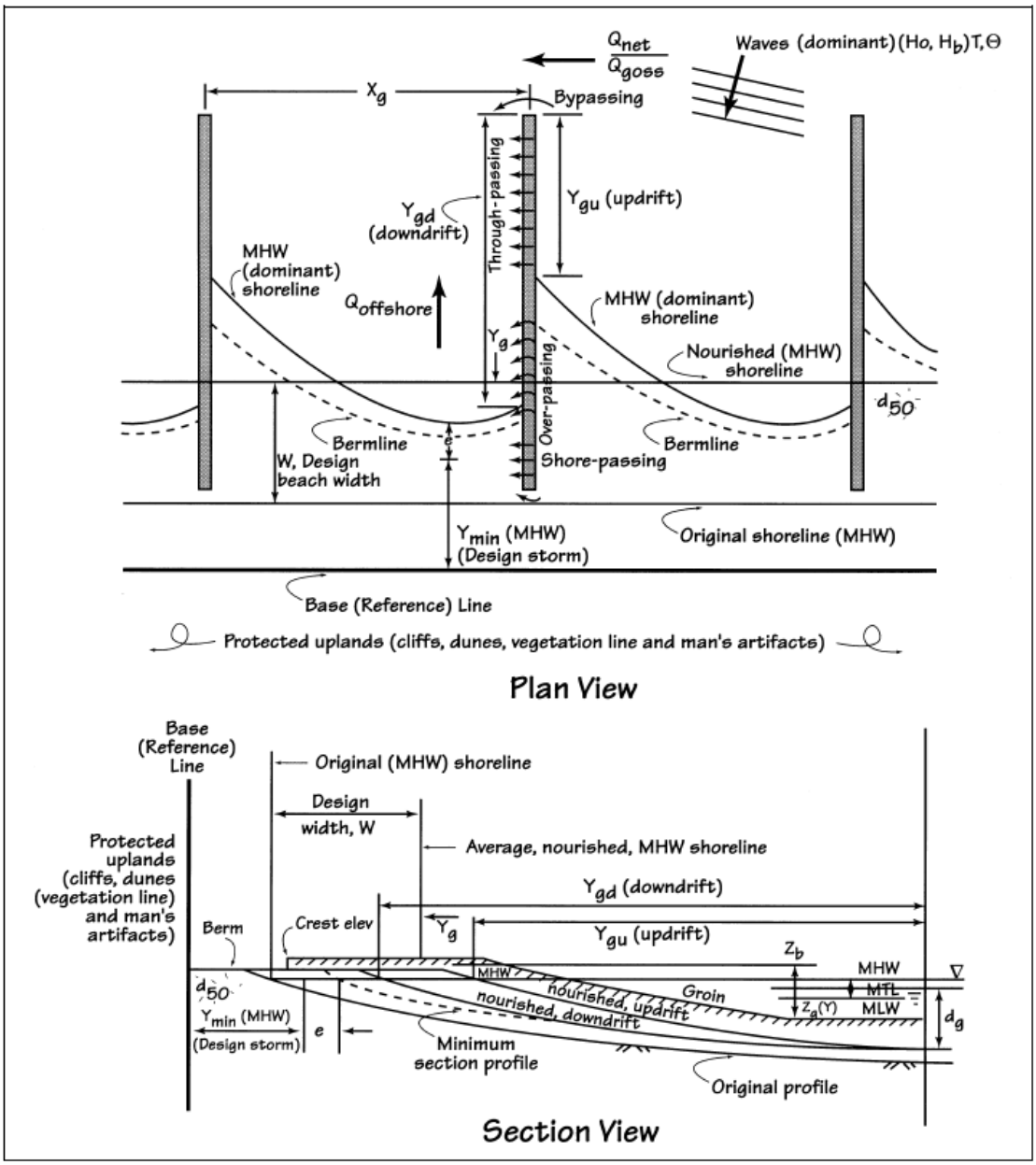
C.2.3 Groynes

C.2.3.1 Brief overview of design, function and use

Groynes are the oldest and most common shore-connected, beach stabilization structure. According to CEM (2008) they are probably the most misused and improperly designed of all coastal structures. They are usually perpendicular or nearly at right angles to the shoreline and relatively short when compared to i.e. navigation jetties.

Groynes offer little or no reduction in wave energy to shore-normal incident waves during storms. The main function of groynes involves adjustment of the shoreline to the presence of the obstruction in the longshore sediment transport only by causing accretion on the updrift side of the groyne and a decrease in beach width on the downdrift side of the groyne. Their performance is effective in case they maintain a minimum, dry beach width for specified storm conditions and bypass an average, annual amount of sediment to avoid or minimize the downdrift impacts. Modern coastal engineering practice is to combine beach nourishment with groyne construction to permit sand to immediately begin bypassing the groyne field. Figure C9 is extracted from CEM (2008). It shows the key design parameters.

Figure C.9: Key design parameters for system of groynes



Source: CEM, 2008

Fishtail groynes are a type of combination of breakwaters and groynes. They prevent longshore sediment transportation and absorb part of the incident waves.

Sand filled geo-bags is also becoming popular in use as coastal defence structures and especially for groynes due to considerable attention being given to significantly improve the design life of the bags themselves. Here their application is limited to waves up to Hs = 1.5m to 2.0m.

C.2.3.2 Risks associated with the design of Groynes

It is critical that the groyne field is designed to appropriate length, spacing, length and height to encourage beach build up within the groyne bays and to minimise down drift erosion. If sediment budget is not sufficient to build up the beach along the sea frontage within the groyne field through natural processes, then artificial beach material (most commonly sand) replenishment is used to build up the beach. However, Kraus, Hanson, and Blomgren (1994) state that groynes may not function well and should not be considered under the following conditions:

- Where cross-shore sediment transport is dominant
- When constructed too long or impermeable, causing sand to be jetted seaward
- When strong rip currents are created to cause potentially dangerous swimming conditions
- Concrete groynes are impermeable and do not allow the sand to migrate through the structure which is the case of rubble mound groynes.

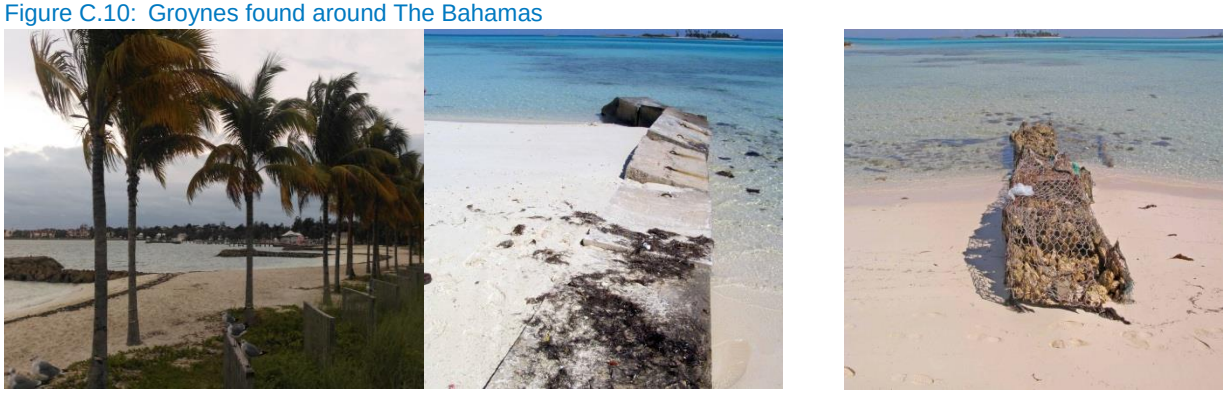
C.2.3.3 Groynes within The Bahamas

Groynes have been constructed along many of the beach frontages on the various islands of the Bahamas to retain the sandy beaches which attract a vast number of tourists and the local residents who regard their beach as a desirable amenity.

Two of the main types of groynes found in the Bahamas are straight and fishtail and they are located along the sandy foreshore at Montagu, Saunders, Public Beach Treasure Cay, Gillam Bay, Abaco Island and Nassau Harbour New Providence Island (Figures C10 and C11). In view of the restriction imposed on the use of hardwood timber due to its depleted source, the loss of timber forests and its impact on the global warming, a more sustainable material source such as rock is being extensively used in the construction of groynes. They are easy to construct starting from the structure root located on land and moving seaward, and are less expensive than timber or concrete groynes. However, sourcing rock material of adequate and durable quality locally or importing from abroad together with the relative costs should be considered during design.

Groynes formed of gabion baskets infilled with rocks have been seen in Bahamas along the islands. However these are generally considered susceptible to damage by waves. They are considerably less expensive than a rubble mound groyne but not suitable for use at very exposed sites with waves exceeding the Hs = 1.0 to 1.5m. Furthermore, if the gabions break, the metal pieces and rocks which can be found on the coast impose high risks to the safety of people, both the users of the beach and bathers.

Figure C.10: Groynes found around The Bahamas



Source: Mott MacDonald, 2016 and BEST Commission, 2011

C.2.4 'Soft' alternatives

C.2.4.1 Brief overview of design, function and use

Beaches

Beaches or dunes systems are good at acting as natural defences to waves and storms. The beach sediment can act as a barrier to the water and reduce erosion of land behind the beaches. The Bahamas' coastline is characterised in many places by beaches which are fed by sediment which is generated from the carbonate depositional environment within the Bahamian Platform. The Bahamian Platform is one of a chain of sixteen carbonate platforms that stretches for 1500km. The environment around The Bahamas provides the factors required for creation of shallow water carbonates, which are then deposited on the continental shelf.

Beach recharge and **beach vegetation** are considered 'soft' coastal protection alternatives. However, in most cases they are supported by a system of 'hard' type structures such as breakwaters, groynes, fishtail groynes.

Mangroves

Mangrove forests may consist of any of the four species of tree to which the term 'mangrove' is applied. They are Red mangrove (Rhizophora mangle), Black mangrove (Avicennia germinans), White mangrove (Laguncularia racemosa), and Buttonwood (C. erectus). Each species of mangrove can tolerate specific environment conditions which the others cannot.

On approaching a mangrove wetland from the water, the first thing to catch the eye is the "true" mangrove, the Red mangrove. Numerous prop roots extend downward from its trunk to anchor the tree in the mud of the wetland. The Red mangrove is one of few flowering plants which are specially equipped to live in the ocean. As an adaptation to living in salt water, Red mangroves have evolved unusually dense wood which

sinks in water. The wood has special chemicals which gives it its characteristic red colour. Leaves from the Red mangrove accumulate on the bottom of the water and eventually become sufficiently permanent to support the mud dwelling Black mangrove.

Black mangroves are relatives of Teak and are easily recognized by their trademark tubes called pneumatophores which penetrate the surface of the mud. These make the mud look like a bed of nails. There is very little oxygen in the mud where Black mangroves grow and so the pneumatophores provide life-saving access to the open air. They also hold the mud firmly together, preventing erosion from rain and waves and building up the shore further. The mud is slowly transformed to hard ground and the next in the line of plant succession, the White mangrove, takes over.

White mangroves colonize areas in the upper reaches of the tides. They can develop pneumatophores below the mud but have their breathing pores in their trunks. White mangroves are recognized by their succulent green leaves which have two conspicuous salt-secreting glands on the leaf stem or petiole. In its turn the White mangrove surrenders to the Buttonwood.

Buttonwoods are able to live in dry saline areas. Their satiny leaves are familiar to most Bahamians. The flowers are small but the fruits that the flowers form are the most characteristic being small, brown and in clusters looking like buttons.

Mangroves occur in tropical and subtropical wetlands all over the world. At one time it was thought that more than 60% of the world's shorelines were lined with mangroves[1]. Coastal development, land reclamation and erosion throughout the tropics have greatly reduced this coverage. In The Bahamas there is unfortunately no law that prohibits the destruction of mangrove wetlands. Despite the uninviting conditions inhuman terms, mangrove wetlands have proven to be among the most biologically productive of marine ecosystems. Mangroves are rich in animal life and serve as nursery ground to many economically important marine species. Scalefish (groupers and snappers), crabs and young crawfish seek refuge among the roots. Below the high-tidemark, Red mangroves are overgrown with algae, sponges and tunicates. Among the branches of the mangroves birds such as herons, egrets and pelicans build their nests.

Their maze of the mangrove roots produce a living seawall making mangroves effective barriers against stones and help prevent coastal erosion. Additionally this network of roots stifles water currents, increases the debris and sediment that settles at the bottom of the water, and actually leads to land-building.

The specific role of mangroves in coastal and sea defence protection has been recognised and referred to in numerous documents and studies. The influence of anthropogenic factors and the threat of man-made sea defences as a result of poor management practices and unregulated use of mangroves include, but are not limited to:

- Removal of mangroves for domestic purposes
- Removal of mangroves to open up land for agriculture and coastal aquaculture that expose earthen embankments
- Cutting of mangroves for fuel
- Destruction of mangroves for infrastructure projects

- Clearance of mangroves for removal or reduction of nuisance of mosquitoes
- It is under normal circumstances, restoration or rehabilitation of mangrove vegetation are necessary where the eco system has been altered to such an extent that it no longer naturally correct or re-new itself. Mangrove restoration by means of replanting is only considered in areas where recovery by natural process can no longer take place quickly enough for effective mangrove protective and other functions are realized.

Coral Reefs

Coral reefs are made up of thousands of small, slow growing individual coral polyps that are cemented together from secreting calcium carbonate that builds over thousands of years to create coral reef structures. Corals require clear, clean, nutrient free, warm waters to thrive. Development of coral depends on their environment and tidal flows off shallow banks can further expose coral to sediment and large fluctuations in temperature. As a result the composition and growth of coral species can vary greatly, along with the structure they provide as habitat for fish and other reef creatures, leading to different species assemblages on different reefs.

C.2.4.2 Risks associated with design of soft alternatives

Maintaining the necessary landforms for sustained vegetation growth is paramount over the long term. Linking this to ridge maintenance is key is resiliency of this option is to occur. It is more useful in “high exposure” sites and undertaken in tandem with other soft engineering schemes. A number of factors need to be taken into consideration when assessing the potential for the natural beach or dune system to act as a coastal protection asset:

- The geomorphology of a shoreline area is should account for the geology of the area and natural forcing;
- That investigation of a number of features at a site can help the driving forces of the system to be understood even if there is a lack of data available –as the form and shape of the system directly reflects those forces. The various indices that are presented are a collection of the type of information that may be used to help build up this understanding of the dynamics depending on the local specifics; and
- The shape of the shoreline is a function of the existing mix of forces and contingency therefore needs to be built in to combat disasters and climate change. That contingency will ultimately depend on the shoreline and whether it can roll back and up and maintain existing functioning, or the line has to be held through lack of space.

The sustainability of undertaking Mangrove rehabilitation must address parameters good for mangrove growth and management. The following parameters are important when addressing the above:

- Coastal dynamics of the site – Mangroves grow well in a sediment depositional environment of low energy. Strong waves increase coastal erosion and result in uprooted vegetation. Low tides also allow colonisation of the tidal zone by mangroves
- Water regime at the site – Mangrove eco system requires tidal flushing for the supply of nutrients and for the removal of carbon dioxide, toxic wastes and organic debris. Tidal flushing is also required for

the reduction of salinity as hyper saline condition promote death of vegetation. Freshwater supply too is necessary to maintain suitable salinity for favourable growth.

- Presence, absence of types of existing vegetation - There is a mix of vegetation in most of coastal mangrove .
- General water quality at site – Mangroves can grow in pH 5.3 to 7.8. Larger variation in short period of time within this range can also cause destruction of mangroves. Sufficient oxygen is required for survival of mangrove vegetation. Stagnant water will have limited oxygen content.
- General soil quality at the site – Mangrove vegetation grows best on fine alluvial mud-flat soil mainly of silt and clay. The soil must be consolidated so that the roots can set properly and firm into the soil.

C.2.4.3 Soft alternatives in The Bahamas

Beaches

The problem associated with the loss of some of the beach frontages in the Bahamas is the rolling back of the existing dunes which protect the hinterland. This is due to the increase in intensity of the storms and sea level rise and beach erosion. Artificial dune building, the planting of local native species and the provision of wind- blown sand trapping measures would go some way in preventing the landward movement of the beach crest.

Erosion of beaches in The Bahamas is often related to a shortage of sand or direct human interference, such as sand mining, dredging or major construction.

There are a number of beach management procedures that can be implemented to control erosion and sediment movement. However, without a good understanding of the sediment supply processes and patterns, these procedures may not work effectively or may not be sustainable in the long term. In particular, the impact of climate change within The Bahamas[78] may have significant effects on sediment supply through increasing sea surface temperatures, ocean acidification, changes in ocean currents, increases in frequency and severity of hurricanes and sea level rise acceleration.

[78] Simpson, M. C., *et al.,* (2012) *CARIBSAVE Climate Change Risk Atlas (CCCRA) – The Bahamas.* DFID, AusAID and The CARIBSAVE Partnership

Figure C.11: Wind-blown sand control measures

Source: Mott MacDonald, 2016

Mangroves

Mangroves exist along the coastal frontages in the various islands of the Bahamas. Mangroves form an important part of the coastal ecosystems, for example mangrove forest ecosystems function as nurseries for many juvenile scale fish and interact with coral reef ecosystems, which in turn provide habitat for the adult fish.

Coral Reefs

A nation of over 700 islands and cays, the marine environment is critical to the ecology, economy and culture of The Bahamas. The country also has more coral reef area than any other nation in the region and boasts one of the world's largest contiguous coral reefs, The Andros Barrier Reef. In The Bahamas there are several types of reefs. Along the east side of Andros barrier reefs run parallel to the shore separated from the island by a lagoon. In Exuma Cay, Berry Island and parts of the south eastern Bahamas fringing reefs border the shoreline. Reefs also form on the edge of banks where there are no large islands, such as Cay Sal Bank and along the eastern edge of the Tongue of the Ocean, southwest of New Providence. The Bahamas also have three major reef zones: reef crest, patch reef and force reef. All with its own set of species.

The health of the reefs in The Bahamas was measure by using The Bahamian Reef Health Index (BRHI). From this index none of the reefs surveyed were categorised as being in Good health overall. Most coral reef sites in the Bahamas were either in an Impaired or Fair condition. The Average BHRI for reef zones surveyed was Impaired, but no sites at reef crest scored as Poor and patch reefs scored the greatest proportion of Poor and Impaired sites. Bahamian reefs have got into this condition from various factors that threaten their survival. Climate change is a key issue facing coral reefs as it increases the frequency, duration and intensity of period of elevated sea temperature. Warming of the sea due to climate change can also lead to mass mortality from coral bleaching and outbreaks of disease. Another key threat is over fishing both legal but unsustainable fishing and illegal. Unsustainable fishing can drive fish stocks to collapse, with severe economic and ecological consequences. Coastal Development is another factor

threatening corals, by altering shorelines, increasing sediment, pollution and decreasing nearshore habitat for key species

C.3 Summary

A review has been carried out on the type of existing coastal defences in the Bahamas with particular reference to the sites identified, visited and discussed at meetings with the various stakeholders during the initial missions under the ICZM Feasibility Study. This review examines the type and design of the existing coastal structures in the light of the most recently available good design practice. It can be seen that some of the key issues relating to coastal engineering in The Bahamas are:

- Clarity of land ownership and ability to coordinate coastal protection design;
- Control over development by hotels and private developments;
- Lack of planning with regard to coastal management – ensuring a holistic approach that considers the larger island or sub-island scale;
- Lack of design guidance and clarity when designing to climate change scenarios; ad
- Lack of inclusion of innovative and green-engineering designs.

Appendix D. Project Data Sheets

Appendix E. Component A Terms of References

Appendix F. Component B Terms of References

Appendix G. Component C Terms of References

Appendix H. Environmental and Social Management Plan

Appendix I. Terms of Reference for Ex-Ante Economic Assessment

Appendix J. Stakeholder Engagement Summary Report

Appendix K. Summary of Technical Briefs

K.1 Overview

In addition to undertaking a baseline review within this Project, technical notes have been developed under Component 1 of the overall Feasibility Study. These technical notes summarise the baseline, key issues for ICZM and provide recommendations under five key topics:

- Governance and Planning;
- Policy;
- Environment;
- Economics; and
- Climate Change Vulnerability and Adaptation Considerations.

Key summaries of these Technical Briefs are presented below.

K.2 Governance and Planning

K.2.1 Key Facts

- Integration of spatial planning and administrative integration of land and sea areas are “crucial components” of a national ICM strategy[79].
- Integrated management is a particular problem in The Bahamas due to the fragmented nature of environmental institutional structures combined with a lack of a coordinating lead agency with a statutory mandate for the environment.
- Lack of legislative provisions mandating public consultation and disclosure of information leads to tensions surrounding planning decisions in the coastal zone.
- The vulnerability of coastal communities and populations is worsening due to sea-level rise, hurricanes and subsequent coastal erosion. This is not sufficiently recognised or dealt with in government regimes or legislation.

K.2.2 Summary of Key Issues

Current government policy and legislation does not have the monitoring and enforcement capabilities required for a fully effective newly implemented coastal zone management regime. Adaptation to current policy and legislation is needed, to include: the integrated management of land and sea settings, disaster risk reduction efforts and climate change adaptation, and an update of climate change and coastal records and the implementation of ways to continuously monitor and collect data for current coastal processes, climate change and ecological response.

K.2.3 Summary of Recommendations

Develop a coastal zone management regime

[79] Glaeser, Bernhard. (2008). Integrated Coastal Management (ICM) between hazards and development. In Krishnamurthy, R.R. et al. (Eds.), Integrated Coastal Zone Management (xii-xxi). (Singapore, Chennai: Research Publishing Series).

Create Discrete legislation establishing a Coastal Zone Unit: responsible for a defined geographic area. This will, require amendments to existing environmental legislation.

Regular monitoring of beaches and reefs: should become a routine occurrence under a Coastal Zone Unit in The Bahamas, as it is in Jurisdictions such as Barbados[80]. Part of the coastal management regime should also focus on training of coastal managers to carry out monitoring.

Data collection, monitoring and enforcement: Suggested that a significant amount of the budget allocated to the coastal management regime is used for data collection, monitoring and enforcement. Mandates for enforcement should extend to the enforcement of provisions of separate but related environmental legislation where infractions affect the coastal zone.

Disaster risk reduction and climate change adaptation: Need to be more closely integrated into coastal planning decisions. Areas defined as hazardous zones need to be designated and coastal development should be prohibited in these areas as a priority.

Country should update its Climate Change Adaptation Policy and including within it a policy regarding loss and damage due to climate change. The CZM legislation should include these considerations.

Loss and damage Policy: "adverse effects of climate variability and climate change that occur despite global mitigation and local adaptation efforts."[81]. Includes both slow onset events (sea level rise, coral bleaching and ocean acidification) and extreme events (hurricanes and typhoons). As the Bahamas is vulnerable to both slow and extreme onset events it is recommended that a definition of loss and damage as well as a policy to deal with it, is developed and adopted nationally and used in the CZM program.

Recommendations for the ICZM Policy Framework are segregated into Options 1 and 2 and are set out below as described in the Governance and Planning Technical Brief[82]:

K.2.3.1 Option 1: Discrete ICZM Legislation

Short Term:

- Establish ICZM Unit within ICZM Legislation;
- Include climate change adaptation, disaster risk reduction and planning tools in mandate; and
- Analysis and application of appropriate planning tools by ICZM Unit.

Medium Term:

[80] Innis, Lorna V, Braithwaite, A. and Rowe, A. (2008). Governance, ecosystems monitoring and coastal engineering in some Caribbean small islands. In Krishnamurthy, R.R. et al. (Eds.), Integrated Coastal Zone Management (1099-128). (Singapore, Chennai: Research Publishing Series).

[81] Kees van der Geest, Michael Zissener, and Koko Warner, 'Addressing Loss and Damage with Microinsurance,' Envisioning Resilience Towards Climate Compatible Development, Special Issue No. 109, April 2014, 3.

[82] CCS and SEV Consulting (2016) Governance and Policy Technical Brief

- Institute “harmonizing tools”: ICZM Steering Committee; Inter-agency representation; Delegation Agreements; Strategic Management Plans;
- Planning tools: Identify vulnerable areas based on local knowledge; Establish hazard areas for no new builds; Amend building code with coastal set-backs; Institute community-based adaptation activities;
- Develop dredging guidelines; and
- Climate change adaptation policy updated with loss and damage policy included.

Long Term:

- Environmental legislative audit for overlaps;
- Co-ordination of planning legislation, environmental management legislation, climate change adaptation and disaster risk reduction mandates;
- Develop integrated data sets across relevant institutions;
- Vulnerability, exposure and impact analyses undertaken nation-wide;
- Develop established criteria for identification of vulnerable coastal areas on basis of analyses;
- Selection of planning tools extended to identified vulnerable areas; and
- Implementation of national loss and damage policy.

K.2.3.2 Option 2 – ICZM in Planning Legislation

Short Term:

- Develop further amendments to Planning and Subdivision Act 2010 including establishment of discrete ICZM Unit and integrate with planning functions.

Medium Term:

- Co-ordination of planning legislation, environmental management legislation, climate change adaptation and disaster risk reduction mandates (NB this may take place in the longer term);
- Enact and implement amendments to Planning and Subdivision Act;
- Institute “harmonizing tools”: ICZM Steering Committee; Inter-agency representation; Delegation Agreements; Strategic Management Plans;
- Planning tools: Identify vulnerable areas based on local knowledge; Amend building code with coastal set-backs; Establish hazard areas for no new builds; Institute community-based adaptation activities;
- Develop dredging guidelines; and
- Climate change adaptation policy updated with loss and damage policy included.

Long Term:

- Environmental legislative audit for overlaps;
- Develop integrated data sets across relevant institutions;
- Vulnerability, exposure and impact analyses undertaken nation-wide;
- Develop established criteria for identification of vulnerable coastal areas on basis of analyses;
- Selection of planning tools extended to identified vulnerable areas; and
- Implementation of national loss and damage policy.

K.3 Policy

K.3.1 Key Facts

- "Optimally, environmental policy is based on information and logic, in which decision-makers are helped, through efforts of natural and social scientists and the public to solve complex problems" (Ray and Ray, 2004). These factors are often missing from decision making and policy writing.
- The past implementation of the National Environmental Management Plan and National Environmental Policy was slow.
- The Bahamas have a goal of sustainability. Development in the Bahamas therefore will include: "limits to growth but allows substitutability of capitals only with the support of appropriate green design or technologies. It also seeks to preserve the environment, achieve social justice, equity and freedoms, while allowing for the development of a viable economy"[83].

K.3.2 Summary of Key Issues

There is no ICZM specific policy and so there is a lack of regulatory framework for planning and a lack of enforcement. There is also a no transparency in governance or public awareness. The introduction of an ICZM will balance protection and development within the Bahamas. It will encourage the use of local knowledge in its plans and through a regulatory framework will reduce competition or user conflicts and may effectively enforce beneficial projects and prevent environmentally/socially harmful undertakings.

K.3.3 Summary of recommendations

Goal of Sustainability: Need to change some existing policy objective to comply with the goal of sustainability, particularly the National Maritime Policy.

GOBH will not set unrealistic economic goals within the ecological limits of its ecosystems while still trying to ensure the social well-being of the Bahamian people

ICZM Policy Framework Principles: include a Precautionary Approach where work may still be done to protect the environmental or a coastline and its community even though there is a lack of scientific certainty.

'Brother's Keeper' principle' involves citizens understanding that they can have an economic, environmental or social impact on the wider environment and fellow citizens. This ethos should also be held by the decision makers in government to ensure policy is made with locals and individuals in mind.

Strong public participation: the public are engaged throughout the decision making process

[83] Wells-Moultrie, S. (2016). Assessing sustainability in Small Island Developing States: A comparative analysis of sustainability assessment tools and their applicability to Small Island Developing States. Gainesville: University of Florida.

A summary of prioritized recommendations as presented in the Policy Technical Brief[84] is presented below:

Short Term:
- Incorporation of identified principles into the ICZM Policy Framework;
- Incorporation of the relevant SDGs into the National Policy Framework;
- GOBH decision on the ICZM legislative framework design;
- GOBH decision on the ICZM institutional framework design;
- Establishment of ICZM Unit or designation of ICZM to existing agency;
- Designation of BNGISC as centre for ICZM spatial data collection and mapping;
- Designation of agency as central repository of research publications and data on the Bahamian coastal zone and coastal resources;
- Environmental legislative audit; and
- Identification of ICZM research priorities.

Medium Term:
- Development of the ICZM legislative framework;
- Development of the ICZM institutional framework;
- Enactment or amendment of legislation for ICZM implementation to include legal mandate for ICZM Unit;
- Development and implementation of National ICZM Program;
- Data collection guided by ICZM research priorities; and
- ICZM spatial planning by ICZM Unit and BNGISC.

Long Term:
- Continued implementation of National ICZM Program.

K.4 Environment

K.4.1 Facts
- There is a Lack of willingness by policy makers to incorporate changes to present procedures and operations
- There is currently no sustainable approach to development
- The public are not aware of coastal issues: how they are at risk, the plans for future development or their own impact upon the environment.
- Lack of CZM and legislation has led to poor coastal/ marine pollution and waste management, and over fishing.

[84] CCS and SEV Consulting (2016) Policy Technical Brief

K.4.2 Summary of Key Issues

Human stressors and climate change threaten the environment throughout the Bahamas. In order to reduce the threat, an ICZM should only support programs that in some way promote or take into account environmental protection or ecological enhancement.

K.4.3 Summary of recommendations

Sharing of information: ensures the support and involvement of relevant administrative bodies and sectors involved in the management of the coastal environment; it also involves communities and other stakeholders with the coastal planning programs.

Develop strategies that will enhance communication and therefore communication between government, NHO's, the community and its organisations.

Implement multiple-use zoning for managed and protected areas: this method promotes the principles of the ecosystem based approach while achieving a balance between conservation and protection, and the sustainable use of the coast and marine resources.

Encourage the use of nature-based solution or green infrastructure as mitigation tools: The multiple functions of green infrastructure mean it can be both socially (providing water drainage or green space) and environmentally beneficial.

Where traditional grey infrastructure is still needed, it can be reinforced with environmentally based solutions.

Increase ecosystem resilience: reduce human stressors on the environment (pollution, reduce fishing, stop unsustainable coastal development)

Protect natural buffers: but also plan for inland migration of coastal ecosystems

Integration of ecosystem-management plans with: poverty reduction plans, development plans and disaster risk strategies.

Long-term monitoring of coastal processes and ecosystems: allow for adaptive coastal/environmental management.

Introduction of Ecological Corridors: Encourage connectivity between coastal and marine ecosystems

Regional Scale protection: establishment of ecologically representative networks of MPAs within and beyond national jurisdiction to protect ecosystems at a regional scale.

Establish "Predictive Protected Areas": areas that show a level of resilience to climate change and could accommodate future refugia.

MPA's (marine protected area): increase effectiveness of MPA's and implements new MPA's and other marine protection practices.

A summary of prioritized recommendations as presented in the Environment Technical Brief[85] is presented below:

Short Term:

- Seek public sector buy-in during the consultative process with the sharing of information on the benefits received through healthy functioning ecosystems and the development of an ICZM plan;
- Encourage the use of nature-based solutions or green infrastructure as mitigation tools when addressing coastal rehabilitations issues or mitigations requirements for impacts;
- Develop a shared vision of the desired ecosystem condition that takes into account existing social and economic conditions in the ecosystem, and identify ways in which all parties can contribute to, and benefit from, achieving ecosystem goals; and
- Ensure technical information and information on the benefits that different individuals and groups receive from goods and services provided by the ecosystems that are identified during the consultations and flow to into the development of the ICZM policy.

Medium Term:

- Develop coordinated approaches among central & local governments and public - private sector agencies to accomplish ecosystem objectives, collaborating on a continuous basis with central and local, governments, and other stakeholders to address mutual concerns;
- Establish baseline conditions for ecosystem functioning and sustainability against which change can be measured; monitor and evaluate actions to determine if goals and objectives are being achieved;
- Promote the establishment of ecologically representative networks of MPAs within national jurisdiction to protect ecosystem structure;
- Determine top research priorities in areas of national importance for IZCM and coastal enhancements; and
- When developing the ICZM plan consideration should be given to the effective integration of scientific information with an understanding of how the ES affect the welfare of different individuals and groups within the society.

Long Term:

- Policies can then be developed to take into account ES trade-offs at multiple spatial and temporal scales. Successful strategies will recognize the inherent complexities of ecosystem management and will work to develop policies that minimize the effects of ES trade-offs;
- Develop ecosystem-based plans with properly targeted scenarios and strategies, included in larger national and local planning efforts (national development plans and marine spatial plans) and prepare for adaptive management responses; and

[85] CCS and SEV Consulting (2016) Environment Technical Brief

- Integrate the full suite of ecosystem-based management actions into poverty reduction, sustainable development plans and disaster risk reduction strategies, whenever possible.

K.5 Economics

K.5.1 Facts

- Ecosystem service (ES) values can inform decision-making and policy for coastal zone management:
  - We can identify economically valuable services that should be prioritized.
  - Use ES values to inform accounting measures and indexes that include environmental resources
  - Estimate the costs associated with environmental threats, which can help to increase support for and inform appropriate budgets for adaptation and mitigation measures.
  - Use ES values to inform damage assessments for environmental damage from oil spills or ship groundings.
  - Use ES values as an input in decision-making such as cost benefit analysis and decisions related to green investments.
- There is increasing pressure on ES from climate change – efforts should be made to preserve them as a matter of urgency[86].

K.5.2 Summary of Key Issues

There are a number of ways in which ecosystem service values can inform decision-making and policy for coastal zone management. Given the increasing pressure on ES from climate change, land use change, over-exploitation and pollution, which will only continue to grow, it is important these recommendations that promote social, economic and environmental development and preservation are implemented.

K.5.3 Summary of recommendations

Tourism is concentrated in coastal habitats - these areas need to be protected to ensure the sustainability of future tourism revenues, which are the cornerstone of the Bahamian economy. It is recommended that:

- Future management should seek to protect habitats which are valuable and which support tourism
- Future research should seek to identify those habitat sites where ES values are very high
- Local level stressors should be mitigated to increase resilience to large scale threats
- Full funding for MPAs needs to be achieved so that active management can occur
- Consider equity and sustainability related aspects of ES provision

Sustainable livelihood opportunities exist in areas related to the environment in the Bahamas that increase or maintain the capital of The Bahamas so it continues to underpin economic growth and improvements in wellbeing for Bahamian citizens. It is recommended that there is:

- Investigation of markets and provision of enabling conditions for payments for ecosystem services relating in particular to raw materials extraction, bio-prospecting, carbon sequestration and research

[86] Carpenter, S. R., Mooney, H. A., Agard, J., Capistrano, D., DeFries, R. S., et al. (2009). Science for managing ecosystem services: Beyond the Millennium Ecosystem AssESment. Proceedings of the National Academy of Sciences, 106 (5); 1305-1312.

- Promotion of The Bahamas as a world-class eco-tourist destination and expand this area of the tourism market, for which visitors will pay a premium.
- Sustainable livelihoods relating to eco-tourism, boat services, environmental monitoring, protected area management, research, renewable energy, coastal defence engineering, green technology sales and waste management should be promoted and invested in.

Incorporate ES values generated here into national level accounting using the UN SEEA “experimental ecosystem accounts” approach.

Update national level accounts annually as a monitoring tool for ES health and informing coastal management.

ES could be used to inform damage assessments in The Bahamas:
- Instigate fines for environmental damage - increase caution from potential polluters.
- Use present value calculations of ecosystem service values to inform damage estimates.

The value of the goods and services will increase over time, as they become increasingly scarce. They need to be quantified so that the true costs and benefits of decisions related to coastal management can be understood and factored into development planning, policies, it is recommended:
- Lost ecosystem service benefits are considered for habitat conversion
- Use cost benefit analysis and scenario analysis to understand the range of impacts resulting from land use decisions and coastal management policies.
- Consider trade-offs between different ecosystem services
- Consider trade-offs between different stakeholders
- Consider the full range of costs and benefits (including ES values) of extractive activities such as oil and aragonite extraction and aquaculture
- Use a spatial approach to identify those areas most meriting protection and those areas where extractive activities and development will minimize costs and trade-offs

A summary of prioritized recommendations as presented in the Economics Technical Brief[87] is presented below:

Short Term:
- Future management should seek to protect habitats which are valuable and which support tourism;
- Services related to coastal protection, erosion control, tourism and cultural values should be considered in terms of policy decisions;
- Full funding for MPAs needs to be achieved so that active management can occur;
- Promote The Bahamas as a world-class eco-tourist destination and expand this area of the tourism market, for which visitors will pay a premium;
- Sustainable livelihoods relating to eco-tourism, boat services, environmental monitoring, protected area management, research, renewable energy, coastal defense engineering, green technology sales and

[87] CCS and SEV Consulting (2016) Economics Technical Brief

waste management should be nurtured by increasing research, streamlining and clarifying legislation and using tax cuts or other fiscal measures to promote investment;
- Cost assessments should be conducted to value potential losses from threats as more information becomes available;
- Potential costs should be highlighted to the public and the government, to increase support for mitigation;
- Monitor threats to the coastal environment;
- Instigate fines for environmental damage;
- Use present value calculations of ecosystem service values to inform damage estimates;
- Invest in increasing capacity to conduct high quality economic research related to natural resources including ecosystem services to inform ICZM at graduate and postgraduate level;
- Monitor economic activity related to use of ecosystem services and natural resources regularly to test for sustainability; and
- Use cost benefit analysis to consider the full range of impacts from land use and management policy decisions and threats to the coastal environment arising naturally or from economic activity.

Long Term:
- Future research should seek to identify those habitat sites where ES values are very high;
- Local level stressors should be mitigated to increase resilience to large scale threats;
- Consider equity and sustainability related aspects of ES provision;
- Investigate markets and provide enabling conditions for payments for ecosystem services relating in particular to raw materials extraction, bio-prospecting, carbon sequestration and research;
- Increase the proportion of research grants going to Bahamian institutions;
- Incorporate ES values generated here into national level accounting using the UN SEEA “experimental ecosystem accounts” approach;
- Update national level accounts annually as a monitoring tool for ES health and informing coastal management;
- These costs should be used to inform appropriate budgets for mitigation;
- Consider and measure ES trade-offs between competing uses of coastal resources to understand the implications of different potential policy and management actions; and
- Use economic activity information to undertake management that maximizes net benefits to the Bahamas.

K.6 Climate Change Vulnerability and Adaptation Considerations

K.6.1 Facts
- Policy and planning tools help increase resilience and capacity for climate change adaptation (CCA). They can be used alongside engineered solutions to sea level rise, flooding and increased storminess.
- It is imperative that engineering solutions compliment policy and planning tools in order to achieve integrated Disaster Risk Management (DRM) and CCA strategies that effectively address climate change vulnerabilities – CCA and DRM can be combined to provide recommendations for comprehensive CCA considerations for ICZM.

K.6.2 Summary of Key Issues

Coastal erosion/flooding and the impact of climate change on the coastal zone are priority issues. Vulnerability and adaptation to these risks may be better achieved through the development of a national land use management plan, the generation of increased public awareness and cooperation with other stakeholders and the integration of coastal activities by a CZM unit.

K.6.3 Summary of recommendations

Develop a comprehensive National Land Use Management Plan for the entire Bahamas which incorporates climate change concerns, and makes prescriptions regarding the location of coastal developments based on them.

- Coastal developments based on a national land use management plan will help The Bahamas achieve more sustainable infrastructure in the coastal zone.

Generate increased public awareness regarding climate change impacts on the coastal and marine environment, through Public Education and Outreach (PEO) activities.

- This will enable sectors building and developing the coastal zone to integrate their management schemes for disaster and climate change-related risks with the interests of the public and other stakeholders involved.

Establish a Coastal Zone Management Unit to integrate coastal activities, inclusive of appropriate monitoring and risk assessment and mapping, to formulate appropriate response adaptation measures, as well as to compile Geographical Information System (GIS) datasets for all the major islands of The Bahamas.

A summary of prioritized recommendations as presented in the Climate Change Vulnerabilities and Adaptation Considerations Technical Brief[88] is presented below:

Short Term:

- Establish an ICZM Unit to ensure climate change concerns are incorporated into other national policies and plans, and regularly meet with agencies which have responsibilities in the coastal zone to bring further awareness to issues, challenges and best practices in ICZM;
- Build adaptive capacity regionally and locally; utilizing forums such as the Caribbean Climate Outlook Forum (CariCOF), and the annual planning meeting for disaster risk managers organized every hurricane season on each island by the National Emergency Management Agency (NEMA); and
- Foster PEO activities to increase awareness of opportunities for stakeholder engagement in DRM and CCA, through multimedia communications and inclusive participatory activities. Establish an ICZM Unit.

[88] CCS and SEV Consulting (2016) Climate Change Vulnerabilities and Adaptation Considerations Technical Brief

Medium Term:

- Support Hazard/Sensitivity Mapping and DRMSIS Pilot Project, which will increase availability and access to GIS data that can be used to create higher resolution models of flood vulnerability maps and other tools for robust-decision making in town and emergency planning; and
- Create community adaptation plans tailored to specific needs of each community in order to demonstrate effectiveness of CCA directives that can be scaled up to national level.

Long Term

- Advocate appropriate engineered solutions to protect coastal resources and assets sustainably, thereby avoiding maladaptive practices that may limit environmental and socioeconomic opportunities; and
- Prescribe locations of coastal developments, utilizing all of the aforementioned recommendations, to protect the sustainability of natural and built environments and ensure adaptation funds are not spent on shoreline protection haphazardly.

Appendix L. Institutional Assessment Report