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## Honiara Coastal Environment Impact Assessment, Solomon islands





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Suva, Fiji, 2021

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## ABBREVIATIONS

CEIA	Cumulative Environmental Impact Assessment
CO2	Carbon dioxide
EAI	Environmental Impact Assessment
HCC	Honiara City Council
ICMASP	Integrated Coastal Management and Adaptation Strategic Plan
IWR2R	International Waters Ridge to Reef
NDS	National Development Strategy
OBMs	Outboard motors
EMS	Environmental Management System
R2R	Ridge to Reef
SSEC	South Seas Evangelical Church

## EXECUTIVE SUMMARY

The purpose of this study is to develop a cumulative environmental impact assessment (EIA) for the Honiara Coastal Environment Baseline Assessment, comprising of supplementary assessment reports of Biological and Ecological, Bathymetry and Hydrology, and Water Quality as part of the 'Ridge-to-Reef' (R2R) programme. To develop this R2R assessment, information on cumulative coastal environmental impacts and related details were collected, collated, and written up into an CEIA to address the impacts of interactions between activities, and the accumulation of impacts over time.

Honiara is a highly developed and built-up area and does not contain areas of high biodiversity value such as in other parts of Solomon Islands. The four main development types along the study area are:

1. Seawall, reclamation, and erosion control activities;
2. Building activities including both residential and commercial;
3. Fishing and recreation activities; and
4. Transport and wharf related activities.

The major relevant impacts of these developments are; coastal soil erosion, sedimentation and siltation, loss of flora and fauna, landform modification, waste and pollution and oil spill risk.

There are 2 main recommendations from this study:

1. The development of a database to store, observe and manage developments and related information within Honiara; and
2. The development of an integrated coastal management and adaptation strategic plan for the area.



Figure 1 Gillnet fisherman in dugout canoe at Mataniko



## INTRODUCTION AND BACKGROUND

### Study Area

Honiara is the capital city of the Solomon Islands and situated on the central northern coast of Guadalcanal Island (Figure 1). Honiara was established as a town after WWII to take advantage of infrastructure developed during the war. During the early days of Honiara, the dominant coastline features were, river mouths and wharves with the main one being at Point Cruz. A key central feature of the Honiara topography is the Mataniko River which runs through the centre of the city.

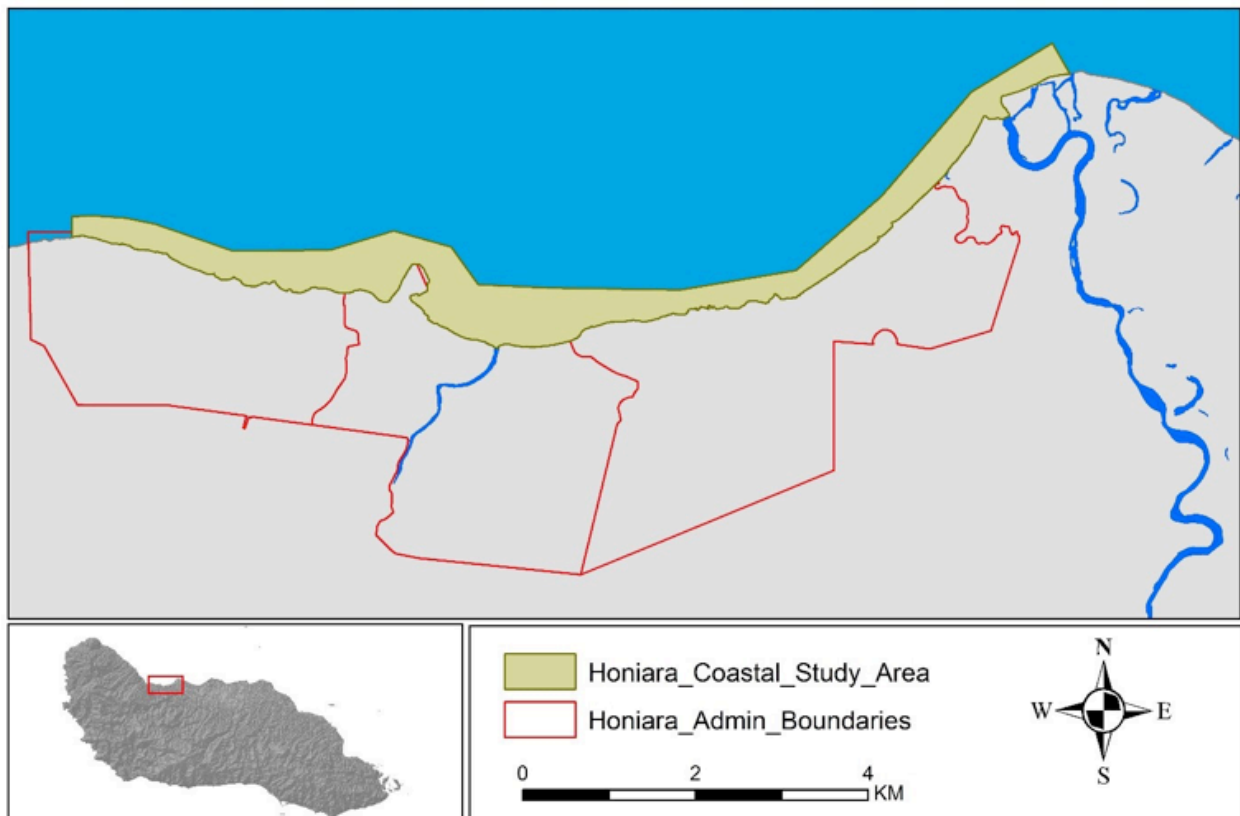


Figure 2 The focal area of this study is the coastal area from Lungga river mouth to White River mouth 200 meters out from the high tide mark, which is basically the Honiara Sea front.



## Study Purpose

The purpose of this study is to develop a cumulative environmental impact assessment (EIA) for the Honiara Coastal Environment Baseline Assessment, comprising of supplementary assessment reports of Biological and Ecological, Bathymetry and Hydrology, and Water Quality as part of the 'Ridge-to-Reef' (R2R) programme. The goal of the Pacific Islands National Priorities Multi-Focal Area R2R programme is to "maintain and enhance Pacific Island countries' ecosystem goods and services (provisioning, regulating, supporting and cultural) through integrated approaches to land, water, forest, biodiversity and coastal resource management that contribute to poverty reduction, sustainable livelihoods and climate resilience".

The Solomon Islands International Waters Ridge to Reef (IWR2R) Project focuses on reducing environmental stress by improving watershed catchment management and sustainable land use. Consequently, a Coastal Impact Assessment is required as an initial task for IWR2R to undertake Honiara Coastal Environment Baseline Assessment. Prior to the coastal environment in Honiara, studies have been already undertaken by other governmental and non-governmental organizations, however, to avoid duplications, the national R2R project has procured local consultant services to undertake desktop reviews and collate existing data in consolidating a baseline report for the Honiara coastal environment.



*Figure 3 Ships docking at Point Cruz wharf*

## Study Methodology

To develop this IWR2R Coastal Environmental Baseline Assessment, information on cumulative coastal environmental impacts and related details were collected through literature and desk review as well as direct observations during field visit. This was then collated and written up into an EIA to address the impacts of interactions between activities, and the accumulation of impacts over time. A Cumulative Environmental Impact Assessment (CEIA) is an assessment of cumulative impacts requires consideration of concepts, which are different from the conventional approaches used in EIA. Some of these are:

- Assessment of impacts during a longer period into the past and future;
- Evaluation of significance in the consideration of other than just local and direct effects (such as indirect impacts, cumulative impacts, and impact interactions);
- Assessment of impacts over a larger (i.e., “regional”) area.

Cumulative impacts occur as interactions--between actions, between actions and the environment, and between components of the environment. The main process of this CEIA is:

- Scoping
- Assessment of Impact
- Evaluation of Significance.

The structure of the document is summarized as follows:

- Introduction
- Policy and Legislation
- Description of Developments
- Description of Environment
- Impacts
- Management and Mitigation

## POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The Environment Act (1998) provides the mandatory requirements for the development of this CEIA. Other major laws and regulations for environmental management in the Solomon Islands are listed below. This Environment Act was passed in 1998 and is an act to make provision for the protection and conservation of the environment, the establishment of the Environment; the establishment of the Environment and Conservation Division and the Environment Advisory Committee and for matters connected there with or incidental there to. The scope of application of this Act applies to land, the seabed out to the limits of the continental shelf and anywhere within marine waters, other than the seabed, out to the limits of the exclusive economic zone. The Act definition the environment is that it “includes the components of the earth (land, water, air) and all organic and inorganic matter and living organisms, all natural and social systems and their constituent parts, and the interactions of their constituent parts, including ecosystems, people, communities and economic, aesthetic, culture and social factors”.

The main objectives of the Act are:

- To provide for and establish integrated systems of development control, environmental impact assessment and pollution control
- To prevent, control and monitor pollution
- To reduce risks to human health and prevent the degradation of the environment by all practical means, including the following: regulating the discharge of pollutants to the air, water (ocean, surface waters or groundwater) or land; regulating the management, transport, collection, treatment, storage, and disposal of wastes; promoting recycling, re-use, and recovery of materials in an economically viable manner.

Section 15 of the Act it imposes the general duty to consider environmental impact. The duty is vested upon the Director, the Division, and the relevant public authority to consider the environmental impact. They will also consider the grants for approval for any existing or proposed development or further expansion in any existing development. They shall have regard, as far as practicable, to the effect such development or expansion would have on the environment. Section 17 provides a guidance to any developer who proposes to carry out any prescribed development in the Solomon Islands. The developer must make application to the Director in such form as may be approved by the Minister.

The Town and Country Planning Act 1979 was Amendment and passed by the National Parliament on thirteenth day of February 2017 and was substituted as Planning and Development Act' in 2017. The Town and Country Planning Act 1979 provides a principal mechanism for the Administration of Town and Country Planning in Solomon Islands, the Making of Local Planning Schemes, the Control and Development of Land and for Matters Connected Therewith and Incidental Thereto. The objective of this Act is to ensure that land in the Solomon Islands is developed and used in accordance with properly considered policies that are formulated on adequate information and are directed to promote the welfare of the inhabitants of the Solomon Islands and others who resort thereto; and, accordingly, the functions conferred on any public body by this Act shall, in accordance with this Act, be exercised in such manner as it considers most suitable for attaining that end.

The Wildlife Protection and Management Act 1998 and Management Regulations 2008 provides for the protection, conservation and management of wildlife that include birds, reptiles, amphibians, mammals, insects, plants, and marine organisms in the Solomon Island by regulating the export and import of certain animals and plants specimens. This Act complies with the obligation under the convention on international trade in Endangered Species.

Two pieces of subsidiary legislation were created under this Act:

- Wildlife Protection and Management Order 2014; and
- Wildlife Protection and Management Regulations 2008.

The Protected Areas Act 2010 also provides for the declaration and management of protected areas or areas where special measures need to be taken to conserve biological diversity and the regulation of biological prospecting research and for related matters.

The Fisheries Management Act 2015 provides a provision for the conservation, management, development and sustainable use of fisheries and marine resources of the Solomon Islands, to monitor and control fishing vessels within and beyond the fisheries waters, to repeal the *Fisheries Act 1998* and to make consequential amendments to the Provincial Government Act 1997 and the *Town and Country Planning Act (Cap. 154)*. The objective of the Fisheries Management Act is to ensure the long-term management, conservation, development and sustainable use of the Solomon Islands fisheries and marine ecosystems for the benefit of the people of Solomon Islands.

The Delimitation of Marine Waters Act 1988 is to make a provision for the demarcation of the marine water appertaining to the Solomon Islands, to declare the rights of the Solomon Islands to any matters connected there with and incidental. The following regulations provide a definition that is relevant to the marine waters of the Solomon Islands that is particularly know us:

- Internal waters
- Territorial waters
- Exclusive economic zone
- Continental shelf
- Legal character of marine waters
- Right of passage
- Ability to make regulations.

The Honiara Urban Resilience & Climate Action Plan 2016 provides a blueprint for implementing priority action to address the vulnerability of the city to disaster and climate change while maintaining the capacity to meet the overarching HCC goal 'to be acknowledged as a clean, safe, harmonious, environmentally responsible, prosperous and resilience capital city providing a high quality of life for its multi-cultural community and its visitors'.

The National Development Strategy 2016-2035 with the overall vision of 'Improving the Social and Economic Livelihoods of all Solomon Islanders, the projects fall suitably under the two main objective of the NDS and that is to 'Sustained and inclusive economic growth and Poverty alleviated across the whole of the Solomon Islands, basic needs addressed'.

## DESCRIPTION OF THE BASELINE AND EXISTING ENVIRONMENT

Honiara is in a highly developed area (Figure 2) and it does not contain areas of high biodiversity value such as in other parts of Solomon Islands. For this reason, the environment and ecology in Honiara have not been the subjects of significant environmental research or scientific baseline studies. However, the current marine and coastal ecosystem of Honiara still plays an important function to the people of Honiara. This map below shows the coastal landforms along the coast of Honiara that refers to the remarkable change in term of shape from natural to manmade landscape. Most of the reef system of Honiara is located at the western side of white river to the Ports area. The Coastal landforms of central Honiara are modified seawall, building, wharf, and reclamation development with limited sand located in front of Mataniko River. The landforms from the east coast of Honiara along the Ranadi to Lungga river front is tied with sandy beach and gravel and is known as an industrial zone of Honiara. There is a possibility for certain landforms and coastal features of Honiara that are more vulnerable to industrial development and climate change and sea level rise.

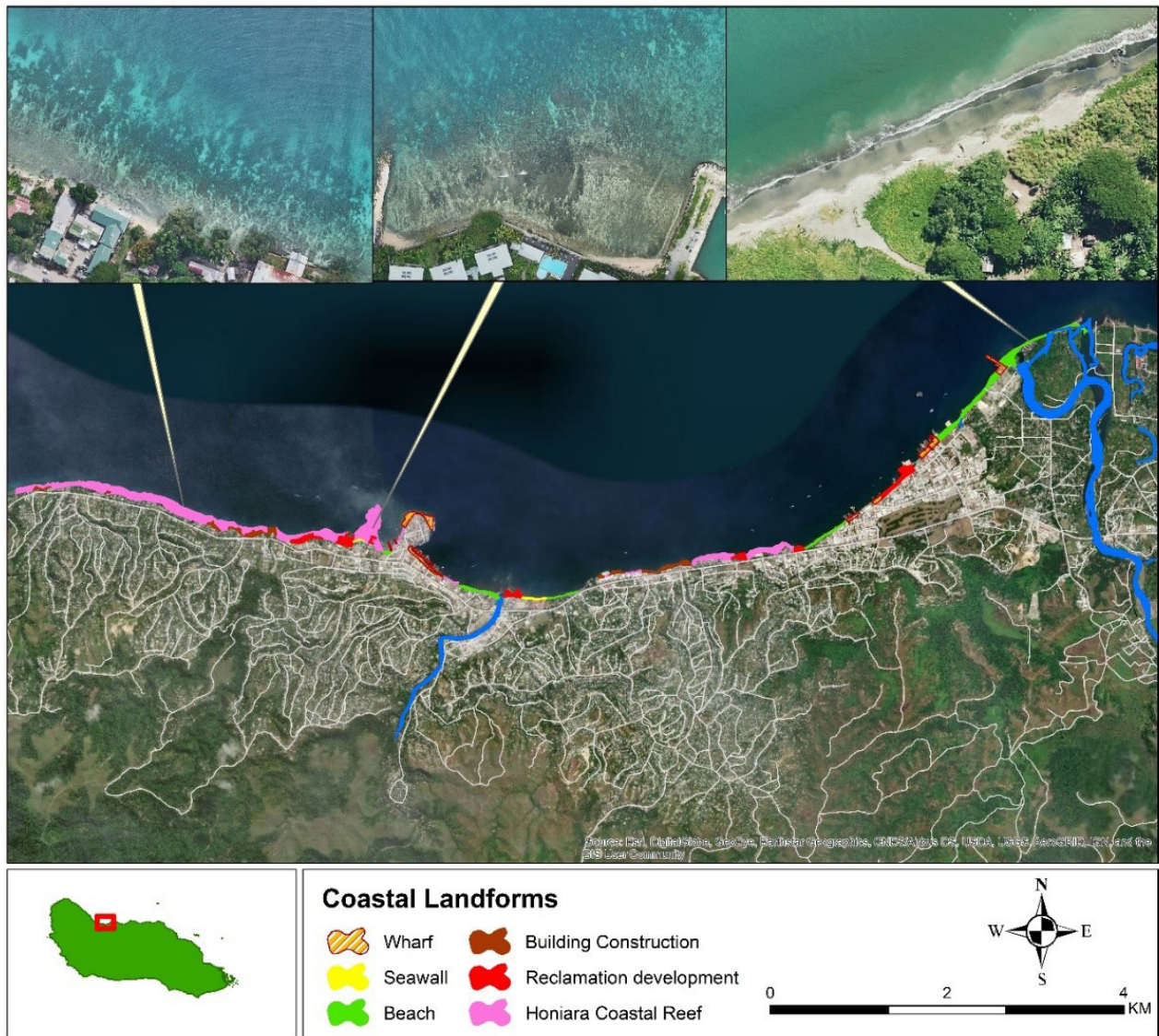


Figure 4 Honiara Coastal Landforms

## Physical

For this study, the physical description of the site was based on the primary observation of the physical features of the coastline, and the bathymetry data was produced by the bathymetry survey team during the study. The whole coastline area was divided into two (2) separate regions to clearly present the physical description of the study site.

For the eastern Honiara intertidal zone area, the coastline was observed to have a higher percentage of black sand deposits with fewer coral patched areas. This includes few parts of the west coast of Honiara starting from the Mataniko River through the Mamana water settlement, the United Church and the SSEC Church, the Honiara Central Market and eventually to the Honiara's main sea Port intertidal zone areas. There are several reasons for this occurrence, and it includes; - the long shore drift which carries the sediments (rocks and silts), in an easterly direction, the geographical position of the Mataniko River within the Honiara city boundary, where it continuously carries high loads of sediments and silts during rainy days and bad weather conditions. This includes the high tides where it also carries high loads of sedimentation to the shorelines from the ocean. The high concentration of sand deposits along the intertidal zone area of East Honiara was due to the high rate of physical developments such as excavation and land clearances for site developments, and other dredging activities that continued to occur inland. These factors are also same for the Lungga River where it also contributes to the high deposition of sand in a westward direction along the coast of Honiara due to the ocean currents that continues to impact the intertidal zone area of the study site. Additionally, the geophysical setting of the entire east Honiara coast where it has a longitudinal coastal feature.

For the west Honiara intertidal zone area, most of the shoreline compositions are made up of corals and molten rocks. This is largely due to the; - low ocean currents impacting the coastline area of the western end of Honiara, an earlier eruption of the nearby Savo Island volcano where it has resulted in higher rates of molten rock deposition along the coastline, a low level of soil erosion from the streams where they tend to carry limited sedimentation loads, rocks and silts as compared to the large rivers such as Mataniko and Lungga rivers. The shallow and narrow coral strip features along the west Honiara coastline with deeper depths at the edge of the corals, which stretches towards the offshore areas. The general feature for the entire coastline of east Honiara intertidal zone was mostly comprised of black sand whilst for west Honiara coastline, it was mostly made up of corals and rocks.

## Ecological

There are four major substrates found throughout the Honiara coastline with sand being the dominant substrate followed by boulders, dead coral then live coral. As such the benthic habitat within Honiara can be considered to have relatively low habitat and ecological value. Fine-scale assessments of benthic communities in the western section of Honiara had shown the dominance of sub massive and massive coral growth forms, a variety of the stony coral family *Poritidae*, belonging especially to the genus *Porites* spp. Fifteen genera and nine families of corals was identified in Honiara with other common invertebrates like *L. laevigata*, *H. atra*, *D. setosum*, *N. niloticus*, *A. planci* and *T. maxima* recorded. A total of 31 species of reef-fin fish was recorded for Honiara with *Pomacentridae* being the most dominant in diversity and abundance which is a lower reef fish fauna in contrast to most sites throughout the main archipelago of the Solomon Islands. The overall coastal reef conditions of Honiara are poor. The overall average of live coral cover is 5.83% which is low with live coral cover rapidly degrading from the west to east Honiara.

## Economic

The major economic activities that occur within the focus study area are transportation, recreation, and fishing and infrastructure development activities. For transportation, these include large ships and small boats to transport both goods and people. Honiara is the largest port and urban location in the Solomon's which means a high amount of people and goods from large shipping containers with imported items to local products for the communities pass through these waters both coming in and going out. The largest port houses the Point Cruz docks which cater to international freighters, inter-island ships and smaller outboard motorized boats and a small number of dugout canoes. Port activities include the loading, unloading and storage of goods from both international and national sources. The Honiara coastline is home to 4 major hotels which also offer guests access and use of the coastline for recreational purposes such as swimming, fishing, or paddling. For fishing, small scale local fishing occurs along these areas mainly by sink line or mesh netting at the river mouth and fish are also collected from fishing vessels for sale at local markets. There is also the presence of large infrastructure development activities such as seawalls including land reclamation and the infrastructure of port and transport facilities such as wharves, boat ramps and buoys for the use by ships and boats.

## Social

The social impact of Honiara coastal zone is used extensively and increasingly for the large of numbers of activities from human development. Some of the activities are not always compatible and may lead to a wide array of the problem that increases pressure on the coastal ecosystem. The coastal of Honiara provides a wide array of direct ecosystem services, providing livelihoods, raw materials, transport opportunities and waste disposal services. The shoreline of Honiara is an increasingly high demand for human settlement, recreational and activities such as shipping and fishing boats.

The main central business district of Honiara is located on the flat land of the coast. Within the greater Honiara boundary, the land is used for government facilities, education facilities and central hospital, Solomon Islands National University, commercial and business building facilities, industrial area, and residential area. Most of the residential area occupy the hills and some resides along the valley in the south and southwest of Honiara. The eastern region of Honiara where Lugar and Henderson areas is used for residential and cultivated for farming purposes.

The living conditions of Honiara city is urbanized compared to the other provinces in the Solomon Islands and the remote communities in Guadalcanal province. However, many households in Honiara still collect firewood for cooking from the coastal and forest of Honiara, especially those urban settlements along the coast of Honiara. The fishermen from the coastal settlements are reliant on the coastal zone of Honiara for fishing, to supplement their food and income supply. Some community members still fetch water from stream and groundwater. A major concern here is the domestic wastewater that comes from households, as it needs treatment or proper storage rather than dumping into rivers and streams. Many households in Honiara collect raw material such as sand, gravel, coral rock, stones along the coast of Honiara for building and construction. Those human activities have contributed to the increasing pressure on the coastal ecosystem of Honiara.



*Figure 5 Wharf construction at Ranadi*

## **DESCRIPTION OF THE CURRENT AND FUTURE DEVELOPMENTS**

The four main development types along the study area are seawall, reclamation, and erosion control activities, building activities including both residential and commercial, fishing and recreation activities and transport and wharf related activities. This section will briefly describe the physical and operational characteristic of each major development type.

### **Seawall and reclamation and erosion control activities**

The physical characteristics of seawalls are a form of coastal defence constructed where the sea and associated coastal processes impact directly upon the landforms of the coast. Its purpose is to protect the land area from the action of tides, waves, or tsunamis. Predominately constructed with concrete and filled in with limestone, gravel or mixed substrate that is either along existing coastline or built into the sea as reclaimed space. A common feature is the use of concrete X-blocs which act as wave protection in breaking up wave energy. The operational characteristics of seawalls, erosion control developments and reclaimed areas are the continued use of reclaimed space for property or building developments as well as the maintenance of these areas from coastal erosion and storm damages.



## Building construction activities both residential and commercial

The physical characteristics of buildings (residential and commercial) are built-up areas in nature made of concrete, steel, timber, and other materials. The operational characteristics of these buildings are the actual use of buildings for habitation and business which can range from small apartments, large houses to offices, retail outlets and large industrial and manufacturing buildings. Such developments have on-going activities and outputs including maintenance, upgrades as well as the creation of waste including solid, liquid, and hazardous materials.

## Fishing and recreational activities

The physical characteristics of fishing and recreational activities are boats, including dug-out canoes, kayaks, jet skis, outboard motors, and fishing vessels as well as fishing and recreational gear such as cast net, gillnets, fishing hand lines and diving and snorkelling gears. The operational characteristics of fishing and recreational activities are the use of space by people for, swimming, surfing, sport, fishing, boating, and diving. There are few types of recreational areas along the coast such as the Children's Park. The Children's Park in Rove is opposite the police headquarters and on the eastern side of the main road. The size of the area is about 50 meters square, with few trees are planted in the area. Most activities occur from residential as well as hotel sites.

## Transportation and wharf related activities

The physical characteristics of transportation and wharf related activities are the transport vehicles themselves such as the canoes, OBMs, boats and ships as well the departure or transfer areas for these vessels such as wharves, slipway, ramps, landing beaches, anchorage sites and buoys. The operational characteristics of transportation and wharf related activities are use of these vessels and docks, the movement of goods and people as well as the waste produced. Today the coastal shipping is locally owned by a Solomon islander, and it is used for coastal and inter-island transport, ferrying cargo and passengers throughout the islands. The international shipping is generally large container vessels and non-cargo ships, such as fishing mother boats, cruise ships, naval boats, and survey ships. The seaport of Point Cruz, Honiara is the main port in Solomon Islands and serves as link between the international and domestic sea routes.



*Figure 6 Seawall with Xblocs and limestone fill at Ranadi*

## POTENTIAL EFFECTS BY THE DEVELOPMENTS

This section will describe the potential direct, indirect, and incremental effects on the environment including the socio-economic setting by the observed current and potential major developments along the study area.

### Seawall & reclamation and erosion control activities

Potential direct effects of seawall, reclamation and erosion control activities are the modification of natural coastline habitats including the flora and fauna. This may result in the loss of species, ecosystems as well as areas for socio-economic use. However, the creation of these developments can also result in the creation of new, habitats and spaces for socio-economic use. Potential indirect effects of seawall, reclamation and erosion control activities are the modification of coastal currents and beach flows which in turn can affect species such as fish through loss of habitat. Potential incremental effects of seawall, reclamation and erosion control activities are the eventual creation of new habitats and species. These may be beneficial to people or may result in further stress of alien or foreign species establishment. Ultimately, however, coastal protection and reclamation activities should result in the enhancement and protection of current and increased socio-economic activities.

### Building construction activities both residential and commercial

Potential direct effects of building construction activities (residential and commercial) are the modification and loss of the natural environment, habitat, and species. However, constructing these buildings will result in the creation of socio-economic use space. Potential indirect effects of building construction activities (residential and commercial) are the modification of the wider coastal environment and eventual loss of habitats and species. An indirect change is that the socio-economic activities in this space will be lost such as fishing sites. Potential incremental effects of building construction activities (residential and commercial) are the reduction of biodiversity, abundance and diversity, and the creation of a new built-up niche which may favour invasive species. These activities will lead to a domination of built-up space to support socio-economic activity in the long-term.

### Fishing & Recreation activities

Potential direct effects of fishing and recreation activities have a potential negative impact for fishing area along the coast of Honiara where it is important to the coastal communities. The increase in the number of vessels coming in and out of the area, will also disturb their fishing activities. These communities will also be disturbed by the current development along the coastal. The fishermen from the coastal settlements along Honiara stated that they are reliant on coastal zone for fishing for food and sales for small income. Therefore, if these fishing areas are disturbed by the current and future development along the coastlines, there is a potential impact for fishermen and coastal communities of Honiara to experiences scarcity of marine resources. Potential indirect effects of fishing and recreation activities are pressures on coastal zone of Honiara that related to infrastructure construction, waste, and sewage. There is a high possibility for negative impacts which include habitat fragmentation, water pollution, and spill waste accidently entering the water and poisoning the marine species that may lead to serious human health implications. The social impact of infrastructure construction, waste, and sewage on the coastal ecosystem is that it will affect the coral, fish and living organism which the people are depending on. Potential incremental effects of increased fishing and recreation activities will be the reduction of fishes due to overharvesting and potentially increased traffic and pollution from more recreational users of this space.

## Transportation and wharf activities

Marine transport is one of the major components of the transport sector in the country. The marine transport is vital, but there are a lot of activities that may lead to the environmental impact from ships. The general condition of the domestic shipping fleet is poor, and many coastal ships are old. This leads to low safety standards and poor reliability of the services. In addition, there is also a high possibility for the oil, bilge and motor fuel leakage, gasoline and diesel oil leakage from these ships that will pollute the water. The waste production and noise generated from large ship engines will also have an impact on the coastal ecosystem.

Potential direct effects of transportation and wharf activities are pollution. In port environments, there are a lot of activities that may lead to water pollution such as; loading and unloading petroleum products, pumping ashore fuel from larger vessels to tank farms and transport trucks, cargo handling equipment, ships maintenance and modification (accidental discharge of oil and spill of chemicals in the sea), stormwater runoff from port parking lots to the coast. Sources of noise can be individuated in port areas in the following three main areas: passenger car and heavy vehicle (trucks) road traffic (the most important one), goods movement (from machinery), noise from traffic rail movement in port and surrounding areas. There is a potential impact for all the industrial activities in ports to cause environmental pollution and wastes and noise generation. Potential indirect effects of transport and wharf related activities include; coastal pollution from shipping, particularly around harbours and wharves, and the sites of wrecks; disposal related waste from transport, industrial effluents, sewage, urban and river runoff, natural seepage, offshore oil production and destruction of landscapes because of poor operating practices at quarries and on construction sites. As the environment is important to the economy of the Solomon Island, there is a need to mitigate potential negative impact of development. Potential incremental effects of increased transportation and wharf related activities will increase pollution and the potential for a major disaster such as oil spill. Increase traffic will also have a detrimental effect on the natural wildlife and environment.

## RELEVANT IMPACTS

These are potential negative implications or impacts from the developments. This section continues to align the effects and risks identified in the previous chapter under each specific development activity under a major impact. These major relevant impacts are coastal soil erosion, sedimentation and siltation, loss of flora and fauna, landform modification, waste and pollution and oil spill risk.

### Coastal Soil Erosion

One of the major impact likely to occur is the coastal beach or soil erosion. Modified coastlines can result in soil loosening its compactness and encourages soil erosion into the coastal water. Lack of proper drainage can also further exacerbate the problem and can lead to flooding in the area, whenever there is a high-intensity rainfall event. Though most coastal developments consider and mitigate against coastal erosion, these activities can also exacerbate and transfer impacts to adjacent sites. Extraction of gravel and sand along the coast would result in the direct loss of the coastal beaches. Additionally, with the impact of climate change and sea-level rise this would enhance the erosion rate on the beaches.

### Sedimentation and siltation

Sediment runoffs are inevitable and already happening along coastal areas. This is due to two reasons; the fill materials that were deposited onsite have no retention walls to protect them from eroding and the site is an open coastal sea space and very prone to storm surges, with little reef protection. Unlike sediments deposited by surface water systems, which are highly concentrated in silts and other debris, sediments from the fill materials are coralline in composition and exceptionally fine. They are also not concentrated and are easily dissipated. In other words, the sediments are white sand after the disintegration process by wave actions. For the impact characteristics, they are highly localized and short term, with minor consequences for the benthic communities. Apart from raw sewerage, another major source of marine pollution to the coastline of Honiara city is the sediments from the rivers and streams. Nutrient and sediments runoffs during the operation phase, siltation, and as the structures ages, it will likely impact the ecosystems especially in the water.

### Loss of Flora and Fauna

The Honiara coastline has had much disturbance since WWII and a lot of disturbance to the habitats and species both on land and in the water system have occurred. Therefore, the current biota of flora and fauna is much heavily reduced than original natural state. However, if developments continue, the loss in marine biodiversity will likely continue.

### Landform modification

The clearing of land and sea-shore reclamation are likely to have some negative impact on it imitate surrounding through modification of natural landforms. The landfill works are potentially harmful to the coastline, with possible consequences to adjacent areas. The likelihood of these areas losing their shape, behavioural characteristics and composition can be considered major problem. With the currents, prevailing wind direction and wave actions which act as the controlling and forcing mechanisms in coastal landforms, the behavioural characteristic of coastal landforms is compromised through developments, assisted by the absence of any littoral drift. This will be a long-term impact though it is expected to be localized in spatial scale.

## Waste and Pollution

Solid waste management is a challenge not only for Honiara but, the country at large and this is underpinned by the fact that relevant agencies are inadequately resourced in terms of funding support, ineffective legislation, and poor planning, amongst others. Poor waste management practices have detrimental consequences for the environment (reefs, lagoons, beaches, and land), which in turn can affect the tourism industry. It is anticipated that solid wastes through the likely sources of metals, plastics, papers, and domestic household wastes such as discarded food and other biodegradable materials will continue to be a major issue. It is a common occurrence for PET bottles, aluminium cans, biodegradable wastes to be haphazardly discarded, where commercial and household activities are located.



*Figure 7 Coral Sea Hotel development at Townground*

## Oil Spillage Risk

Fuel and oil leaks are a potential impact that is possible in the future of the Honiara coast as a major port. The oil spillage can be detrimental to the aquatic biodiversity due to its toxicity to biota. Key sources of potential oil spills are from large marine vessels and the fuel depot.

## RISK AND ENVIRONMENTAL MANAGEMENT, MONITORING AND MITIGATION PLAN

With specific reference to the impacts described in the previous chapter, an analysis has been carried out using a risk matrix. The management, monitoring and mitigation of these risks will then be highlighted in the following plan.



*Figure 8 Rubbish dump on coastline at Kukum*

## Risk Matrix

Based on the relevant impacts, a risk matrix has been created to determine the level of risk which is based on the likelihood and severity of impact (Table 1). Likelihood – the probability or chance of an event occurring. Severity – the cost or damage of an occurrence of the event.

Table 1. Risk Formula of Likelihood vs Severity = High, Moderate, Low

	Low Chance	Moderate Chance	High Chance
Low Severity	Low	Low	Moderate
Moderate Severity	Moderate	Moderate	Moderate
High Severity	Moderate	High	High

## The major impacts and risk matrix

The risk matrix table below (Table 2) shows the major impacts that were identified during the study along the coastal areas within the Honiara City boundary area, from Lungga river mouth point to White River mouth point on Guadalcanal Island, Solomon Islands. The risk matrix has taken into consideration the direct impacts that the identified factors have on the environment, the social and the economical aspect of Honiara City.

Table 2. Summary risk table for each impact in relation to environment, society, and economics

	Environment	Social	Economic
Coastal Soil Erosion	Low	Moderate	Moderate
Sedimentation and siltation	High	Low	Low
Loss of Flora and Fauna	High	Moderate	Low
Change of Landform	High	Low	Low
Waste and Pollution	High	Moderate	Low
Oil Spillage Risk	High	Moderate	Moderate

## Coastal Erosion

Though Honiara City was overpopulated compared to the other 8 provincial sub-centres around the country, infrastructure developments and other man-made developments along its intertidal zone areas have a minimal impact on the Honiara's foreshore areas. The reason for this is because during this study, there is a lower identification of coastal erosions which are attached to the ongoing infrastructure developments along the foreshore areas within the city boundary. Infrastructure developments such as the construction of seawalls, retention walls, wharves, backfilled coastal areas remain stable without causing any major coastal erosion which may cause a detrimental impact on the environment. The other considerable factor too was that it reflects the work of the environmental

law enforcement institutions based in Honiara City in their process of enforcing proper control and enactment of their respective regulations on developers along the intertidal zone areas of Honiara City. These include the Ministry of Environment, the Ministry of Health and Medical Services and the Honiara City Council.

The social aspects that coastal erosions might have on the people's livelihoods remain on a moderate level in Honiara City boundary. This happens because of considerable climate change factors which have many direct impacts on Honiara City residents who are living along the foreshore areas of the city. Some of the noticeable examples of the climate change factors are - the unpredictable state of cyclone intensities of the country, the ongoing sea-level rise, the unpredictable storm surges, flash floods, king tides and the high-intensity gale forces which develop during cyclonic seasons. These climate change factors remain a risk to the Honiara city residents, especially those who are living along the coastal areas because they are faced with the direct impacts when those climate change associated factors occur. These occurrences have posed many risks to the lives of the coastal residents because their seafront areas are prone to coastal erosions during bad weather and cyclone seasons. With that, factors such as relocation also remains an issue for these residents, however, this will very much depend on the availability of space inland as there are also current land tenure issues between the Guadalcanal Province Administration, the Tandai House of Chiefs, the Hautaba House of Chiefs, and the National Government.

The economic aspect of the coastal erosion occurrences along the intertidal zone area of Honiara City boundary –study area- remains at a moderate level. This is because there are past incidences which have a direct link to coastal erosion which has affected business houses. These include damages to the seawalls on reclaimed areas where business houses are located, during bad weather situations causing business to close for a period e.g., the business houses which are situated along the Kukum highway (retailers and wholesalers) and those such as the Tropicana beach resort in west Honiara. Due to these unwarranted closures, business owners and their daily customers are directly affected. However, this situation does not last long as their coastlines are continued to be maintained by the responsible landlords and the owners of the business areas after the bad weather seasons.

## Sedimentation and Siltation

The level of sedimentation and siltation along the intertidal zone area of the study site remain high. This occurs due to the following identified factors:

- Unregulated Infrastructure developments inland.
- Inland excavation for residential and commercial developments.
- Unpredictable heavy rainfalls inland which resulted in frequent soil erosion and surface runoffs.
- Establishment of quarry sites along the Lungga River which involved river dredging activities by construction companies in Honiara. This has resulted in high sedimentation loads in the river which eventually washed down to the foreshore and the offshore areas of Honiara City boundary.
- Increased number of sea transportation activities for the movement of goods and services in and out of the Honiara ports area. This is especially the huge foreign liners, cargo ships, tourist boats, oil tankers, steamers, and other commercially operated vessels. These vessels also create high loads of sedimentation and siltation due to the up swirls of the seabed sediments through their propelled engines.
- High ocean currents which continue to disperse and move sediments into the Honiara City Bay.

- Many unregulated water and effluent discharging points along the study site-Honiara City intertidal zone area.
- Many natural streams with the two (2) larger river mouth openings along the foreshore area. This includes, Lungga river, Mataniko river, Mbokona stream, botanical garden stream, and the White River stream including other streams which have ran through the residential areas up stream to form the river deltas. These rivers and streams allow for the transportation of soil sediments and silts down to the intertidal zone area which also contributes to the level of sedimentation and silts of the study site. Mostly, the increased load of sediments has resulted from heavy land degradation activities inland due to the higher social demands of the Honiara City population.
- Increased residential buildings (roof tops) and pervious surfaces inland.

The impact of sedimentation and siltation on the social aspect within the study area remained low. This is because the level of sediments and siltation load does not have a major noticeable impact on the peoples' livelihoods. To some extent, this might have a direct impact on other freshwater and marine organisms however, further studies should be done on this area to determine this factor. Also, Honiara residents continued to enjoy their normal living without any disturbances in relation to the sedimentation and siltation load issues on the foreshore and the reef areas of the study site.

The impact of sedimentation and siltation on the economical aspect within the study area remain lower. This happens because it does not directly affect the coastal residents of the study site in terms of their daily survival due to their heavy reliance on processed foods in the shops and the continuous supply of garden foods, vegetables and seafood at the central main market, King George market and White River market in Honiara.

## Loss of flora and fauna

Loss of flora and fauna species within the physical environment of the study area remained high. This happens because of the following identified factors:

- Mass clearance of foreshore areas for industrial, commercial, and residential developments.
- Introduction of foreign invasive species such as the African giant snail which resulted in loss of flora and fauna.
- The high number of manufacturing industries within the Ranadi industrial area which resulted in unregulated discharge of manufacturing wastes into the environment. These manufacturing wastes contains potentially poisonous substances which have negative impacts when in contact with flora and fauna species within the study site. For example, fibre glass manufacturing products and un-used paint manufacturing products.
- Infrastructure developments.

The loss of flora and fauna within the study site has also contributed negatively to the social standing of the area of interest. There was a suspected number of flora and fauna which may have been removed due to the ongoing infrastructure developments on the intertidal zone areas between Lungga river mouth point and the White river- mouth point. This is obvious because there are a smaller number of different types of flora and fauna species that are found along the foreshore area of Honiara City compared to other sub-urban centers around the country where they have many types of flora and fauna in abundance though there are major infrastructure developments which



occurred on their respective coastal sites. The other contributing factor too was that, due to loss of flora and fauna, the area looks bare and dry as the natural aesthetic scenario of the foreshore areas has been lost dramatically.

Based on the economic aspect of the study site, the loss of flora and fauna has a minimal and low impact. This is because most of the flora and fauna that are found along the foreshore area of the study site are common species. All these territorial flora and fauna species are in abundance on many of the islands around the country, with little economic value.

## Change of Landform

Based on this study site, there was a noticeable impact on the landform of the area. The degree of landform alteration of the site remains high due to several factors:

- Ongoing excavation and backfilling of the foreshore areas for structural and civil works purposes for industrial, commercial, and residential developments by proponents has also resulted in landform changes to the area. High Ocean currents associated with strong cyclone intensities during bad weather state of the country, continues to impact the shorelines which also resulted in landform changes in the area.
- Flash floods associated with the bad weather situation of the country, also poses a degree of landform changes at the foreshore areas. This happens because of the high load of sediments and silt deposition along the intertidal zone and the foreshore areas of the study site.
- High saltwater inundation also a considerable factor due that it also affects the prone regions along the foreshore areas. This also leads to coastal erosion which has resulted in changes to the original landforms within the study area.
- Weak enforcement of the relevant ACTS that governs coastal developments within the study site by relevant Government Agencies and stakeholders.



*Figure 9 Building construction development at Rove*

Despite the changes to the landform of the study site, it does not have any major impact on the social aspects of the site. The low level of impact within the social sector was due to the following reasons:

- Proper design and construction of seawalls on reclaimed shorelines along the intertidal zone areas.
- Construction of appropriate buffer zones for civil works along the foreshore area to avoid major environmental oversight on the developed site.
- Minimal level of excavation on the offshore areas of Honiara City boundary.
- High population lives inland and further away from the intertidal zone area. Only limited number of residents live on the foreshore areas of the studied site.

The change of landform has had some impacts on the economic sector of the studied site. However, from analysis, the changes to the landform remained at a lower level. This happens because of the following identified factors:

- There is no major economic expenditure that was done by business institutions including the Government on the maintenance of the shorelines along the coast of Honiara City.
- The geographic layout of the study site where it has gradual slope towards the offshore region. This helps to slow down waves where it has the potential to alter the original landforms along the backshore area and the coast area.
- Low frequency of ocean currents affecting the backshore areas along the coast of the study site. This is because of the study site's geographic location which was situated in a longitudinal bay on the leeward side of Guadalcanal Island. As such all coastal infrastructure developments within this area are maintained with less economic expenditure on repair and maintenance works.

## Waste and Pollution

The waste and pollution issue within the physical environment of the study area remains high. This occurs because of the following identified factors:

- High population growth of Honiara City.
- Lack of waste management awareness to the public by responsible authorities such as Ministry of Environment, Honiara City Council, and the Ministry of Health & Medical Services.
- High importation of non –recycled products such as the KASU butane can for in house stoves for cooking.
- Lack of resources to collect residential and commercial refusals on a timely manner by the responsible authorities such as HCC. This is in terms of limited number of rubbish disposal trucks.
- Limited frameworks and policy guidelines on waste management control.
- Weak enforcement of the relevant ACTS that governs waste management within the study site by relevant Government Agencies and stakeholders.
- Poor monitoring to properly control waste and pollution issues by relevant Government agencies and stakeholders.

The waste and pollution issues that associates with the social aspects of the study area was at moderate level. This rating was determined due to the following factors:

- Frequent occurrence of water borne diseases that continue to affect the urban population. Example, water borne diseases such as dysentery.
- High importation of vehicles and cars into Honiara City which emitted huge amounts of CO<sub>2</sub> into the atmosphere. This causes air pollution to the urban population.
- Non proper urban planning on city sewerage piping system in the city, has resulted in many sewerage effluent discharge points along the coast and the intertidal zone area of the study site. This leads to food web issues which have the potential to affect human health as well. For example, food poisoning from fresh sea foods sold at the central market in Honiara.
- The huge deposition of rubbish such as plastics, empty rubber bottles and cans along the coastal areas of the study site has resulted in degradation of the original aesthetic view of site. This occurs because of high importation of foreign goods as well.
- The huge amounts of wastes and pollution along the coastal areas of the study site too has resulted in limited access to leisure activities and bathing for Honiara residents.

The level of waste and pollution factors affecting the economic sector of the study site was at minimal and lower rate. This happens because most business houses in Honiara especially those engaging in wholesale and retailing business activities are more focused on profit making perspectives rather than having a wider consideration to safeguard the surrounding environment and the social aspects of the society. Additionally, there are relevant frameworks and policies that are available on the national level to curb the waste management and pollution agenda of the country, however, there is a minimal level of implementation being done by the relevant Government Agencies and its stakeholders. Thus, there are monetary budgets and external funds that are available to curb the waste and pollution management issues, however, this is yet to be effectively phased out for its impact to be felt at the local level.

## Oil Spillage Risk

Oil spillage in the natural environment of the study site has a high-risk, and this is due to the following identified factors:

- Unregulated practices that involve the direct disposal of petroleum and oil products into the environment by end users. Example, the disposal of used engine and gear oil containers into the Mataniko River.
- Oil leakages from automotive engines of moving machineries, equipment, vehicles, cars, OBMs and ferry boats.
- Petroleum and oil spillages at fuel stations.
- Direct discharge of industrial wastes along the backshore and the foreshore areas of the study site.
- Poor monitoring of oil and petroleum spillage issues by the relevant Government agencies and stakeholders.
- Limited frameworks and policy guidelines Oil and Petroleum spillage.
- Weak enforcement of the relevant ACTS that governs oil spillage within the study site by the relevant Government Agencies and stakeholders.

The oil spillage impacts on the social part has a moderate due to the following factors:

- Oil spillage causes bad odour in the environment, has a direct effect on human health especially increased chronic diseases and respiratory diseases.
- Oil spillage causes dirty environment and disturbances to the biological and the ecological components of the natural surroundings.
- Oil spillage causes contamination to the shorelines which resulted in a smaller number of terrestrial flora and fauna.
- Food poisoning due to the contamination from oil spillage in the intertidal zone area through anthropogenic activities inland.

The oil spillage risk has a moderate level of impact on the economy. This is because of the risk of incurring huge costs in oil spillage clean-up in cases of an environmental oversight. This requires technical experts to undertake the cleaning tasks where they are highly paid.



*Figure 10 Washed ashore shipwreck at Ranadi*

## Management & Mitigation Plan Outline

Highlighted below in Table 3 is an outline of a management and mitigation plan to help monitor and mitigate risks and effects from the described impacts. This management & mitigation plan below shows the necessary actions that must be undertaken to safeguard the natural environment of the study area. The application of these mitigation measures will ensure that the coastlines, the backshore areas, the foreshore areas, the intertidal zone areas with the natural environment are fully protected amidst the ongoing needs for coastal development by proponents from Lungga River point to White River-river point on Guadalcanal Island in Solomon Islands.

Table 3. Outline of a management to monitor and mitigate the above expressed impacts.

Relevant Impact	Management, Monitoring and Mitigation activities
Coastal Soil Erosion	<ul style="list-style-type: none"> <li>• Establish guidelines and monitor coastal developments</li> <li>• Develop erosion control or sea wall development minimum standards</li> <li>• Limit work or movement in high-risk areas</li> <li>• Limit substrate extraction along coastal areas</li> <li>• That all seawall designs and other civil works requirements must be approved by the Ministry of Infrastructure Development, the Ministry of Environment, and the Honiara City Council Planning Board before actual construction.</li> <li>• Wave breakers must be installed at 20M-30M out in the off-shore area to reduce wave speed before hitting the seawalls.</li> <li>• The seawalls must be designed according to the gradual slopes in the intertidal zone area along the coastlines.</li> <li>• Additional wave breakers such as huge rocks must be stationed at the toe of the seawall to avoid direct impact of wave intensity and overtopping during cyclonic seasons and bad weather.</li> <li>• Environmental fines shall be imposed by the responsible authorities if seawall damage has determined major environmental impacts on the surrounding coastlines.</li> <li>• Strictly no excavation is to be allowed on any coastal reclamation sites along the coastlines of the study area. Otherwise determined by a national approving entity.</li> <li>• All seawall designs must have a minimum of 300mm thickness and beyond with installation of minimum 12D reinforce steel rods in placed for concrete pouring.</li> </ul>
Sedimentation and siltation	<ul style="list-style-type: none"> <li>• Establish guidelines and monitor coastal developments</li> <li>• Establish run-off management standards for all coastal developments especially during construction</li> <li>• That all backfilling on approved coastal reclamation sites must have a minimum of 6 months seasoning period before proceeding on for further construction.</li> </ul>

Relevant Impact	Management, Monitoring and Mitigation activities
<b>Loss of flora and fauna</b>	<ul style="list-style-type: none"> <li>• Conduct biodiversity assessments to record key and threatened species</li> <li>• Establish protection or managed marine areas</li> <li>• In any coastal development along the coastal areas of the study site, an Environmental Impact Assessment must be authorized by a national approving entity such as the Ministry of Environment to determine the level of biological and ecological data that are available for the coastal site before proceeding to construction.</li> <li>• Excavation limits and site clearance limits for any approved coastal development must have official consent by the Ministry of Environment and other approving entities before actual works can proceed onsite.</li> <li>• Sites along the coasts which have rare flora and fauna species must not be disturbed.</li> </ul>
<b>Landform modification</b>	<ul style="list-style-type: none"> <li>• Establish limits for construction and modification such as extent of development past high-tide mark</li> <li>• Retain set percentage of natural coastal from being built-up</li> <li>• Responsible authorities must limit all commercial quarry activities along the main rivers within the study sites.</li> <li>• Restrictions on excavation level of inland areas for residential and commercial developments such as on slopes and hilltops must be done by responsible ministries and stakeholders to avoid heavy runoffs with high sedimentation loads during rainy seasons. This will eventually end up in the water bodies in rivers and streams where they shall be transported and deposited along the coastlines of the study site. Such huge loads of sedimentation have the potential to change landforms.</li> <li>• Avoid riverbank, stream bank and coastal excavation.</li> <li>• Installation of buffer zones on coastal construction sites to avoid coastal erosion.</li> </ul>
<b>Waste and pollution</b>	<ul style="list-style-type: none"> <li>• Set guidelines, monitor waste, and implement fines to offenders Carry out Honiara Coast Clean Up Campaign</li> <li>• Mass awareness on proper waste disposal.</li> <li>• Installation proper urban sewerage piping system.</li> <li>• Imposing of heavy fines on perpetrators who does unlawful waste discharge along the coastal area.</li> <li>• Responsible authorities must strictly enforce litter bylaws.</li> <li>• Proper monitoring and certification of all commercial, industrial, and residential waste management plans.</li> <li>• Government to provide more subsidies to business houses who are involved in recycling of used and old manufactured products.</li> <li>• Encourage more tree planting along the coastal areas of the study site.</li> <li>• Impose high tax on business houses that imports plastics, can and rubber products.</li> <li>• Carryout frequent inspection on all seafood products that are sold in the central market and other food outlets.</li> <li>• Impose huge fines on ship owners for their boat wreckage along the coastline of the study area.</li> </ul>

Relevant Impact	Management, Monitoring and Mitigation activities
Oil spill risk	<ul style="list-style-type: none"><li>• Set minimum standards to reduce probability of oil spill disasters occurring in the vicinity</li><li>• Effective enforcement of environmental law, maritime and fisheries laws on pollution by responsible authorities.</li><li>• In the event of oil spillage, experts must be hired to do the clean-up tasks.</li><li>• Effective monitoring of all fuel stations, manufacturing industries and machineries to minimize the level of engine oil leakages.</li><li>• Ensure all manufacturing industries which are near the coastal area have a properly sealed treatment plant. This is to avoid release of oil and toxic substance into the environment.</li></ul>

## LESSONS LEARNED

There are 2 main recommendations from this study, 1) a database to store, observe and manage developments and related information within Honiara and 2) for a development of an integrated coastal management and adaptation strategic plan for the area. There is no reliable information on coastline change trends that will help identify the basis to support development and assistances in proper land used. Currently there is no national database of information on coastal change a locally available. Some of the information on an eroding coastline is only available through EIA reports. Visual interpretation is very important to use to identifying coastal change. Analysing of coastline changes in Honiara is conducted by using multi-scale and multi-temporal remote sensed imagery and GIS. As population continues to grow and infrastructures development expand, this will result in increasing pressures to the coastal ecosystem, which shows that there is need for accurate information regarding coastline change for years. Information on the rates of erosion and accretion is important to predict the future coastline position for different years by using remote sensing imagery and GIS. The absence of coastline change data will also have a negative effect on development and communities settled along the coastline but if this information is available it will help in developing coastal planning.

There is a need to design an integrated coastal management and adaptation strategic plan (ICMASP) for the greater Honiara coast to be managed by the HCC. This ICMASP will involve all key stakeholders and provide avenues to managing environmental impacts and risks associated with development in Honiara. Solomon Island Port Authority management also needs to develop and implement an environmental management system (EMS) to monitor the operation of Honiara Port to ensure that it complies with international good practices. There is also a need to develop Air quality standards and monitoring system and implementing emissions regulations for industries. Monitoring emissions from Air, land and sea transport and regulation developed and enforced is also important as well.



*Figure 11 Dugout canoes of fishermen on the beach*



## REFERENCE

- Delimitation of Marine Waters Act 1988. 1988. Available at: <https://www.ffa.int/node/1893> (Accessed: 1 August 2020).
- Eke, A. Kukum Sea Front Commercial Center Public Environment Report. 2015. Telios Corporate and Consultancy Service. Honiara, Solomon Islands.
- Environment Act 1998. 1998. Available at:  
[http://www.paclii.org/sb/legis/num\\_act/ea1998159/](http://www.paclii.org/sb/legis/num_act/ea1998159/) (Accessed: 1 August 2020).
- Fisheries Management Act 2015. 2015. Available at:  
[http://www.paclii.org/sb/legis/num\\_act/fma2015193/](http://www.paclii.org/sb/legis/num_act/fma2015193/) (Accessed: 1 August 2020).
- Francis, H., Airahui, J. Land Reclamation and Construction of Storm Water Drainage at Rove Sea Front. 2019. Honiara, Solomon Islands.
- Honiara Water Quality and Resilience Framework Report- Pollution & Nutrient Sources. 2017.
- Centre for Environment, Fisheries and Aquaculture Science (Cefas). Suffolk, United Kingdom.
- Kool, J., Brewer, T., Mills, M., Pressey, R. Ridges to Reefs Conservation Plan for Solomon Islands. 2010. ARC Centre of Excellence for Coral Reef Studies, Townsville, Australia.
- National Development Strategy 2016 to 2035. 2016. Ministry of Development Planning and Aid Coordination. Honiara, Solomon Islands.
- Protected Areas Act 2010. 2010. Available at: [http://www.paclii.org/sb/legis/num\\_act/paa2010157/](http://www.paclii.org/sb/legis/num_act/paa2010157/) (Accessed: 1 August 2020).
- Solomon Islands State of Environment Report 2019. 2019. Secretariat of the Pacific Regional Environment Programme (SPREP). Apia, Samoa.
- Solomon Islands Ecosystem and Socio-Economic Resilience Analysis and Mapping (ESRAM), Volume 3: Honiara. 2018. Secretariat of the Pacific Regional Environment Programme (SPREP). Apia, Samoa.
- Solomon Islands: Honiara Urban Profile. 2012. United Nations Human Settlements Programme (UN-Habitat). Nairobi, Kenya.
- Solomon Islands: Waste management and pollution control strategy 2017-2026. 2016. Secretariat of the Pacific Regional Environment Programme (SPREP). Apia, Samoa.
- Town and Country Planning Act 1979. 1979. Available at: [http://www.paclii.org/sb/legis/consol\\_act/tacpa293.rtf](http://www.paclii.org/sb/legis/consol_act/tacpa293.rtf). (Accessed: 1 August 2020).
- Wildlife Protection and Management Act 1998. 1998. Available at: [http://www.paclii.org/sb/legis/num\\_act/wpama1998317/index.html](http://www.paclii.org/sb/legis/num_act/wpama1998317/index.html) (Accessed: 1 August 2020).





