



Pacific  
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# CONSERVATION AND ENVIRONMENT PROTECTION AUTHORITY

## PNG International Waters Ridge To Reef Project

### Tuna Bay Mangrove Management Plan 2021-2023





**CONSERVATION AND ENVIRONMENT PROTECTION AUTHORITY  
PNG International Waters Ridge To Reef Project**

**Tuna Bay Mangrove Management Plan  
2021-2023**

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Produced and reviewed by GEF Pacific International Waters Ridge to Reef Regional Project,  
Pacific Community (SPC), Suva, Fiji



Suva, Fiji, 2021

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## ABBREVIATIONS

|            |   |
|------------|---|
| ADB        | Asian Development Bank  |
| BBNMS      | Bootless Bay National Maritime Sanctuary                              |
| BBNMS-PAWG | Bootless Bay National Maritime Sanctuary Protected Area Working Group |
| CBO        | Community-based organization  |
| CBMM       | Community Based Mangrove Management                                   |
| CEPA       | Conservation and Environment Protection Authority                     |
| GEF        | Global Environment Facility   |
| JICA       | Japan International Cooperation Agency                                |
| Ha         | Hectares  |
| IUCN       | International Union for Conservation of Nature                        |
| IW         | International Waters  |
| MEA        | Multilateral Environmental Agreements                                 |
| NCD        | National Capital District   |
| NCDC       | National Capital District Commission                                  |
| NEC        | National Executive Council  |
| NFA        | National Fisheries Authority  |
| NGO        | Non-government Organizations  |
| NMS        | National Marine Sanctuary   |
| NPA        | National Protected Area   |
| PA         | Protected Areas   |
| PINBIO     | PNG Institute of Biodiversity   |
| PNGCLMA    | Papua New Guinea Locally Managed Marine Areas                         |
| PNG IW R2R | Papua New Guinea International Waters Ridge to Reef                   |
| PSP        | Permanent Sampling Plots  |
| R2R        | Ridge to Reef   |
| SPC        | Secretariat of the Pacific Community                                  |
| SPREP      | Secretariat of the Pacific Regional Environment Programme             |
| TNC        | The Nature Conservancy  |
| UN         | United Nations  |
| UNCLOS     | United Nations Law of the Sea   |
| UPNG       | University of Papua New Guinea  |
| WCS        | Wildlife Conservation Society   |
| WWF        | World Wildlife Foundation   |

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# 1. INTRODUCTION

Mangroves play a very important role in the defence of coastal ecosystem and the fact that they thrive in coastal areas gives some indication of their ability to cope with coastal hazards (Tol, 2014). Spalding et al. (2014) shows that the mangroves ability to modify coastlines by capturing sediments, weakened wave energy and provide many associated benefits that help reduce the vulnerability of coastal communities. Consequently, PNG government is committed to the conservation and protection of the Tuna Bay mangrove forest.

The Bootless Bay National Maritime Sanctuary (BBNMS) is located approximately 20 km south-east of Port Moresby (147°11'10" to 147° 18'49" N and 9°30'15" to 9°33'42" E) which straddles the borders of the National Capital District (NCD) and Central Province. The Bay comprise of Taurama/Tuna Bay, Bogoro Inlet, Dogura Inlet and Tubuseria, with five main islands (i.e., Manunuah, Loloata, Motupore, Bunemotu, and Gairemotu). The Bay area has small creeks, but no big rivers, with eastern barrier reef borders the Bay and the open Coral Sea (CEPA-JICA 2020).

The protection of Bootless Bay as a National Protected Area (NPA) was mooted by several stakeholders following the United Nations (UN) Ocean Summit in New York in 2017, when the former Prime Minister, Mr. Peter O'Neil, declared the Bay area to be the pilot marine sanctuary for the country.

Different stakeholders worked together in preparing for the establishment of pilot marine sanctuary. This was made possible with funding support from the government of Japan through JICA under CEPA-JICA Biodiversity Project and formed a Bootless Bay National Maritime Sanctuary (BBNMS) protected area working group (BBNMS-PAWG). This group prepared a proposal for Bootless Bay to be declared as a National Marine Sanctuary (NMS). In February 2020, the National Executive Council (NEC) declared the Bootless Bay as a National Marine Sanctuary (refer to Annex 1).

Tuna Bay is a small circular Bay with a width of about 1km at its widest and has a narrow opening of about 0.25 km that opens out into the bigger Bootless Bay. It is approximately 220ha in size and has a relatively shallow (15m) inlet on the northwest side of the Bootless Bay. The shoreline of Tuna Bay is lined with mangroves in different densities and the bay is within close proximity to neighbouring villages of Pari and Tuna Bay/Taurama. It is also an important cultural heritage site for the local Motu-Koitabu people.

Since 2010, Tuna Bay has been undergoing immense threats and pressure from the expansion of the city of Port Moresby as well as from settlements that are sprawling around the Bay area and the city. Additional threats from sea level rising and industrial waste are eminent. Consequently, the area is experiencing rapid environmental degradation facilitated by weak governance and increasing sales of land by the local landowners (Saulei et al. 2019) (refer to Annex 2).

The Tuna Bay/Taurama local development plan has a 500m protection zone around the NCD's Northwest side of Bootless Bay which provide hope for the existing ecosystems to remain intact. However, this 500m protection zone plan is probably not implementable or enforced because much of this zone is under customary land tenure, characterised by varying land ownership issues.

Therefore, it is important that the above Tuna Bay/Taurama local development plan is reviewed to include plans for developing and managing the natural resources, especially natural scenic land and seascapes, mangrove forests and important food and commercial species such as fish and sea cucumbers. While these natural resources development plan are generally lacking, the changes brought about by the development prospects are increasing the pressures on the natural resources. Currently, the sustainability of the natural resources utilizations in Tuna Bay is uncertain and is a major challenge for both the local resources owners, NCDC and the government.

The total area calculated from desktop analysis for intact or healthy mangrove stand is 95.6 hectares (ha) whereas the degraded mangrove area is approximately 17.65ha. The expansion of the settlement and infrastructures into the Tuna Bay is occurring at a rate of 18.41% per ha/year between 2018 and 2021. The satellite images of past (2011 and 2015) and present (2021) changes to Tuna Bay and the surrounding environment and mangroves is given in Annex 3.

The current rate of loss can be halted or reduce if intervened by appropriate authorities and stakeholders. The preparation of the Tuna Bay mangrove management plan most likely will contribute to the sustainable management of the mangrove ecosystem locally. The management plan compliments the MBNMS Management Plan which encompasses the entire Bootless Bay to achieve the first Maritime Protected Area in the country.

## Objectives of the Plan

This plan builds on the two overall objectives of the Bootless Bay National Maritime Sanctuary (BBNMS), which are: (1) to protect the ecosystems composing of mangroves, seagrass and coral reefs, and to ensure that people use the marine resources sustainably; and (2) to set up a model of Marine Protected Area in the country as per the policy on Protected Areas of PNG.

The specific objective of this plan enables the CEPA implements the Protect Area Policy 2014 and ensure that “sustainable livelihood of communities” under Pillar 2 is achieved for the local communities within the Tuna Bay area and the Bootless Bay area (Figure 1). In meeting the PNG Protected Area Network vision, Pillar 2 focusses on Sustainable livelihoods for communities. Under this pillar, all effort will be made to ensure that men, women, youth and all vulnerable members of the community are part of the interventions put in place and that their fishing activities and where they fish are taken into account. Stakeholder consultations will be inclusive of all sectors of the community, and participatory approaches that ensure consultations are inclusive of women and youths are used. The project will also ensure that benefits to the protected areas network interventions

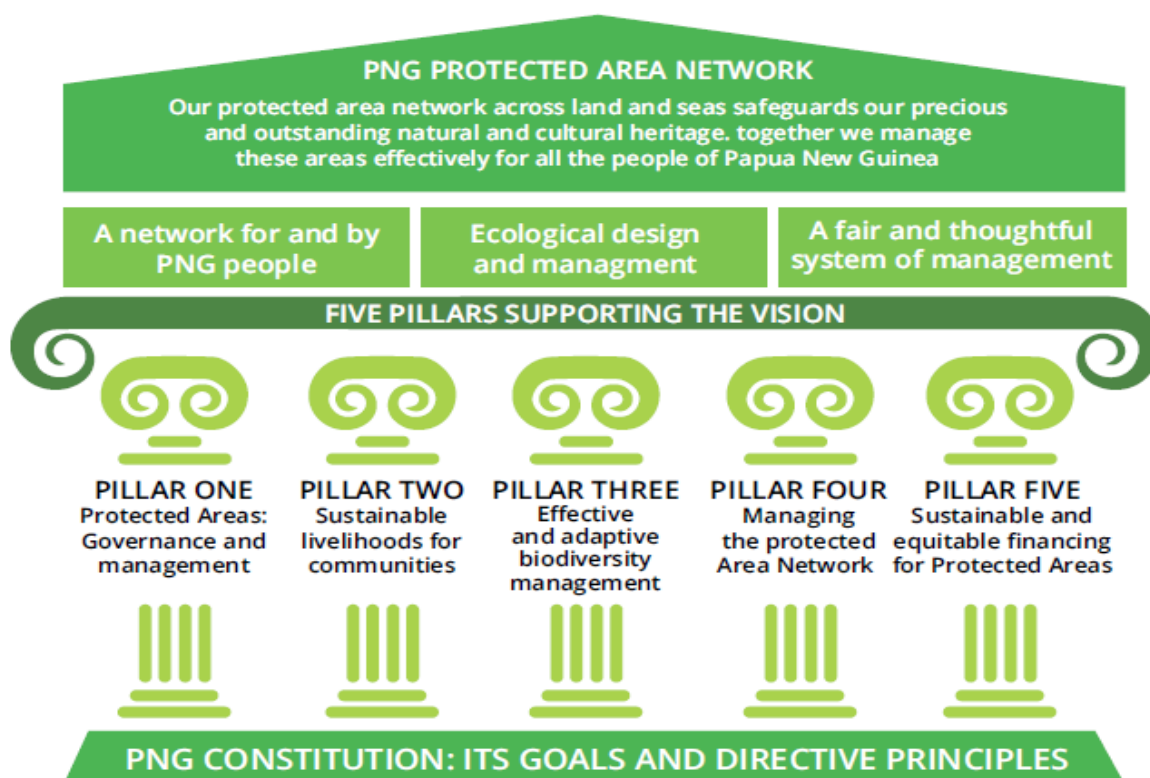


Figure 1: Protected Area Policy (Source: CEPA 2014)

## Vision

The Tuna Bay mangrove system is managed as the premier ecosystem within the Bootless Bay National Marine Sanctuary to preserve its natural beauty and support recreation, species conservation and livelihood enhancement. The Mangrove management plan should demonstrate the importance of conserving and protecting species, habitats and ecological functions or addressing impacts of development and human activities and climate change impacts.

This vision is guided by the following principles:

- i. Protect ecosystems comprising of mangroves, seagrass and coral reefs, and to ensure people use the marine resources sustainably;
- ii. Ensure all management decisions for the mangroves ecosystem and management are based on science and activities promoted through outreach and consultation with surrounding Tuna Bay communities;
- iii. Local communities are well-trained to work together with stakeholders, including settlers to manage, protect, and rehabilitate mangrove habitats and marine ecosystems to ensure their future is not compromised and that all training and work implemented are gender and socially inclusive;
- iv. Tuna Bay communities including settlers, communities taking into account women, youth and vulnerable groups, and other stakeholders are well-trained, knowledgeable, and respectful of one another become good stewards to manage the Tuna Bay and its surroundings, including mangroves and marine habitats;
- v. Scientific projects and programmes in the Tuna Bay are conducted in close collaboration with local universities, including the University of Papua New Guinea and Pacific Adventist University, and where possible, with local communities; and
- vi. The Tuna Bay is recognized as an important priority in strategic and other plans produced by governing authorities, local municipalities, communities and the Conservation and Environmental Protection Authority.



Figure 2: Parts of Tuna Bay mangrove with rising settlement expansion (Photo by Senson Mark)

## Period of the Plan

The Tuna Bay Mangrove Management Plan covers a three-year period from 2021 to 2023 from the time of launching. The plan can be reviewed halfway and at the end of the plan period in 2023. The review should focus in ascertaining whether or the not the Plan has achieved its vision, mission and objectives. The review should provide clear results on implementing key policy actions of the Plan.

## 2. BACKGROUND INFORMATION

### Definition of Mangrove Forest

The term mangroves refer to an ecological group of evergreen plant species belonging to several families but possessing marked similarity in their physiological characteristics and structural adaptations to similar habitats (Aksornkoae, 1993).

Mangroves are a coastal intertidal wetland forest composed of halophytic tree and shrub species. It thrives in a dynamic and physiologically stressful environment that repeatedly experience disturbances, such as pest infestations, storm surges and tropical storms (Friess, 2016). According to Saulei et al. (2019), Tuna Bay is less diverse in all of Bootless Bay area with three dominant species recorded.

### Species of Mangrove trees

The three dominant species recorded in the Tuna Bay area are *Bruguiera gymnorrhiza*, *Ceriops decandra*, and *Rhizophora apiculate*. Several mangrove individuals were identified as a hybrid *Bruguiera sp.* Two endemic species (*Albizia carrii* and *Canthium suborbiculare*) were observed in the western mangrove forest, while an introduced/invasive species were recorded as back-mangrove associate near the Taurama Army Barracks (Saulei et al. 2019).

### Importance of Mangroves

Mangroves are the foundation of a highly productive and biologically diverse ecosystem that serves as a home and feeding ground for a diverse range of species, many of which are threatened with extinction. Even though mangroves make up less than 1% of all tropical forests on the planet, they are highly valuable ecosystems that provide a variety of essential goods and services that help coastal communities' livelihoods, well-being, and security (Duke et al., 2014).

Mangroves are effective sediment trappers that support nutrient reticulation systems such as carbon and nitrogen circulation, and they are possibly the only trees that recycle, allowing other organisms to assimilate it. They can also absorb and store highly toxic heavy metals (Kathiresan, 2012).

### Distribution and Occurrence of Mangroves

The mangrove ecosystems occur in the estuaries and intertidal zones thereby forming integrated ecosystems capable of functions comparable to that of marine and terrestrial ecosystems described in Saulei et al. (2019). For instance, the estuaries and intertidal zones are often characterized by very highly variable environmental factors such as freshwater runoff, sedimentations, tidal currents, waves, and weather patterns that are regularly affecting salinity, temperature, pH, nutrients level, and microbial community.

The survey conducted by Saulei et al. (2019) in 4 transects recorded 785 individuals, comprising of 23 species, with only 7 species being mangrove associates (Table 1). More than 30 mangrove species have been recorded within Bootless Bay area, with true mangrove species comprising of about 23 species, mainly in the Bogoro Inlet area, including the islands (Maniwavie, 2006 and Piskaut et al. 2018; cited in Saulei et al. 2019).

Table 1. Vegetation diversity at Tuna Bay (Source: Saulei et al. 2019)

| Species                          | Frequency | Proportion | Status                       |
|----------------------------------|-----------|------------|------------------------------|
| <i>Eucalyptus confertiflora</i>  | 1         | 0.13       | Savanna grassland            |
| <i>Desmodium umbellatum</i>      | 1         | 0.13       | Mangrove associate           |
| <i>Clerodendron inerme</i>       | 2         | 0.25       | Mangrove associate           |
| <i>Xylocarpus granatum</i>       | 5         | 0.64       | True mangrove                |
| <i>Ceriops decandra</i>          | 173       | 22.04      | True mangrove                |
| <i>Rhizophora apiculata</i>      | 202       | 25.73      | True mangrove                |
| <i>Bruguiera gymnorhiza</i>      | 225       | 28.66      | True mangrove                |
| <i>Bruguiera sexangula</i>       | 3         | 0.38       | True mangrove                |
| <i>Rhizophora stylosa</i>        | 32        | 4.08       | True mangrove                |
| <i>Canthium suborbiculare</i>    | 1         | 0.13       | Endemic, Mangrove associate  |
| <i>Avicennia marina</i>          | 62        | 7.90       | True mangrove                |
| <i>Osbornia octodonta</i>        | 1         | 0.13       | True mangrove                |
| <i>Ceriops tagal</i>             | 26        | 3.31       | True mangrove                |
| <i>Rhizophora mucronata</i>      | 7         | 0.89       | True mangrove                |
| <i>Pluchea indica</i>            | 4         | 0.51       | True mangrove                |
| <i>Azadirachta indica</i>        | 2         | 0.25       | Invasive, Mangrove associate |
| <i>Acrostichum aureum</i>        | 9         | 1.15       | Fern, True mangrove          |
| <i>Excoecaria agallocha</i>      | 9         | 1.15       | True mangrove                |
| <i>Bruguiera cylindrica</i>      | 2         | 0.25       | True mangrove                |
| <i>Scyphiphora hydrophylacea</i> | 10        | 1.27       | True mangrove                |
| <i>Bruguiera exaristata</i>      | 1         | 0.13       | True mangrove                |
| <i>Albizia carii</i>             | 1         | 0.13       | Endemic, Mangrove associate  |
| <i>Bruguiera x hybrid</i>        | 6         | 0.76       | Hybrid                       |

The rapid assessment done by Saulei et al. (2019) concludes that Tuna Bay is less diverse than the entire Bootless Bay, where most taxa are not well defined within the bay enclosure.

The number of mangrove species and seagrasses are lower than Motupore Island. Out of the 36 true mangrove species recorded so far in Papua New Guinea, this study recorded 16 species of all true mangroves. Of special interest is the hybrid *Bruguier sp.* which need further attention.

## Possible effects of Global warming

The average global surface temperature has continued to increase over the last decade. In the 2011-2020 period, it was 1.09°C higher than the 1850-1900 with larger increase over land than over the ocean (IPCC, 2021).

Mangrove ecosystems are threatened by climate change. Friess et al. (2012) states that increase in flooding duration can lead to plant death at the seaward mangrove margins as they are sensitive to changes in inundation duration and frequency as well as salinity levels that exceed a species-specific physiological threshold of tolerance. Due to their lower elevation, mangroves along the micro-tidal and back basin areas are generally at greater risk from sea-level rise than fringing mangrove types due to the species and sediment deposition differences (Lovelock et al., 2015).

## Institutional Roles in the Management of Mangroves

The Conservation and Environment Protection Authority (CEPA) is the implementing agency in the management of mangroves in the Tuna Bay area with the support from SPC under the GEF funded Regional International Waters Ridge to Reef (IW R2R) Project.

The PNG IW R2R Demonstration Project is overseen by a Project Steering Committee (PSC) instituted by CEPA and key agencies namely National Fisheries Authority (NFA), University of PNG (UPNG), National Capital District Commission (NCDC), other relevant Government Agencies and stakeholders such as non-government organisations (NGOs), community-based organisations (CBOs), including landowners and settlers. It is expected that this Committee role continues after the project closes.

## Other Mangrove Management Programmes

Over the years, there have been efforts directed at managing the mangroves of PNG. In 2018, a community-based mangrove planting handbook for PNG was published by SPREP in collaboration with the Asian Development Bank (ADB). Other organizations such as the World Wildlife Foundation (WWF), the International Union for Conservation of Nature (IUCN), The Nature Conservancy (TNC), Wildlife Conservation Society (WCS), and the PNG Centre for Locally Managed Marine Areas (PNGCLMA), and the University of PNG (UPNG) have somehow been involved directly or indirectly with the mangrove conservation efforts around PNG working closely with communities in setting up pilot projects. These were met with challenges, and there were many lessons learned. The success of these projects can be attributed to strong community leadership and support.

## Major Issues

There are legislations in place, however, it covers a wide array of issues and do not deal with mangroves specifically. There are management plans for certain communities that have been developed and also mangrove planting handbooks that have been published but there is no coherent policy for the management of mangroves. For effective management, the relevant ministries and stakeholders involved must enforce laws that are directly or indirectly applicable to mangroves. With the opening and expansion of the Port Moresby to required services, infrastructures and housing development, the Tuna Bay/Taurama area experienced influx of people and development activities. Given the increasing demand for land and housing in Port Moresby, the traditional landowners of the Taurama area have been issuing leasehold agreements to settlers within Port Moresby, who have purchased land to build homes and live in the area.

Most Protected Areas (PAs) lack financial sustainability and tangible benefits. Most PAs were established by the government and non-government organizations, however, many are branded as 'paper parks'. The focus on sustainable financing to ensure community benefits, participates and control PAs gives the new policy originality. This is because under existing land tenure systems, the need for incentives in the work of conservation is necessary to promote conservation. Moreover, under the PA Policy 2014, it is anticipated that there will be establishment of Protected Areas on customary land. This will entail for collaboration between Government (National, Provincial and Local) and landowners to develop transparent processes for the establishment of Conservation Benefit sharing agreements. It is anticipated that these agreements will take into account the biodiversity and socio-cultural context and practices of the area. It is also anticipated to identify the roles and responsibilities of the customary landowners in the establishment, implementation and monitoring of the protected area.

Roads were constructed between 2012-2015 linking Port Moresby with Taurama and Dogura areas, through the mangrove forest, allowing access to the lands and natural resources of the Northwest side of Bootless Bay with Tuna Bay area (Saulei et al. 2019). The development taking place has resulted in mangrove forest clearance, movement of soil and backfilling for land reclamations into mangrove areas, increase in the number of new buildings, roads, jetties and accommodations constructed and pollution of the bay from industrial and home wastes, including sediment run-off into the bay area. These impacts have increased over time resulting in impacts impinged upon the natural environment, especially the marine environment and marine fauna, insect fauna and the avifauna (Saulei et al. 2019).

Despite PNG's effort to take some action towards biodiversity conservation since Rio and the signing of the CBD in 1992, the progress has been slow. In the last three decades the country has faced numerous socio-economic woes, thus the government was unable to implement effectively the Vision 2050 plan because of inadequate funding and resources. The development of the above-mentioned policies and the establishment of the PNG Institute of Biodiversity (PINBIO) to address issues of biodiversity and sustainability can be realized was not done so. Hence, it requires the drive and effort by the government to make protected areas functional and self-sustaining in their operation. There is also a need to review the current laws and try and include an Act specifically for the management and protection of mangroves.



Figure 3: Tuna Bay inlet from an aerial view (Photo by Ridge to Reef Project)

## 3. ACTION PLAN

### 3.1 Establishment of the administrative team for the management of mangrove in the Tuna Bay area

#### Mangrove Action Committee

With the establishment of a management plan, a mangrove action committee needs to be established. This should be made up of representatives of communities and stakeholders whose main objective should be the restoration and management of mangroves. The role of this committee will be to oversee the progress towards meeting the goal of the Mangrove Management Plan. Once they have established their ToR, they will then be focusing towards meeting their targets and maintaining relationship between the stakeholders involved.

#### Monitoring and Enforcement Programs

Appropriate mangrove mapping training should be provided to train locals to monitor the mangroves. This can be done through Google Earth, GIS or monitoring done by locals themselves (refer to Annex 4).

A healthy mangrove survey can be conducted by locals annually with assistance from local municipalities and government agencies. This would enable the people to determine which species is not growing health in its natural habitat or in areas subjected to rehabilitation or in the nurseries so corrective measures are done. Table 2 shows the classification and characteristics of mangrove tree condition. Appropriate permanent sampling plots (PSP) and quadrats should be established to conduct future health surveys, pertaining to foliage density health status, stem diameters and heights, health status, number of trees and species present, stem per hectare and other parameters.

Monitoring of sedimentation loss or build up can be done by locals, hence appropriate trainings should be conducted before the activities is conducted. Sediment monitoring will be done at the same monitoring and reference sites of mangroves or degraded/rehabilitated sites that used in the mangrove health surveys and marked with permanent markers.

In degraded areas, the community committee should ensure any development must promote natural flow of sea water to enter the degraded or revegetation sites using appropriate culvert and drainage construction to ensure natural tide system or events are not affected.

At the end of the monitoring, an action plan should be developed or written evaluated by a management committee (refer to Annex 6).



Table 2. Classification and characteristics of mangrove tree condition

| Classification (Duke et al. 2005) | Characteristics (Duke et al. 2005)        | Quantitative (SKM 2009e)   |
|-----------------------------------|---|--|
| Healthy                           | Leaves green. No visible sign of sickness | <10% dead, yellowing or wilting leaves   |
| Sick                              | Yellow, wilting leaves, low foliage cover | 10-50% dead, yellowing or wilting leaves   |
| Dead                              | Plant dead                                | >50% dead/yellow wilting leaves<br>>50% dead stems and plant beyond recovery/<br>almost dead |

## Enforcement

The enforcement policies and penalties under the Conservation Act will need to be reviewed to accommodate the new management plan for the Tuna Bay area. For the management plan, the new rules and regulation set up will need to go through consultations with all the stakeholders and parties involved. Throughout this process, collaboration with communities needs to be active.

Agreements made should be included in a Memorandum of Understanding between the parties involved. It should be clear that the plan intends for a successful campaign and that violators will be prosecuted. The roles of communities in the protection and management of the mangrove ecosystem should also be stated clearly.

## Legal framework for mangrove ecosystem management

In 2017, a legislative review was completed to develop a new Protected Area (PA) legislation which is now before Parliament for endorsement and enactment as a law. The Protected Areas Policy (2014), emphasizes more on conservation at community level (Leverington et al., 2014). This presents an opportunity for PNG to capture the new approach in the national policy and legal framework for biodiversity protection.

The PA Policy sets the foundation for bolstering the efforts towards biodiversity protection, thus capturing the most relevant objectives of the environmental Multilateral Environmental Agreements (MEAs) to which PNG is a signatory. The Policy also captures the marine protected areas as equally important as terrestrial PAs, given the past gaps in previous policies and legal framework for protected areas. A recent Ocean policy 2020-2030 also strengthens the conservation of marine environment which was never really captured in the Protected Area Policy (Leverington et al., 2020). This policy strengthens the National Fisheries Act and the International Law of the United Nations Law of the Sea (UNCLOS).

PNG has mangrove areas of global significance and is the most taxonomically diverse globally. However, there is no legislation that specifically protects the mangrove ecosystem, and no protected areas established exclusively for the conservation of mangroves. Over the years, the South Pacific Regional Environment Programme (SPREP) prepared action plans but based on their project sites (Ellison, 1997).

## Community-based mangrove management

Community members play a very important role in determining the success and failure of the management plan. Community Based Mangrove Management (CBMM) has over the years been widely advocated as a viable alternative for sustainably managing mangroves which are disappearing rapidly worldwide (Datta et al., 2012).

For projects such as restoration work, community involvement is important, and it will be the responsibility of the project manager to ensure that this runs smoothly. Once a site is identified, the project manager should liaise with relevant stakeholders and the community leaders.

### 3.2 Risk Assessment

Long term funding for the implementation of the project is crucial for CEPA, NCDC, and relevant government municipalities to support local communities to implement this Mangrove Management Plan. Funding can be sourced through the government and the relevant agencies, local and provincial government and other potential donors. The residual impact will be severe.

It will be a challenge to get all landowners to work collaboratively. However, the majority of landowners and women groups may require financial sponsorships to support mangrove activities like clearing of sites for seedlings nursery, and mangroves replanting. This would ensure the mangroves are protected or rehabilitated. The residual impact will be moderate.

Another pressing issue is the rising population in Port Moresby city and its spill over effects into Tuna Bay area. This may result in escalated development of settlements, housing projects, infrastructures and services. Consequently, this might impact the surrounding environment, drainage pattern, ecosystems health and the mangrove forests. Hence, strict compliance to regulations and laws must be upheld and enforced by relevant authorities. The residual impact will be moderate to severe locally.

### 3.3 Contingency measures

Given the end of the Programme of the Ridge-to-Reef (R2R) climate resilient project in tuna Bay, appropriate measures or steps must be taken so that whatever implemented in the program is continually supported or implemented by stakeholders that are working with local communities in Tuna Bay. Appropriate hand-over of appropriate documents and action plans must be provided by the R2R Tuna Bay Project, to ensure continuation of activities it implemented is maintained or promoted in the future.

In terms of direct impacts, any clearing activities will be temporarily stopped until the outcomes of an investigation into non-approval and compliance clearing have been concluded. Options for rehabilitation will be investigated.

For indirect impacts on the mangroves, a change in mangrove health leading to a significant increase in percentage of yellowing, wilting and dead leaves at any monitoring site relative to a reference site will be calculated. Any difference of more than 25% or more in condition foliage between a monitoring site and the average reference sites will lead to an assessment of the potential causes. Results from available mangrove health and sediment monitoring will help determine the decline in mangrove health and the resulting impacts. Identification of contingency measures will be determined in consultation with relevant stakeholders (refer to Annex 5).

## 3.4 Increase in public awareness and education on the benefits of mangroves

### Public awareness

Awareness programmes need to be developed at the very beginning of the project as studies have shown that success often depends on public and educational awareness programmes. The important roles played by the mangroves ecosystem and the threats they faced should be made known to members of the community. Having an understanding of this makes the restoration work and protection of mangroves easier. The awareness programmes can be addressed through media and public education. A public awareness campaign, to run for three months should be proposed. A professional organization should be tasked to produce newsletters, publish reports and also have a website launched for educational purposes and updating of information.

## DESIRED OUTCOMES AND ACTION

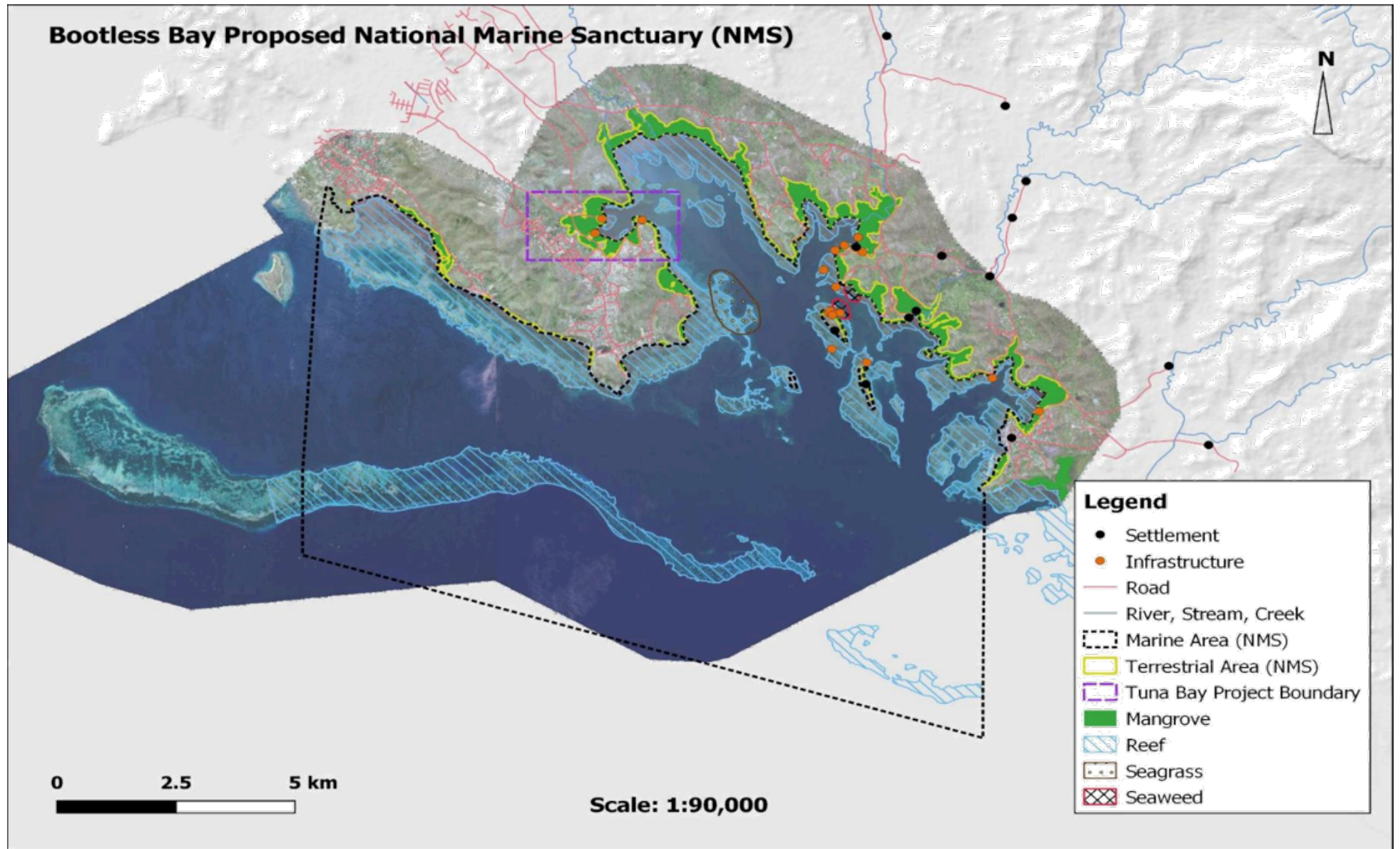
1. Laws that restrict mangrove cutting for firewood, for buildings or clearance for infrastructures development are passed and enforced by local communities and local level government and supported by local municipalities and government authorities;
2. Back filling of mangrove forest for new development such as roads or buildings are restricted and proper environment management plans or permits are attained before any development takes place;
3. Dumping of waste into the mangrove and bay area must be restricted and prohibited restricted;
4. More awareness raising and education is done by local authorities and other government agencies to educate people both men, women, youths and all other users of the resources on protection and managing the fragile mangrove habitats and the surrounding environment;
5. Establishment of nurseries by local communities in areas identified by locals are promoted and local site-specific species are germinated, raised in nurseries and replanted in degraded sites and mudflats identified. Appropriate training on mangrove nursery, planting, management and monitoring must be conducted and this can be specifically targeted to women and youth groups;
6. Penalise those trespassing and not adhering to laws passed by local municipalities and LLGs in the area with appropriate penalties including fines;
7. Work closely with NCDC and other government agencies, including Central provincial government and Moresby South Electorate to address high population growth, violation of regulations and illegal constructions;
8. Ensure there is better coordination between inter-government agencies including enforcement and monitoring of activities;
9. Ensure landscape issues are addressed amicably to protect the landscape and coastal fringes from degradation and other impacts;
10. Develop appropriate sustainable livelihood alternative activities such as mangrove honey farming, fish farming and carbon protection initiative are promoted. These alternatives can specifically target women and youths in communities;

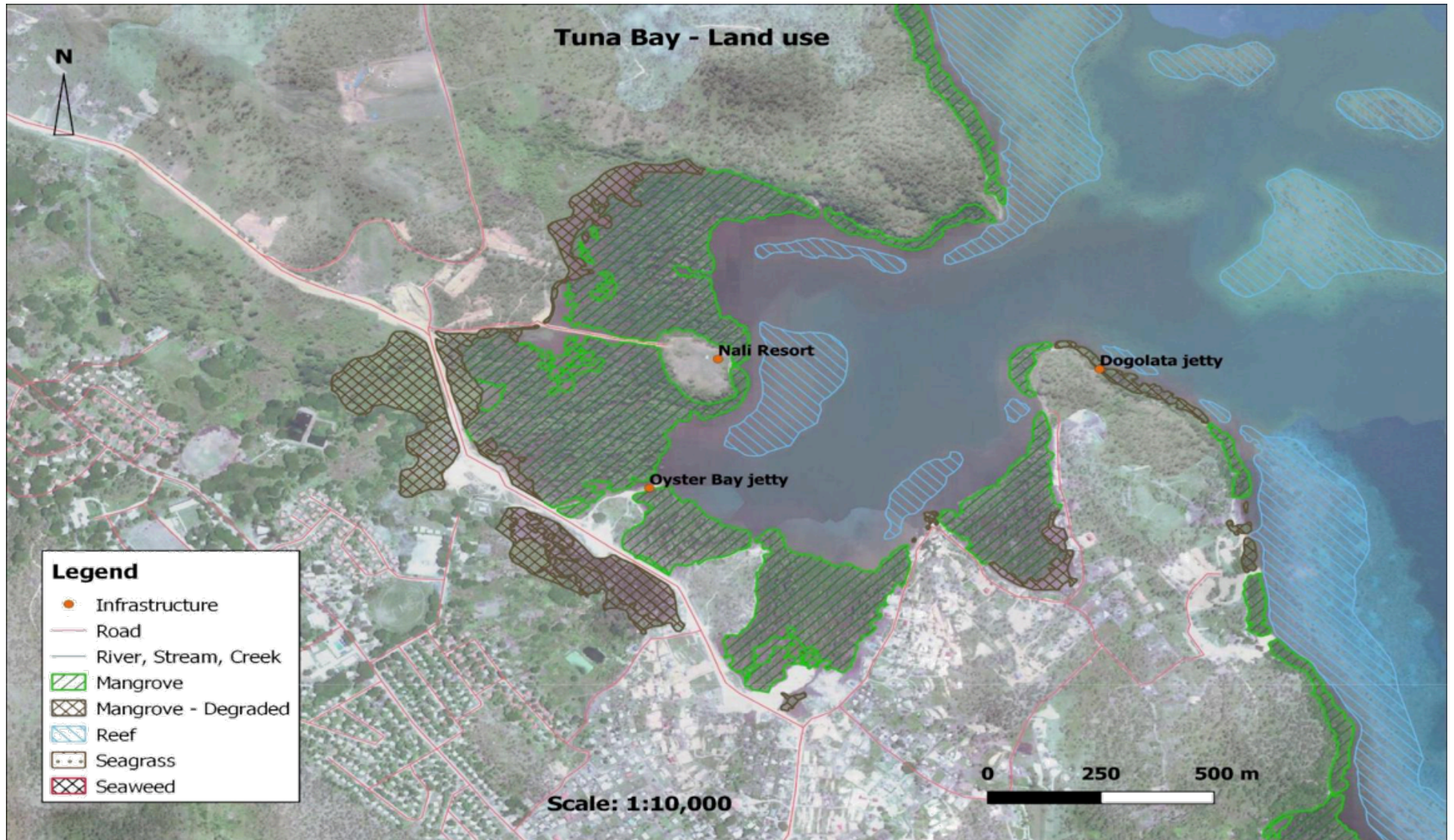
11. Ensure appropriate publicity and information are made available to the local villages, settlers and other stakeholders, and should specifically also include the different areas of fisheries for men, women, youths on the importance of mangroves and local livelihood. This include developing posters, making available scientific information, erecting of signboards etc.
12. Creation of different zone in the entire Tuna Bay is necessary for the locals to protect their reefs, corals, mangroves, seagrasses and habitats in line with the BBNMS management plan. The different zones identified in the mangrove forest cover should be prioritised for rehabilitation and protection work. Establishment of a management committee that oversees the management of development activities and the environment in the bay area including mangrove management. The management committee to be gender inclusive to ensure that the livelihood activities of men, women and all community members are taken into account.

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# Annex 1





## Annex 2



Settlement and urban expansion are main threat to Tuna Bay (Photo by Ridge to Reef Project)



A signboard indicating prohibition of waste dumping or litter in Tuna Bay (Photo by Senson Mark)



## Annex 3



Figure 2: Satellite image of Tuna Bay in 2011 (Source: Google Earth 2021)



Figure 3: Satellite image of Tuna Bay in 2015 (Source: Google Earth 2021)



Figure 4: Satellite image of Tuna Bay in 2021 (Source: Google Earth 2021)

## Annex 4



*A local transplanting mangrove seed into polytene bags for germination in a nursery for future replanting and reforestation activities (Photo by Senson Mark)*

Annex 5



*Community meetings are important means to address issues (Photo by Senson mark)*

## Annex 6

Table 3 shows the conservation management plan of the Bay area while Table 4 shows the Action Plan for most activities that will be undertaken in the management Plan.

Table 3: Management response and priority for mangrove management plan in Tuna Bay

| Management /response  | Priority     |
|---|--------------|
| <b>Preservation, protection and landscape management</b>  |              |
| Ensure the landscapes, biological, economic and cultural values are preserved or management from threats, and threats are addressed amicably to protect the landscape and coastal fringes from degradation and other impacts  | High         |
| Re-establishing linkages between landscapes and plant and animal populations on undisturbed, disturbed and rehabilitated sites  | Medium       |
| Re-establishing wildlife populations in areas of their former range   | Medium       |
| Ensure translocation of fauna from one part of the Bay to another is promoted through forest corridor and drainage to avoid isolation and speciation.   | Medium       |
| <b>Biodiversity preservation</b>  |              |
| Ensure invasive species are controlled, managed or eradicated. Also controlling or containing alien invasive species and wildlife diseases in all or parts of the Bay is done.  | High         |
| Flora and fauna are well documented and their conservation status known.  | High         |
| Publication of natural history guide for the Bay area is encourage and periodic review should be undertaken.  | Medium       |
| The preservation and management of genetic resource and local species and their habitats is undertaken by eradication and controlling encroachment, threats, and pressure.  | High         |
| <b>Management of mangrove forest and habitat</b>  |              |
| Planting of site-specific dominant species such as <i>Bruguiera gymnorrhiza</i> , <i>Ceriops decandra</i> , and <i>Rhizophora apiculata</i> , <i>Bruguiera gymnorrhiza</i> x <i>B. cylindrica</i> and <i>Bruguiera</i> x <i>hybrid</i> . Two endemic species ( <i>Albizia carrii</i> and <i>Canthium suborbiculare</i> ) must also be germinated and planted. | High         |
| Appropriate management actions are undertaken to replenish, reforest or improve degraded and secondary mangrove forest using best means such as replanting, spacing, community participation etc  | High         |
| Ensure rehabilitation of degraded sites and replenishing with mangrove seedlings through tree planting are done and monitored over time.  | High/Ongoing |
| Establishment of nurseries by local communities in areas identified by locals are promoted and local site-specific species are geminated, nursieried and replanted in 17.65ha of degraded sites and mudflats identified.  | High         |
| Improve the management and conservation efforts to mitigate impacts of Tuna Bay within the Bootless Bay   | High         |

| Management /response   | Priority     |
|--|--------------|
| Creation of different zone in the entire Tuna Bay is necessary for the locals to protect their reefs, corals, mangroves, seagrasses and habitats in line with the BBNMS management plan. The different zones identified in the mangrove forest cover should be prioritised for rehabilitation and protection work. These buffer zones should have sign boards erected. | High         |
| Establishment of a management committee that oversees the management of development activities and the environment in the bay area including mangrove management.  | High         |
| <i>Monitoring</i>  |              |
| Conduct monitoring of activities of the management plan and mangroves  | High/Ongoing |
| Monitor and control movement of people and activities in the bay area  | High/Ongoing |
| Undertake regular reviews in implementing the plan of management and undertake regular reviews of the bay's environment condition and management.  | High/Ongoing |
| <i>Nursery</i>   |              |
| Appropriate training on mangrove nursery, planting, management and monitoring must be conducted.   | High         |
| Develop a reforestation and monitoring management plan   | High         |
| <i>Training and capacity building</i>  |              |
| Improve data records by training local communities   | Medium       |
| Trainings local on data collection, monitoring of mangroves, nursery techniques, planting and reforestation, etc   | High         |
| Conservation science training should complement research work  | High         |
| Develop appropriate facilities and training materials for local rangers and committees   | Low          |
| <i>Rules and law Enforcement</i>   |              |
| Enforcement of rules such as prohibiting cutting of trees, waste dumping, excavation and backfilling of vulnerable and prohibited sites, over fishing and hunting is communicated to all users or settlers to minimise impacts and improve ecosystems health.  | High/Ongoing |
| Laws that restrict mangrove cutting for firewood, for buildings or clearance for infrastructures development are passed and enforced by local communities and local level government and supported by local municipalities and government authorities.   | High/Ongoing |
| Penalise those trespassing and not adhering to laws passed by local municipalities and LLGs in the area with appropriate penalties including fines to minimise impacts.  | High/Ongoing |
| Dumping of solid and liquid or any toxic wastes into the mangrove and the bay area must be restricted and prohibited.  | High/Ongoing |
| Back filling of mangrove forest for new development and land reclamation, for roads or buildings, are restricted and proper environment management plans or permits are attained before any development takes place.   | High/Ongoing |

| Management /response  | Priority     |
|---|--------------|
| <b>Research</b>   |              |
| Work with partners such as universities and government to develop modest research facilities with partner organisations.  | Medium       |
| Research is promoted and encourage to educate users and visitors and to inform the public   | High         |
| Support should be given to university classes and studies conducted in the bay area   | Low/ongoing  |
| <b>Sustainable livelihood</b>   |              |
| Appropriate sustainable livelihood alternative activities such as mangrove honey farming, fish farming and carbon protection initiative are promoted.   | High         |
| <b>Partnership and collaboration</b>  |              |
| Ensure there is better coordination between inter-government agencies including enforcement and monitoring of activities.   | High         |
| CEPA and the local communities plus the stakeholders of Bootless Bay, including municipality governments are encouraged for collaborative work with partners.   | High         |
| Work closely with NCDC and other government agencies, including Central provincial government and Moresby South Electorate to address high population growth, violation of regulations and illegal constructions.   | High         |
| Undertake consultation with key stakeholders  | High/ongoing |
| <b>Education and awareness</b>  |              |
| More awareness raising and education is done by local authorities and other government agencies to educate people on protection and managing the fragile mangrove habitats and the surrounding environment.   | High/Ongoing |
| Ensure appropriate publicity and information are made available to the local villages, settlers and other stakeholders on the importance of mangroves and local livelihood. This include developing posters, making available scientific information, erecting of signboards etc. | High/ongoing |

Table 3: Action Plan

| Action   | 2021                 | 2022                 | 2023                 |
|--|----------------------|----------------------|----------------------|
| Ensure weekly, monthly, and annual monitoring of activities within the bay area is undertaken to ensure the management plan is implemented accordingly | On going             | On going             | On going             |
| Work in collaboration with local communities to preserve the landscape by conduction workshops and awareness   | On going             | On going             | On going             |
| Assist local community groups, SME, CBO and ILG to revive culture and tradition practices of conservation  | On going             | On going             | On going             |
| Appropriate management actions are undertaken to eradicate or control encroachment and deforestation of mangroves                                      | On going             | On going             | On going             |
| Establishment of a nursery and maintaining   | December             | December             | December             |
| Replanting of Mangrove seedlings   | June 5 <sup>th</sup> | June 5 <sup>th</sup> | June 5 <sup>th</sup> |
| Ensure endangered species are protected. Illegal hunting and fishing are outlawed, habitats are protected and invasive species controlled              | On going             | On going             | On going             |
| Support suitable research personal within the community and empower them with appropriate skills and trainings   | Ongoing              | Ongoing              | Ongoing              |
| Document flora and fauna, monitor sedimentation loss or build-up and develop posters and information pamphlets   | Ongoing              | Ongoing              | Ongoing              |
| Enforcement of rules and bylaws  | Ongoing              | Ongoing              | Ongoing              |
| Establish collaborative research and work with partners and stakeholders   | On going             | On going             | On going             |
| Publish information and make them readily available to the public  | Ongoing              | Ongoing              | Ongoing              |
| Erect or maintaining signboards containing rules, notices or awareness   | Ongoing              | Ongoing              | Ongoing              |
| Develop a planting management plan   | December             |                      |                      |
| Update the Management plan   |                      |                      | December             |









