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Pacific Regional Ridge to Reef International Waters Project

Site Diagnostic Analysis Report
Mataniko River Catchment, Solomon Islands

Pacific R2R Ridge to Reef

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Site Diagnostic Analysis Report Mataniko River Catchment Solomon Islands

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Abbreviations

BA	Biodiversity Assessments
CBD	Convention of Biological Diversity
CITES	Convention on International Trade on Endangered Species
DCGA	Democratic Coalition Government for Advancement
DO	Dissolved Oxygen
ESSI	Ecological Solutions Solomon Islands
ESRAM	Ecosystem and Socio-economic Resilience Analysis
ESSI	Ecological Solutions Solomon Islands
HCC	Honiara City Council
IW R2R	International Waters Ridge to Reef
MECDM	Ministry of Environment, Climate Change, Disaster Management & Meteorology
NGO	Non-Government Organisation
PGA	Provincial Government Act of 1997
SIWA	Solomon Islands Water Authority
SPC	Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
SIG	Solomon Islands Government

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Executive Summary

The Site Diagnostic Analysis Report for Mataniko River Catchment documents the processes and approaches used to design the Mataniko River Integrated Management Plan with the intent to ensure direction, rehabilitation, cooperation, and partnership. The diagnostic analysis process involved reviewing past reports and consultations with key stakeholders and local communities who reside along the river, landowners, those who live within the catchment areas, as well as stakeholders who have other direct or indirect connections with the catchment.

The report highlights important ecosystems, the services they provide and the need for their protection. It further highlights the importance of cross-sectoral engagement between the different government ministries, state-owned enterprises, city council and local communities to develop and implement the management plan. The integrated watershed management plan must be a bottom-up approach that empowers the communities and customary landowners to co-develop the management plan and take an active and leading role in its implementation and monitoring. Key stakeholders must play the role of advisors and provide budgetary support for the management plan.

The integrated management plan is based on the ecosystem-based management approach that includes the ridges to the communities to the reef or the terrestrial ecosystem, freshwater ecosystem, and marine ecosystem. Finally, to fully manage these systems, human behaviours must be managed first before we can manage the Mataniko catchment.

1 Introduction

The overall goal of the Mataniko catchment diagnosis is to allow for a precise characterisation of the catchment in relation to Ridge to Reef objectives and programme of activities. The diagnosis provides a baseline against which the effectiveness and efficiency of the project can be evaluated.

The common framework of Ridge to Reef allows the operator to carry out initial, mid-term and end-of-project diagnoses on the pilot sites in a coherent and consistent manner. As a guiding framework, it leaves room for adjustment to reflect each pilot site's specificities.

The site diagnostic process provides a structured approach to identify, understand, and prioritise key issues impacting on the ecosystem goods and services. A range of risk assessment tools such as problem-tree and causal links analysis are available to the operator. The diagnostic analysis will scale the relative importance of source and causes (from the 'immediate' to the 'root') of the problems within the ridge to reef platform and to identify potential preventive and remedial actions.

1.1 The IW R2R Project in Solomon Islands

Objective

The regional International Waters Ridge to Reef (IWR2R) project aims to test the mainstreaming of climate-resilient approaches to integrated land, water, forest, and coastal management in Pacific Island countries through strategic planning, capacity building and piloted local actions to sustain livelihoods and preserve ecosystem services.

The specific objectives are to:

1. Identify ecosystem types, ecosystem services and threats in the context of:
    - ecosystem types present, in the context of the relevant ecosystem services;
    - the present condition or health of the ecosystems, based on existing information if available and/or recent observations (qualitative or opportunistic) throughout the course of the assessment;
    - key ecosystem services in terms of direct community dependencies;
    - the role of ecosystem services in providing socio-ecological resilience;
    - critical ecosystem linkages or dependencies; and/or the main existing threats to an ecosystem and/or ecosystem service.
2. Map key ecosystems and related ecosystem services, including high-use areas and/or major threats based on existing spatial data.
3. Identify the current state of ecosystems, trends, and drivers of change with root causes, scenarios, and governance factors.
4. Undertake a 'total economic valuation' to define the economic value of key ecosystems services relevant to an Ecosystem and Socio-economic Resilience Analysis.
5. Assess the vulnerability of ecosystems services to the effects of climate change, based on climate change projections and other existing threats.
6. Provide broad recommendations regarding strategic ecosystem-based adaptation options.

All IWR2R projects in Pacific Island countries take a gender mainstreaming and social inclusion approach. This means that stakeholder engagement and consultations are participatory in nature and consider the participation of women, youth, and other vulnerable members of communities in project planning, development, implementation, and monitoring. In addition, all project impacts on women and men will be analysed to ensure that all sectors of the communities are included.

In the Solomon Islands, the IWR2R project is led by the Environment & Conservation Division of Ministry of Environment, Climate Change, Disaster Management & Meteorology (MECDM) with the focus on developing an integrated watershed management plan for the Mataniko River Catchment.

An integrated watershed management plan for Mataniko River Catchment will:

- promote responsible landscape management;
- provide an opportunity for public dialogue and watershed education;
- promote gender and social inclusion in all consultations and interventions;
- promote conservation;
- promote tourism-based enterprises; and
- contribute to developing a long-term development strategy for watershed resources, thereby protecting ecosystem goods and services.

The Millennium Ecosystem Assessment (2005) categorises ecosystem services into four conceptual areas:

- **provisioning services** – the products obtained directly from ecosystems, such as food, water, fuels, medicines, and fibres;
- **regulating services** – the benefits obtained from the regulation of ecosystem processes, such as water regulation, erosion control, regulation of climate cycles and pollination;
- **cultural services** – the largely non-consumptive benefits obtained from ecosystems, such as spiritual, religious, and aesthetic well-being; and
- **supporting services** – the main ecosystem processes that underpin all other services, such as soil formation, photosynthesis, primary production, nutrients, and water cycling. Supporting services make it possible for the ecosystems to provide the above services.

This diagnostic analysis aims to assist the development of the integrated management plan for the Mataniko river catchment by providing baseline information on the provision of these ecosystem services in the catchment.

The report thus, addresses:

- goods and services valuation,
- biodiversity assessments, and
- water quality of the watershed catchment.

The other physical and ecological characteristics of the Mataniko Catchment are available in the Rapid Coastal Assessment – also referred to as the RapCA – report and, together with other relevant technical reports, will inform policy discussions at the site diagnostic analyses workshops.

1.2 Background to Studies

Mataniko river catchment is one of the wards in Honiara's demarcated zones. It is classified as highly vulnerable to natural disasters or hazards such as tropical cyclones and earthquakes, which often result in flooding, landslides, tsunami. In terms of population, the Mataniko ward in Honiara has a high rate of population growth and urbanisation inland (residing beside the Mataniko river catchment with the majority of its population within the youth range. This is highlighted in the report by Trundle and McEvoy in 2016). This increases the importance of a management plan as it will be used as a guideline for resource use, response, and priorities in times of disaster. It will help in the management and safeguarding of the vital resources utilised by the people living within the Mataniko catchment and watershed areas.

The government has existing national, regional, and international frameworks that act as guidelines or procedures that non-government organisations (NGOs), government ministries and other institutions can use during times of disasters. These include:

- Sendai Framework for Disaster Risk Reduction 2015–2030
- Hyogo Framework for Action 2005–2015
- Pacific Disaster Risk Reduction and Disaster Management Framework for Action (Regional Framework for Action or RFA) 2005–2015

- National Adaptation Programme of Action or NAPA, 2008
- National Disaster Risk Management Plan 2010
- Solomon Islands National Climate Change Policy 2012–2017
- National Development Strategy 2011–2020.

However, research published by the World Bank in 2014 found that such frameworks had inadequacies that made them inefficient in dealing with the rapid reaction that vulnerable communities need. As a result, some assessments by SPREP, SPC and other regional and international organisations have stated that an ecosystem-based management plan for the Mataniko Ward is urgently needed. This project attempts to meet Honiara's need for ecosystem management, particularly in Mataniko Ward.

Mataniko River catchment has been victim to many natural disasters in the past. The worst was the flooding in April 2014 that severely affected the Guadalcanal, Isabel, Malaita, and Makira provinces. The Mataniko community within the Honiara city ward and part of Guadalcanal Province was one of the most expensive and visible victims of the 2014 floods (World Bank 2015).

Mataniko Ward is situated in the central region of Honiara. It stretches from Mataniko River mouth, where an informal Lord Howe settlement is located, to customary Guadalcanal land further inland. The area consists mostly of informal settlements. An assessment conducted by UN-Habitat: Cities and Climate Change, 2014, identified the most vulnerable places in Honiara. The informal settlements along the Mataniko River were highly ranked.

The main threat for these peri-urban zones is natural disasters, particularly flooding. These areas lack proper sanitation and water sources, and have houses constructed with traditional building materials (Trundle and McEvoy 2016).

The lack of sanitation across the city heightens the vulnerability of the city in addition to climate impacts, flooding, health issues and the use of urban springs and water sources for washing, drinking and garden irrigation interacting with effluent and other pollution.

These informal and traditional villages depend on Honiara central market for income, where they sell food, they grow (and which they also use for subsistence). Thus, it is important that the different uses of resources by women, men, youth, and all sectors of the community be identified to fully understand resource use patterns, benefits or risks of any management that maybe implemented. The most effective, and for some, the only way to access Honiara central market is through the bridges that are, by evidence, vulnerable to extreme flash flooding. In April 2014, the bridges providing access to town experienced severe damage, including the destruction of the old Mataniko bridge. The follow up assessment found that the flooding affected the old and new Mataniko bridges, smaller bridges in Vara Creek and up the river, and cost up to USD 10 million dollars (Rini 2014, SIG 2014)[1].

Climate change plays a significant role in resource availability and management as well as in the frequency and intensity of natural disasters. Mataniko catchment is highly vulnerable to these changes in weather patterns due to its location and the informal settlement structure. Such settlements have low access to clean drinking water and proper sanitation[2]. These areas depend on subsistence farming for income and food (Teloest Consultancy 2018). Unsustainable farming practices in the catchment area are leading to increased threats to natural resources from land clearing, pollution of waterways, and overharvesting of terrestrial and coastal resources. Therefore, an ecosystem-based approach is considered the most sustainable, feasible and effective way to manage and utilise natural resources that have great significance to the people[3].

The threats and challenges outlined above contribute to further issues such as disease outbreaks, injuries, and deaths. For example, in the April flooding in 2014, all except one of the fatalities occurred in the communities of Vara Creek and Koa Hill, directly adjacent to the Mataniko River. This highlights the seriousness of the vulnerability of these communities. Additionally, 62% of these deaths were below the age of 14 years. These deaths are results of drowning and injury suffered from being taken by the flood. In addition to the deaths and injuries, the flood resulted in a flu and diarrhoea outbreak (Natuzzi et al. 2016).

1 Solomon Islands Rapid Assessment of Macro and Sectoral Impacts of Flash Floods in the Solomon Islands, 2014

2 Teleost Consultancy Report 2018

3 Ibid 3

A study, which explored environmental factors associated with diarrhoea prevalence among children under the age of five years in the Mataniko settlements, found the diarrhoeal prevalence rate for the Mataniko informal settlements (Mamana wata, Lord Howe settlement, East Koa Hill settlement) to be 45.9%, much higher than the national prevalence rate of 9.4% as found in the Solomon Islands Demographic and Health Survey 2006–2007 (Gali et al. 2020). This means all the Mataniko informal settlements are prone to diseases because of the environmental factors such as presence of stagnant wastewater, poorly managed solid waste as well as the proximity of households to the river.

There are various ways that ecosystem-based adaptation approaches can be implemented. In a report by SPREP 2018, options were selected for Honiara based on a cost effectiveness analysis (SPREP 2018).

1.3 Scope of the baseline assessment

To address the issues of the Mataniko River catchment, the entire local population and communities must work together to ensure long term success. This integrated watershed management plan sets out clearly the priorities, challenges and issues pertaining to the Mataniko watershed. The plan also contains strategic interventions required to address these priority environment issues. Hence, this integrated watershed management plan, if successfully implemented and enforced, should restore biodiversity, and support a clean, healthy, and vibrant environment in the Mataniko watershed catchment. The plan provides strategic directions and priorities for the management and routine operations within the catchment area. The development of an integrated watershed management plan for the Mataniko River catchment area aimed at changing the mind set of landowners away from a dependence on extractive activities (mining, logging, and sawmilling activities) and unsustainable agriculture practices, towards more environmentally sustainable land use and alternative income generation initiatives. The baseline assessments used in the diagnostic analysis cover results and analyses taken through series of technical undertakings and activities, including:

- Valuation study on Mataniko catchment ecosystems and services
- Water quality assessment
- Organised diagnostic analysis workshop with relevant stakeholders.

The approach is to consult, liaise and collaborate with MECDM and other relevant authorities and communities within the Mataniko River catchment watershed to review relevant instruments and documents and develop a Mataniko River Catchment Watershed Management Plan. This plan will ensure protection and restoration of the Mataniko River catchment watershed.

2 Methodology

Several studies were undertaken. The first involved the baseline assessment work described above. The second study required familiarisation with and describing the study sites, and the third involved a literature review to define the social and ecological space of the area prior to conducting field work with the communities.

2.1 Description of Study Sites

Mataniko (or Matanikau) catchment area is located in northwest part of Guadalcanal. The Mataniko River was one of the strategic locations during the second world war campaign of Guadalcanal for Solomon Islands. It is the main conduit of several tributaries from about 100 kilometres inland, flowing downstream as the Mataniko River, separating the Central Business Area with China Town and National Referral Hospital. Along the Mataniko River catchment from inland are hamlets, villages, squatters, residential areas such as Tuvaruhu, Vara Creek, Number 3, and China Town, then the Lord Howe and Mamana water settlements, along with several others (see Fig 1). According to Trundle and McEvoy (2016), the Mataniko catchment area has a high growth rate and young population, and this is prone to increase settlements.

Mataniko catchment is classified as a highly prone area to natural disasters and hazards such as tropical cyclones associated with flooding, landslides, and tsunami. Catastrophic flooding occurred in 2014, causing loss of lives and huge damage, which resulted in the government needing to relocate, rehabilitate and compensate a number of people living within the Mataniko River catchment. The flooding was triggered by uncontrolled surface runoffs and debris upstream, which formed a dam that later burst, flushing down the Mataniko River.

The significance of Mataniko catchment (as outlined above) provides the imperative for the government to develop effective and considerate policy instruments pertaining to resource and land use, disaster, and community quick response plans. There is, therefore, a high need for an ecosystem-based management plan for the Mataniko Ward. This was further supported by Mataniko River Environment Baseline (Teleost Consultancy report) 2018 report, which highlighted the need for an ecosystem-based management plan in Honiara.

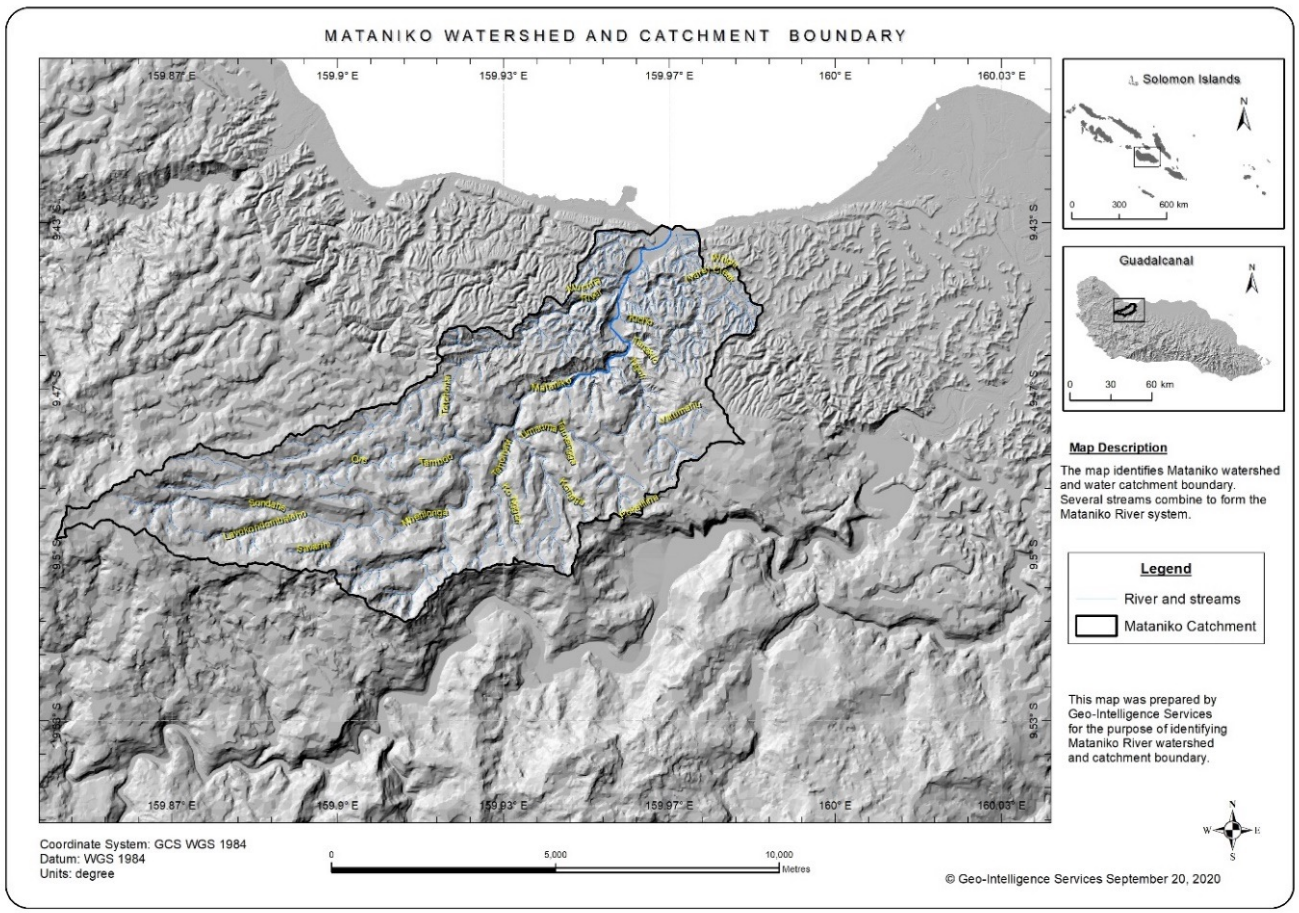

Figure 1: Image showing the Mataniko watershed and catchment boundary

The following methods were used during this project:

a. Desk study review. Past and current reports or studies were sourced from MEDCM Project Management Unit office, Ecological Solutions Solomon Islands (ESSI) office, SPREP portal for reports, other internet sources and other grey literature.

b. Community consultation meetings, which were inclusive of men, women, youth, and other members of the communities.

c. Key stakeholders meeting with government agencies such as MECDM and Ministry of Mines and Energy and Rural Electrification, Honiara City Council (HCC) Public Health Section, and Solomon Water.

2.2 Community Consultations

The community stakeholder consultations were conducted between 15 July and 2 August, 2020. Table 3 provides a summary of attendees at each consultation, disaggregated by gender and age. Numbers of attendees ranged from 13 to 30 people, with more female attendees than male. The low participation is attributed to the fact that most people were at work.

Table 1: Summary of community consultation attendees for each village

	Ngalitatae	Musona	Cana Hill and 9 Ridges	Vara Crk & Namoliki	Koa Hill	Fijian Quarter	Renlau	Tuvaruhu
Consultation Date	15 July	16 July	16 July	17 July	17 July	20 July	20 July	21 July
Total Number of actively involved participants	20	30	13	30	20	15	26	26
Male Portion	5 (25%)	4 (13%)	5 (38%)	4 (13%)	6 (30%)	7 (47%)	5 (13%)	17 (65%)
Female proportion	7 (35%)	9 (30%)	5 (38%)	9 (30%)	7 (35%)	2 (13%)	13 (50%)	9 (35%)
Youth Male proportion	5 (25%)	10 (33%)	3 (24%)	12 (40%)	2 (10%)	3 (20%)	7 (27 %)	
Youth Female proportion	3 (15%)	7 (23%)	0	5 (17%)	5 (25%)	3 (20%)	1 (10%)	

Community consultations were scheduled by the project manager through communication with the chair or secretary of the community committee. All necessary protocols were followed, including introductions of the ESSI team to the community prior to the formal meeting. With the committee, the project manager provided an overview of the project, emphasised its importance and introduced the ESSI team.

The team leader next explained the activities for the community consultation and participants were usually divided into three small groups. One group for all the men, one group for all the women and the third group for the young people.

A map of the Mataniko Watershed was provided to each group with paper to record discussions. Groups identified a chair, secretary (to record the discussions) and a presenter. Groups were asked to discuss and record their answers to the following questions

1. List all the ecosystems within the Mataniko Watershed Area and their benefits that your community receive from the ecosystem and the ecosystem services that it provides.

2. What are the threats and how can you mitigate the threats to the Ecosystems and the ecosystem services that you have benefited from the Mataniko Watershed?

3. What community rules or by laws would you like to propose for your community in order to project the ecosytem and the ecosystem services?

4. Draw on the map the areas of importance to you with regards to the ecosystem and the ecosytem services that that those areas provide.

An ESSI team member was present on each group to provide guidance or prompt answers to their questions or just clarify the activities they are doing and its importance.

The group discussions were usually very lively because participants were talking about places that they benefitted from or an issue of great concern to them. Some even mentioned things that they have lost because of the current situation and challenges that they have.

Figure 2: Project Manager gives an overview of the project.

Figure 3: ESSI team leader introduces his team

Figure 4: ESSI team team talks about the activities for the consultations

2.2.1 Ngalitatae Community

Figure 5: Two women representing Ngalitatae women's group presenting on behalf of their group

Figure 6: Youth from Ngalitatae present on behalf of their group.

2.2.2 Mousona Community

Figure 7: Women's discussion group at Mousona community

Figure 8: Men's group from Ngalitatae presentation on behalf of their group

Figure 9: Women's group presentation at Mousona Community

Figure 10: Men's Group Presentation at the Mousona Community

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Figure 11: Women participants during Mataniko watershed consultation meeting at Cana Hill SSEC church Hall

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Figure 14: Men's discussion group at Cana Hill

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Figure 16: Vara Creek Youth discussion group.

Figure 17: Namoliki and Vara Creek Youth discussion group.

Figure 18: Namoliki and Vara Creek Men's discussion group.

Figure 19: Namoliki and Vara Creek Youth group presentation

Figure 20: Namoliki and Vara Creek youth group map presentation

Figure 21: Namoliki and Vara Creek Men's group presentation

Figure 22: Namoliki and Vara Creek women's group presentation

2.2.5 Koa Hill

Figure 23: Koa Hill Youth discussion group.

Figure 24: Koa Hill women's discussion group.

Figure 25: Koa Hill Youth group presentation.

Figure 26: Koa Hill Women's group presentation.

2.2.6 Fijian Quarter and Number 3 Community

Figure 27: Fijian Quarters and Number 3 women discussion group.

Figure 28: Fijian Quarters and Number 3 Men's group presentation

Figure 29: Fijian Quarters and Number 3 community Female youth group presentation

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Figure 30: Renlau Youth discussion group 1.

Figure 31: Renlau youth discussion group 2.

Figure 32: Renlau Women's discussion group.

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Figure 33: Tuvaruvu participants.

Figure 34: Tuvaruvu Men's discussion group

Figure 35: Tuvaruvu Women discussion group.

Figure 36: Tuvaruvu and Tanakio youth discussion group.

2.3 Other Key Stakeholders

The key government stakeholders are the Ministry of Forestry and Research; Ministry of Environment, Climate Change, Disaster Management and Meteorology; Ministry of Fisheries and Marine Resources; Ministry of Mines, Energy and Rural Electrification; Ministry of Health and Medical Services; Ministry of Tourism and Culture; Ministry Home affairs and Ministry of Lands and Housing. Solomon Water is another key stakeholder.

For these key stakeholders, we reviewed their governing acts and regulations and how these can contribute towards designing a comprehensive management plan for the Mataniko River. Meetings were conducted with individuals of each of the ministries and were asked if they have any future plans for the Mataniko Watershed. The final management plan will incorporate across ministries, Honiara City Council, the residents of the Mataniko Watershed and any interested and concerned individuals.

3 The Ecological Assessment Review

The objective of the ecological assessment review is to assess the status of the Mataniko River catchment environmental conditions and to provide a basis for evaluating environmental impacts and mitigation related instruments to help the government and its people rehabilitate the Mataniko River catchment.

An ecological assessment review involves looking at past and present reports defining the state of the freshwater biodiversity in the area. The biological baseline of this assessment will be based on the report produced by Sobey (2020) for the Mataniko catchment.

This review focuses on the following;

- Describing the physical environment of the Mataniko River catchment
- Water Quality and ecological conditions of Mataniko River catchment
- Formulating recommendations for the development of a management plan for the rehabilitation of Mataniko River catchment.

3.1 Mataniko River catchment vicinity

Mataniko catchment is defined from Mamana Water Community and Lord Howe Settlement at the coast and extends inland southwest into the Guadalcanal mountain range. It has a total length of over 20 kilometres and covers an area of 5802 hectares. The Mataniko River catchment includes the residential areas, village settlements, business facilities within China Town and the land cover.

The upper Mataniko River water catchment is dominated by lowland, ridge top forest type and riparian plants distributed randomly along the riverbanks. Tall trees form the top canopy layers reaching up to only about 20 metres in height. Medium sized trees, shrubs, herbs, ferns, and orchids are widespread. Due to this ecosystem, vertebrate assemblage is relatively rich.

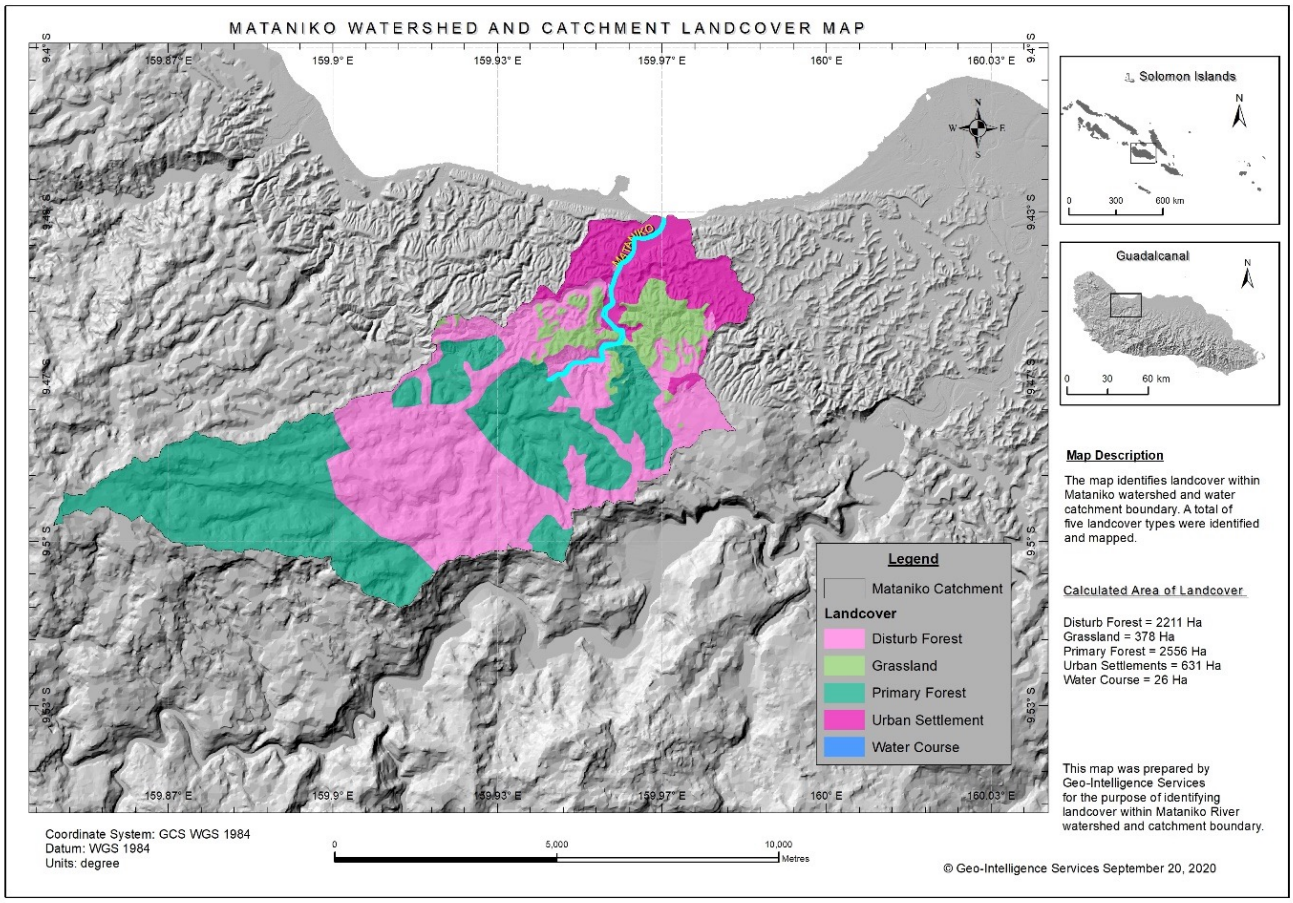

Figure 37: Shows the map of land cover of Mataniko River catchment

The map shows an alarming rate of disturbed site (lower reach of the river) toward the upper catchment areas from ongoing expansion of Honiara. Along the catchment are the villages mentioned above.

The river is highly polluted from solid waste originating from the human settlements along the river, other residential areas, and shops adjacent to the river. During flooding most of this waste ends up on the Honiara seafront, causing nuisance to the coastal residents and foreshore developments.

3.2 Geology, Hydrology and Geomorphology

According to Coleman's classification, the Mataniko river basin and catchment are part of the Central geological province (Coleman 1965). The geology is dominated by diorite formations bounded by outcrops of the Miocene limestone (Hackman 1979). Calcareous sandstone/mudstone from the Miocene to recent calcareous sandstone/mudstone overlies Oligocene diorite within the Mataniko watershed and catchment boundary. Sand, clay, and gravel are distributed at the bottom valleys of the watershed and catchment boundary and are visible within the watershed and catchment boundary. The upper parts of marine terraces and river gorges are covered in Pleistocene coral limestone.

In the northern ridges of the catchment, the limestone is exposed into steep ridges and outcrops to a greater or lesser extent to the eastern and western ridges. Grass escarpment, set on the Pleistocene "Honiara beds", a group of calcareous sediments of varying lithology that rise from the sea as a series of three or four terraces, fronts the limestone towards the coast (Hackman 1979). These sediments rest on little-known Lungga beds in some places. The majority of alluvial deposition occurs within the valley, with sediments confined to small fans along the river's edge. The catchment area's surface topography is dissected, with narrow ridgetops and extremely steep ridge slopes. During extreme rainfall events, narrow valleys like those found along the Mataniko catchment are prone to hydrological short-circuiting floods.

The biophysical environment is characterised by *Themeda australis* and *Imperata cylindrical* grasslands, hilly forests, and small patches of lowland and swamp forests. A detailed vegetation history reveals that massive grassland extensions occur at the expense of forest taxa as a result of burning events consistent with forest clearance and urban settlements (Haberle 1996). The biophysical environment in the lower and mid-sections of the Mataniko water catchment had been altered by past human activities such as farming, settlement and road construction.

3.3 Terrestrial Ecology

Studies have been conducted on terrestrial and aquatic fauna in the Mataniko catchment and reported by Sobey (2020). A team from the Ministry of Fisheries, as part of the Honiara Coastal Assessment, has documented the marine fauna survey (Moses and Posala 2020).

3.3.1 Terrestrial Flora

According to the report by the Teleost Consultancy in 2018, the Mataniko watershed catchment is made up of six different types of flora composition from the coastal area to the headwaters of the catchment. The different compositions are:

a. Coastal or beach habitat on the front line near the sea.

b. The grasslands introduced legume trees and shrubs, and coastal trees along the beach side and both sides of the main road.

c. The riparian zones along the Mataniko river buffer system.

d. The freshwater swamps – ponds connected to the lower parts of the Mataniko river.

e. The upland ridges invaded and covered by a diversity of grass species.

f. Remnant primary forest and secondary forest re-growth are the flora composition at the upper hill ridges and valleys of the catchment.

Sobey (2020) reported a total of 76 plants from the plots within the riparian and disturbed primary forests. Most of the plants are native, with five endemic species (*Canarium salomonense, Ptychosperma solomonensis, Melastoma novae-georgiae, Physokentia insolita, Heterospathe solomonensis* and the endemic palm *Rhopaloblaste elegans*), one invasive species (*Brousonnetia papyrifera*) and one introduced species (*Ochroma lagopus*). The common invasive tree in the catchment is the African tulip tree. The following commercial and timber trees were recorded *Spathodea companulata*. *Pommetia pinnata, Calophyllum peekelli, Vitex cofassus, Pterocarpus indicus and Celtis latifolia*. The rosewood tree, *Pterocarpus indicus*, is listed as Endangered on the IUCN Red List (Sobey 2020). The disturbed primary and riparian ecosystem and its services are valuable to the Mataniko catchment. The natural vegetation has been modified due to human activities therefore, care must be given to maintain the vegetation throughout the catchment.

3.3.2 Terrestrial Fauna

Terrestrial fauna includes thirteen species of native birds and two endemic birds – the Solomon Sea eagle, which is endemic to the Solomon Islands, and Guadalcanal boobook, which is endemic to Guadalcanal Island; six native species of lizards; three native species of geckos; one native species of tree snake; six native species of frogs, and an introduced cane toad; two native species of bats; one introduced pig; and the introduced coconut rhinoceros beetle (Telios 2018 and Sobey 2020).

3.4 Freshwater Ecology

3.4.1 Freshwater Fauna

The freshwater fauna component documents all the aquatic fauna, which consist of macroinvertebrates, vertebrates and algae that have been recorded within the Mataniko watershed catchment.

3.4.2 Macroinvertebrates

Two native mayfly species, one native species of diving beetle, one native species of water strider, nine species of native dragonfly, two species of native damselfly, three species of butterfly, three species of native freshwater prawns, one species of native crab, four species of native snails, one introduced giant African snail species and three species of algae were recorded (Telios 2018 and Sobey 2020).

3.4.3 Vertebrates

Ten native and one endemic freshwater fish species were recorded from the Mataniko watershed catchment (Telios 2018 and Sobey 2020).

3.5 Surface water baseline field review

The surface water quality of Mataniko catchment has been assessed by consultants in 2018 with progressive monitoring results by the MECDM. These tests are mainly on the following:

- *E. coli* and coliform bacteria
- Heavy metals
- Cations
- Anions (chlorine, sulphate, and alkalinity)
- Nutrients: phosphorus (P), nitrate (NO3-N) and ammonium nitrate (NH4-P)
- Physical parameters: temperature, pH, oxygen reduction potential, dissolved oxygen, conductivity, turbidity, total dissolved solids, and salinity.

3.5.1 E. coli and coliform bacteria

Due to humans accessing the Mataniko river catchment for swimming, recreation, fishing, transport and food and water, it is crucial to prevent diseases and infection. A key indicator is the bacteriological quality of the water which involves testing for traces of *Escherichia coli (E. coli)* levels. *E. coli* is the dominant bacterial organism in animals and especially in human faeces. (Steblin 2007). *E. coli* indicates pathogens in the water column, and thus, risks to human health. Total coliform is also an indicator of pathogens that can cause acute and chronic health effects.

According to World Health Organization (WHO) Guidelines for Drinking Water Quality (4th Edition), levels for safe drinking water are 0/100 ml, and 200 MPN/100 ml for water used for recreational purposes. Thus, as expected, *E. coli* and total coliforms are high due to the human activities, various types of waste and untreated sewage.

Reports obtained for this review indicate that in the Mataniko river catchment, total coliform and *E. coli* levels increase downstream (where there is greater human activity).

3.5.2 Heavy Metals

Heavy metals are natural constituents of the environment but are present in trace amounts. However, several metals originate from anthropogenic sources due to increased mechanical technologies, industrial activities which use imported metal material, and improper disposal of waste containing metal. Although they can be detected it is difficult to remove heavy metals from the environment. Long-term exposure to heavy metals may lead to carcinogenic acute and chronic health effects.

Weathering of sedimentary deposits derived from volcanic rocks on Mataniko river catchment may release heavy metals such as arsenic and chromium. The trend of human settlements along the river may increases possible generation of domestic and industrial effluent, which finds its way into the river contributing to the water column pollutants.

During the tests for cadmium, chromium, lead, and mercury in 2018 studies, concentrations were found to be below the detection limits. Other trace metals indicate their natural occurrence, especially copper, which is indicated on the upper reaches.

3.5.3 Cations

A phenomenon known as “water hardness” can be measured how water reacts with soap to form noticeable deposits of precipitate white foam on the water. With hard water, a considerable amount of soap is needed to produce lather (foam). Hard water is caused by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations, but also includes aluminum, barium, iron, manganese, strontium, and zinc.

The level of cations is expressed as milligrams of calcium carbonate per litre. Calcium carbonate concentration that is below 60 mg/l is considered soft water; 60–120 mg/l moderately hard; 120–180 mg/l as hard; and more than 180 mg/l as very hard (WHO 2011). Sources of calcium and magnesium in Mataniko River catchment would be from sedimentary rocks, namely limestone, and from seepage and runoff from soil.

Potassium-based water softeners are commonly used to remove minerals such as calcium and magnesium ions from hard water. The calcium and magnesium are replaced with potassium and sodium ions. Potassium is an essential element in animal and plant tissue. Potassium and sodium can cause health effects in susceptible animals, however, consuming is still not harmful. Sodium is commonly leached from the terrestrial environment to groundwater and surface water (WHO 2011a). Sewage effluents due to unmanaged treatment facilities can be a source of sodium and potassium in the river.

3.5.4 Anions (Chlorine, Sulphate and Alkalinity)

Chlorine is used as disinfectant and bleach for domestic and industrial purposes and to treat drinking water to control bacteria levels. It reacts with water to produce hypochlorous acid and hypochlorite. The WHO threshold for chlorine levels for safe drinking water is 5 mg/l.

Sulphate is discharged into water columns from industrial waste and through atmospheric deposition. Most sulphate occurs in groundwater and from natural sources; if ingested at higher levels, it may result in gastrointestinal effects (WHO 2011a).

Alkalinity is determined by geological composition of soil and bedrock through which the water passes.

Carbonate, bicarbonate, and hydroxide compounds are sources of natural alkalinity. This parameter is important to aquatic life because it creates buffers against rapid pH shifts. High alkalinity means the water column is acidified and may be harmful to aquatic life.

Chloride has higher indication near to the coastline or estuary in varying amounts and is associated with residential expansion and settlements. In contrast, the chloride indication is relatively low on the upper catchment. Higher chloride levels indicate pollution.

As sulphate is associated with saltwater environment, the results obtain in 2018 had confirmed higher levels at and near to the coastline. From mid-reach to the upper catchment, sulphate was below the WHO standard 500 mg/l. Sulphate in Mataniko River catchment is influenced by sedimentary layers in the upper catchment gorge that contains iron.

The study found that alkalinity in the Mataniko River catchment is high in most of the areas sampled. The tendency for Mataniko River to neutralise acidity increases downstream and is influenced by rocks, soil, salts, certain plants, and wastewater discharges from settlements along the river catchment. Saltwater intrusion and sediment composition are also factors that contribute to high alkalinity.

3.5.5 Nutrient species: nitrogen, nitrate, and nitrite as nitrogen

Soil fertility for farming in the Mataniko River catchment cannot be disputed due to the natural occurrence of the nitrogen species, but are present in reduced form as a result of microbial reduction of nitrate.

Due to clearance of vegetation for multiple reasons from gardening to human settlements, nitrates seep into surface water as runoff and percolate into groundwater. The recommended value for nitrate is 50 mg/l (11 mg/l as nitrate-nitrogen).

The recommended value for nitrate can change rapidly due to surface runoff of fertilisers, uptake by phytoplankton and de-nitrification by bacteria. Nitrate and nitrite levels are expected to be low on the upper reaches of Mataniko River Catchment due to less microbial reduction activity. Higher levels of both would be expected in the densely populated areas downstream due to waste water disposal and seepages from septic tanks from the urban areas.

3.5.6 Total Phosphorous

Phosphorous is an essential nutrient for all living organisms and plays a significant role in biological metabolism. It is commonly the first nutrient to limit biological productivity. Water bodies with low phosphorous concentrations can support diverse and abundant aquatic life. However, high phosphorous concentrations adversely affect aquatic ecosystems (Chambers et al. 2001).

Phosphorous occurs in three forms in aquatic systems, namely: inorganic phosphorous, particulate organic phosphorous, and dissolved (soluble) organic phosphorous (Canadian Council of Ministers for the Environment 2004). Total phosphorous concentration ranges between 0.01 mg/l and 0.05 mg/l in non-populated water (WHO 2011a). Significant elevations of total phosphorous may result in algal productivity (algal bloom), rapid plant growth and low dissolved oxygen from additional decomposition of plant materials in water bodies.

Surface water rich in organic matter or bogs tend to exhibit high total phosphorus concentrations. In lakes or areas of low turbulence in rivers, sediments tend to contain much higher concentrations of total phosphorus. (Canadian Council of Ministers for the Environment 2004)

3.6 Physical parameters: Temperature, pH, Dissolved Oxygen (DO), conductivity, turbidity, total dissolved solids, and salinity

3.6.1 Temperature

Temperature is a property of water that indicates how cold or hot a water body or column is. It also defines movement of molecules in the water body. It is, then, an important water quality monitoring and assessment indicator for quality of life in a water body or water column (Brett 2014). It also defines the level of toxic substances in the river or water column.

The normal water temperature for Mataniko river ranges between 25^{0}C to 27^{0}C at daytime and 5^{0}C to 3^{0}C during cold nights (Brett 2014).

Temperature obviously increases downstream, however, it is within the range possible to support lives.

3.6.2 pH

pH is an important water quality monitoring parameter showing the acidity or alkalinity of any water body or river. It is the measure of hydrogen ion (H+) in a sample. The scale for pH is from 0 to 14 where water is normally at pH 7 (neutral). If the pH is above 7, the water is alkaline/basic and below 7, it is acidic.

The pH tolerance for aquatic life ranges from 6.5 to 9.0; drinking water is between 6.0 to 8.5, where other than these levels can be harmful to both aquatic and human lives (USEPA website). At pH 5.5 in Bangladesh, mass aquatic species died due to pollutants. (Chandan 2013).

According to studies by the MECDM in 2019, the pH trend decreases downstream, with maximum pH at 8.6 and a minimum pH value at 8.06. This is due to high concentration of nutrients and organic waste within and beside the riverbanks. This can lead to higher conductivity and salinity due to high solutes in the water column. However, these values are still within safe range for healthy aquatic ecosystem.

The Mataniko River is highly polluted downstream, with sewage waste and diffused waste from Honiara's water outfall and piggery farms along the river. Pools along the meadow areas are sinks for all diffused waste transported downstream from upper catchment residents.

3.6.3 Conductivity

This parameter is the measure of the water's ability to conduct electricity within the river. Conductivity is influenced by temperature, water body, surrounding soil, and presence of dissolved solids that consist of cations and anions: Cl-, SO42-, NO3-, PO43- or Na+, Mg2+, Ca2+, Fe2+, Al3+.

High conductivity levels indicate major discharges or other sources of inorganic dissolved solids in the river. Conductivity within the Mataniko River was noticed to increase at the upper catchment and slightly decrease in the mid reaches before escalating downstream more than five times that of the upper catchment. This suggests that there is some human activity in the upper catchment, but this is far greater in the densely populated areas downstream, e.g. in areas such as China Town. In the mid reaches, where the water is still and relatively shallow, some solutes might sink to the substrate.

3.6.4 Dissolved Oxygen (DO)

Dissolved Oxygen is a naturally occurring parameter produced through the photosynthesis process and important for aquatic life. A DO level that is too high or too low can harm aquatic life and affect the water quality. The maximum level of DO that can support aquatic life would be 110 %. Inhibiting DO will result in fish or aquatic organisms getting killed. At 0% aquatic flora will increase in growth and dominance.

The average value for DO calculated for Mataniko River water quality was 95.95%, with most of the values above the average range. The average DO for Mataniko River falls in the safe range to support aquatic organisms. The low DO values in downstream sites closest to the river mouth, indicate high organic and inorganic waste pollution compared with the upper stream river.

3.6.5 Turbidity

This parameter reflects the clarity of water and is measured by how well infrared light penetrates the water medium. The unit of measure is FNU or NTU. Turbidity is influenced by high amounts of suspended solids entering the water column, thus changing the water colour. As a result, these suspended solids can absorb heat, which is detected as infrared light.

The MECDM study found that turbidity is lower in the upper catchment and increases in the mid to lower reaches. Water beyond the Solomon Islands Water Authority (SIWA) sewage site was observed to have high turbidity (readings above 10 NTU), likely due to nutrients, waste and mucky mud from surrounding sites, residences, and businesses. Turbidity in the upper catchment was 1 NTU and the water was seen to be colourless with fewer substances suspended in the water column.

3.7 Marine Ecology

3.7.1 Corals

The study recorded 15 genera from 9 families of corals in the Honiara coastal seashore. Most of these are stony corals of the order Scleractinia.

3.7.2 Invertebrate

The common marine invertebrates recorded are blue starfish, sea urchins, lollyfish, clam shell, trochus shell and crown of thorn starfish.

3.7.3 Vertebrate (Fish)

Reef fin fishes from 9 families, 20 genera and 31 species were documented during a study of the coastal ecology baseline assessment of Honiara coast area.

3.8 Waste management system

3.8.1 The waste stream in Mataniko River Catchment

The uncontrolled, unmanaged, and unregulated expansion of human encroachment into Honiara's urban areas has put pressure on the government to provide services. Waste management services are one of them. Human settlements, residential areas, state infrastructure and business facilities or centres, all contribute to the waste stream in the Mataniko River Catchment.

According to the Mataniko Environment Baseline report (2018), due to ineffective disposal methods and approaches, the majority of waste was solid waste. Organic waste from decaying leaves is not included in the study because it is assumed that land use activities in the upper catchment, such as subsistence farming, will exacerbate their occurrence.

Waste material tends to accumulate near the coast and is affected by the country's wet and dry seasons.

Sinclair Knight Mertz (SKM) conducted a waste characterisation study in 1990 with the goal of establishing mechanisms, approaches, and methods to address Honiara City's alarming waste rate. The report highlights the following:

- Plastic waste or solid waste is high.
- Only a few returnable bottles reach landfills due to the recycling scheme in place at the time.
- Aluminum was collected for recycling before it could be collected to reach the landfill.
- Metals have been observed to make their way to landfills.
- Organic waste or biodegradable material is very high at 65% of total waste to the landfill.

According to the report, 0.62 kilograms of waste is generated per person per day. With a population of 48,000 people at the time, the total waste generated annually would be more than 10,862 tonnes.

Melchior Mataki conducted another study as part of his PhD dissertation (2011), this time focusing on the Honiara Central Market and household waste. The study shows a small but significant result: a person's waste generation rate per day in urban areas is 0.87 kilograms (Mataki 2011).

So, for a total population of 64,600 people at the time, total waste generation would be 20,516 tonnes per year. In just 20 years, the amount of waste in Honiara has increased threefold.

The HCC conducted another waste characterisation study in 2011, reporting a waste generation rate of 0.86 kilograms per person per day, resulting in a total waste generation of 20,277 tonnes.

The studies all show that the largest proportion and component of waste is organic or biodegradable waste. The Solomon Islands National Waste Management and Pollution Control Strategy 2017–2026 is a response to this, ensuring a whole-country-driven and -owned approach to address, manage and control waste from the point of origin.

3.8.2 Sources of waste

The majority of waste was from municipal and animal/human sources triggered by irresponsible behaviours and attitudes within the communities. One of the main issues is the lack of information on waste management with respect to the aquatic/marine environment as a habitat that can support lives as well. Municipal waste is increasing at an alarming rate downstream, necessitating state policy planning and legislative enforcement in collaboration with the community.

Sewage flowing into the Mataniko river is untreated waste from the sewage systems and direct discharge of human waste. The construction of comfort rooms, pig and chicken fences along riverbanks has resulted in an increase in bacteria and water-borne diseases. The majority of landowners do not have toilets, so the river is used as a toilet. Foreign goods, such as plastic bags, were plentiful in the river and were thought to have come from Honiara's Chinese shops.

3.9 Natural Vulnerabilities

3.9.1 Risk Assessment

A risk assessment review conducted as part of the project identified 16 potential hazard events and their distribution within the Mataniko watershed and catchment boundary. These are classified into four hazard types: hydrological, geological, climate and anthropogenic hazards.

The study identified tropical cyclones to be the potential hazard event of highest priority, followed by hydrological short-circuiting and high rainfall events, as well as landslides, coastal erosion, earthquakes, and fire (Table 2). The risk assessment provides guidance for development of risk reduction management plans for the Mataniko catchment.

Over the long term, the Solomon Islands is expected to lose an average of USD 20 million per year due to earthquakes or tropical cyclones. The Solomon Islands has a 50% chance of experiencing a single event loss of more than USD 240 million in the next 50 years and a 10% chance of experiencing a single event loss of more than USD 520 million (PCRAFI 2015).

The incidence of natural hazards is determined by the positions of individual islands and geographical regions of larger islands in relation to plate tectonic boundaries, latitude, and longitude, as well as their size and topography (Radford and Blong 1992). As a result of the variability, each island and separate geographic areas within larger islands must be studied individually to determine their exposure and vulnerability to hazards.

In the case of Guadalcanal, environmental and climate-related hazards that affect the northern geographic region include tropical cyclone-related heavy rain and strong winds, flash flooding from heavy rainfall, landslides, rockfall, drought, storm surge and earthquake.

In recent years, environmental and climate-related hazards have had a significant impact on the Mataniko watershed and catchment boundary, resulting in significant economic losses as well as deaths.

Table 2: Level of risk of identified hazards for Mataniko River catchment

Hazards	Level of risk	Descriptive notes
Tropical Cyclone	30	Very high
Hydrological short-circuiting	15	High
High rainfall events	12	High
Landslide (wet movement)	8	Moderate
Coastal inundation	8	moderate
Earthquake above 8 Mg	6	Moderate
Fire	6	Moderate
Flash flooding	4	Low
Landslide (dry movement)	4	Low
High temperature events	4	Low
Ground movement	4	Low
Rock fall	3	Low
Drought or low water	3	Low
Subsidence	2	Very low
Erosion	2	Very low
Chemical spill	2	Very low

3.9.2 Biological Ecology

The Mataniko watershed catchment has a unique biological diversity from the head water of the Mataniko watershed to the coastal environment that includes flora and fauna of the ridges to the reefs. The flora and fauna include all the habitats within the catchment that includes terrestrial, freshwater, and marine taxa. A total of 98% are native species, 1% are endemic species and 1% are introduced species.

The following endemic species sago palm (*Metroxylon solomonensis*), Guadalcanal boobook (*Nixon j. granti*), Solomon sea eagle (*Haliaeetus sanfordi*) and freshwater goby (*Sicyopterus stiphodonoides*) are a few of the endemic species documented within the Mataniko watershed catchment. Despite the very small number of endemic species, this is significant given the size of the watershed catchment therefore, their habitats must be given priority to be protected for the sake of the endemic and the 98% of native species. The Mataniko watershed catchment must be recommended as a Protected Area, given its rich biodiversity from the ridges to the reefs.

Cane toads (*Rhinella marina*), pigs (*Sus scrofa*), giant African snails (*Lissachatina fulica*) and coconut rhinoceros beetles (*Orycytes rhinoceros*) were discovered in the area, all of which are major concerns because they threaten the biological diversity of the catchment. Given their attributes as invasive species, they can reproduce quickly and invade the habitats of the native species. Furthermore, they can supplant native species by preying on them or altering the habitat to eliminate them. The giant African snail and the coconut rhinoceros beetle are attacking food crops posing a threat not only to the flora and fauna but also to the communities' food security and livelihood prospects.

To protect the biological diversity of the Mataniko Watershed Catchment and the livelihood of its residents, an eradication programme for the introduced species must be put in place and be implemented.

3.9.3 Mataniko Catchment Ecostatus Assessment Matrix

The Mataniko Catchment Ecostatus Assessment Matrix in Appendix 1 presents the scores of the status of each site along the river from good to moderate degraded and degraded. The matrix shows that the water quality is good in those areas where there is intact forest and no residents beside the river. The other extreme is also true for the areas where communities reside, urban areas and houses and residents replace the forest areas, and the surroundings are degraded.

The matrix also presents the different threats that affect the water and its ecostatus. It also suggests mitigation options that will help to improve the ecostatus of each site. It is the intention of this report that the communities and their key stakeholders be encouraged to work towards the improvement of the sites that are moderately good to degraded areas.

A number of factors have contributed towards the degraded ecostatus of some sites and include discharge of untreated waste into the river, the deposit of various types of waste on the riverbanks, and placement of pig or chicken enclosures near the river edge. Such practices must be discouraged to help rehabilitate the river and improve its ecostatus.

Poor ecostatus is also associated with health issues such as diarrhoea and scabies, which are most common in young children along the river catchment. Ecostatus health also contributes to human health.

4 Legislation and Policy Framework

It is the intention of the Solomon Islands Government (SIG) to develop management and development plan directives for highly sensitive and significant areas within the Solomon Islands and especially areas surrounding Honiara. The government highlights the importance of these key areas (that include river catchments, reefs-atolls, mangrove areas, seagrass, mudflats, wetlands, and areas above 400 metres ("sky islands") for mountainous regions) that have supported livelihoods for centuries. Recognition of this natural basis for a green and healthy Solomon Islands has been expressed in various policy and legal frameworks.

This is also a significant move to increase green economy without destroying or devastating vegetation and habitats that support their life.

This management plan focuses on managing significant key areas such as the Mataniko catchment and thus, operationalise the government's commitment to promote, develop, manage, and protect the environment and its residents.

4.1 International and Regional context

It is the commitment of the government to adhere to both binding and non-binding regional and international frameworks concerning the environment and sustainable development of natural resources.

Agenda 21 on Sustainable Development

Agenda 21 is a non-binding action plan of the United Nations towards to sustainable development. It is also the product of the Earth Summit – the United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil in 1992 and was adopted by more than 178 governments, including the Solomon Islands.

CITES

The Convention on International Trade in Endangered Species of wild fauna and flora is an international agreement between governments to ensure international trade in specimens of wild animals and plants does not threaten their survival. The convention was developed to put an end on the trade of wild prominent species.

The convention is voluntary and non-binding and provides the framework to be adopted in state domestic legislation for national level implementation.

In responding to this commitment, the SIG had passed the Wildlife Management and Protection Act 1998 for the management and protection of wildlife species and specimens for the purpose of research or development.

Convention of Biological Diversity

The Solomon Islands is a signatory to the Convention of Biological Diversity (CBD) in 1995 which leads to the development of the Environment Act 1998. The CBD is a non-binding instrument, however, it urges member states to comply with international regimes to promote, protect and conserve natural environment resources.

Cartagena Protocol on Biosecurity

The protocol was ratified in 2004 to contribute to ensuring an adequate level of protection in safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may adversely threaten the conservation and sustainable use of biological diversity, human health, and transboundary movements. It is a supplementary agreement to the CBD, which came into force on 11 September 2003.

Nagoya protocol on Access, Benefit and Sharing

The SIG had ratified this protocol in 2018 after it came into force in 2014. It is one of the international protocols that recognises communities and indigenous rights to their knowledge and culture as part of biodiversity. Thus, this protocol ensures a fair share of the benefits from the use of any resources in their domain.

In response to this, the SIG passed the Protected Areas Act 2010, which provides for conserving areas of high biodiversity sites for research. A full mechanism to implement the Nagoya Protocol is yet to be imposed.

The UNFCCC – United Nations Framework Convention on Climate Change – UNFCCC

The convention is a non-binding treaty that urges all nations to stabilise greenhouse gas concentrations at a level that prevents human induced interference with the climate system.

In response to this commitment the SIG had passed a climate change policy, which is now due for review and update. With this also is the mandatory expansion of the MECDM, which houses the climate change division.

Kyoto Protocol

The SIG signed the Kyoto protocol in 1998 and ratified it in 2003. The commitment offers the opportunity for developing states like the Solomon Islands to combat climate change and its adverse impacts by working towards sustainable development at all levels and sectors.

4.2 National and Local Legislation and Policy

4.2.1 Policy context

This management plan is governed by policies and legal instruments that promote sustainable development and resources. Such instruments shape the context at which this management plan is developed and implemented within the communities of Mataniko vicinity.

Gender considerations and social inclusion in the different policies will guide the work on gender and social inclusion throughout project development and implementation.

National Development Strategy 2016–2035

The National Development Strategy sets the nation's development priorities and is based on respecting the national diversity of people's cultures and harnessing economic stability for development in all sectors.

DCGA Policy statement 2016–2020

This policy statement highlights Solomon Island's transition plan and commitments from 2016 into 2020. The government plans to harness sustainable economic development and manage the environment through considerate collaboration and partnerships with communities, social and culturally significant areas, and community empowerment based on community rights.

The Democratic Coalition Government for Advancement (DCGA) will continue to review relevant legislation frameworks to ensure effective management and promotion of the country's environment and ecosystem, addressing climate change and biodiversity protection. Another priority of the government is to improve waste management and disposal mechanisms and to protect key significant areas that are highly potential for research, utilisation, and community benefits.

National Fisheries Policy 2019–2029

The National Fisheries Policy is one of the sectoral policy instruments that demonstrates the fisheries sector's intention to maintain a sustainable fishery in terms of natural resource sustainability.

The fisheries sector is defined as the use of underwater natural resources (for both flora and fauna) for subsistence, artisanal and commercial purposes to improve health, living standards and opportunities.

National Minerals Policy

The National Minerals Policy provides a framework to sustainably develop the mining sector without depriving the rights of the Solomon Islands citizens. While the policy has succeeded in addressing the mining sector's issues and challenges over the years, it is modelled after a rights-based partnership from a commercial perspective, with a process that includes all stakeholders (including the resource owners). It is the task of the government to develop options for company structures considering the social, environmental, and cultural context of a particular area.

The policy was created with the following key principles in mind: relevance, responsibility, community approaches and standards, coordination, transparency, and accountability.

Given the Solomon Islands' approach to the mining sector, this policy cannot be implemented as a stand-alone document and must rely on other legislation, policies, and standards.

National Forestry Policy

The Solomon Islands National Forestry Policy establishes the government's intention to develop the forestry sector sustainably, maximising the benefits to both the people and the government. For the Solomon Islands' forestry sector, the policy is guided by ten key focus areas (principles): forest conservation, sustainable forest management, capacity development, forest economics, marketing, community governance, mentoring, law enforcement, transparency, and integrity.

The objectives are focused on governance, downsizing developments, encouraging reforestation, and replanting and protecting the natural forest through designated declared areas identified for their biological significance.

The forestry industry has grown at an alarming and unsustainable rate over the years. As a result, there were more negative effects on the environment and the stability of rural communities. In this context, the industry's negative effects had outweighed its positive benefits. Through this policy, the government, through the Ministry of Forestry, will refocus the industry to encourage sustainable exploitation of forest natural resources while minimising negative consequences, ensuring that resource owners continue to support the Solomon Islands economy and infrastructure development.

The Mataniko catchment has been impacted by this industry over the years, and this policy would assist the community in rebuilding governance structures, partnerships and collaboration for a better catchment that will have an impact on the community and Honiara as a whole.

4.2.2 Legal context

Provincial Government Act 1997

This act devolves the national government's function to establish nine provincial governments, each with the authority to enact legislation on a range of issues relating to natural resource management and environmental protection, including wildlife, rivers and waters, and marine resources. The Provincial Government Act of 1997 (PGA) and the accompanying devolution orders under PGA Section 33 give provinces legislative authority.

Environment Act 1998 and Environment Regulation 2008

The act and its regulations set the standards for safeguarding the environmental issues arising from development. This environment law provides for conservation and protection of the environment by establishing a division within the MECDM to monitor and measure platforms for environment protection and safeguards. The 2008 Environment Regulation prescribes the platforms for conducting Environmental Impact Assessments.

Wildlife Management and Protection 1998

This act provides for the protection, conservation, and management of wildlife in the Solomon Islands by regulating the export and import of certain animals and plants, ensuring compliance with obligations imposed upon the Solomon Islands under CITES - the Convention on International Trade in Endangered Species of wild fauna and flora and for the matters connected therewith or incidental thereto.

Protected Areas Act 2010

The Protected Areas Act demonstrates the importance of biodiversity and provides a framework for identifying high endemism, scientifically significant, research-worthy, and culturally significant areas, and declaring them for protection, management, and sustainable use.

The Rivers and Water Act 1996

The Rivers and Waters Act was enacted to manage and regulate developments that have an impact on rivers, specifically designated rivers. Unfortunately, only the Lungga River was designated under the act under order LN110/1976, 10th December 1978, which means that the act only governs activities taking place within the Lungga River.

Water Resources Bill

This bill was developed to supersede the Rivers Water Act 1996. The bill's intention is to cover all water bodies, rivers, and streams, whether in a registered, un-registered, public, private, or customary land in the Solomon Islands in terms of administration and development.

Environment Health Act 1980

This act repeals the Public Health Act and provides for the protection and maintenance of environmental health, as well as matters related to or incidental to that. The Minister and such authorised as the Minister appointed under section 4 are responsible for the administration of environmental health services, according to section 3 of the Act.

The Minister may delegate matters to an enforcement authority in accordance with section 5 of the Act. The enforcement shall at any given time make by-laws to facilitate the efficient operations of the environmental health services and exercise powers pursuant to section 8.

Environment Health (Public Health Act) Regulation

This regulation of the Environment Health Act makes provision with respect to food safety and hygiene, provision and protection of water supplies, sewerage, and the prevention of pollution.

Town and Country Planning Act 1996

This act governs the Solomon Islands' town and country planning, including the creation of local planning schemes, land control, and development, as well as matters related to and incidental to those activities.

The act ensures that the Solomon Islands are developed and used in accordance with well-thought-out policies based on accurate data. Each province, as well as Honiara, will have their board. The Minister may then declare any area to be a local planning area by gazette. As a result, a local planning scheme will be established, along with a board to oversee it.

Fisheries Management Act 2015

This act guarantees that the Solomon Islands will manage, conserve, develop and sustainably exploit fisheries and marine ecosystems for the benefit of Solomon Islanders. Non-commercial fishing, including customary fishing, is exempt from the act. Customary rights are recognised, and fishing access is guaranteed, under this act.

The Minister of Fisheries is responsible for all functions, powers and duties of the Permanent Secretary and Director of Fisheries, which are delegated to specialised fisheries appointed officers under sections 15 and 65 of the Act.

By Order in the Gazette, the Minister may declare a Protected Area, and the Director may appoint a management committee to oversee the management of each declared area. The act establishes the requirements and criteria for developing and enforcing a management plan.

4.3 National Management context

4.3.1 National Waste Management and Pollution Control Strategy 2017–2026 (NWMPC)

The NWMPC is a high-level document that focuses on managing waste and controlling environmental pollution. The strategy highlights five main streams of waste: Solid waste, Liquid Waste, Hazardous and Chemical Waste, Health-care waste, and E-waste. The strategy is expected to be the blueprint for managing and controlling waste in all sectors through proper collaboration and partnerships between stakeholders, governance and institution strengthening, resourcing, socialising, and communication.

The strategy also highlights emerging and focused areas in addressing waste and pollution in the aquatic and marine environment, tourism, manufacturing and extractive industries, isolated islands and communities, health, climate change and natural disasters.

4.3.2 Climate Change Policy

Climate change is a cross-cutting issue to which the Solomon Islands is susceptible. The policy was developed as a response to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change recommendation to the global community requiring immediate response measures through policy.

The government aims to build resilience to climate change in the Solomon Islands by mainstreaming responses and from the mountains to the shores and encouraging communities to be strategic in their responses. It also encourages maintaining greenhouse gas concentrations to stay below 450 ppm to prevent rise in global temperature by more than 2 ^{O}C.

4.3.3 National Biodiversity Strategy Action Plans

This action plan is the response to Article 6 and linked to Article 26 and Article 10(a) of the CBD, which encourages member states to develop strategies, plans or programmes for the conservation and sustainable use of biological diversity and integrate the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes, and policies. The national biodiversity strategy and action plans were developed from provisions and principles from existing environmental laws and policies.

The plan promotes or encourages a holistic, sustainable approach to natural resources management, addressing biodiversity in the areas of forestry, fisheries and marine resources and waste management, community collaboration and partnership, governance regimes at all levels, develop policies and plans supporting conservation, food security and sustainable development.

Table 3. Institutional framework and roles and responsibilities

Institute	Mandate	Legal provisions for catchment management	Ongoing efforts
MECDM	- Environment, impacts, management, protection, and conservation - Environment monitoring - Collaborate with MFMR and Ministry of Forestry and other line agencies and stakeholders	- Environment Act 1998 - Environment Regulation 2008 - Protected Areas Act 2010 - Wildlife Management and Protection 1998	Ongoing monitoring of the Mataniko River and Honiara Coastal
Ministry of Health and Medical Services	Establishes the environment health division mandated to monitor environmental health to ensure public health issues are managed.	Environment Health Act 1990	Environment health Officers are stationed in and around all provinces. Coordinates public health monitoring
Provincial Governments	The Guadalcanal Provincial Government is a devolved agency of the Solomon Islands Government to manage and control its own affairs and environment	Provincial Government Act 1997 – devolution of powers for the province to make ordinance to manage and protect their environment.	Lead agencies and providing funding. Ongoing programmes throughout all provinces
SIWA	Pollution control and prevention	SIWA Act Section 7 (e) to provide, construct, operate, manage, and maintain buildings, works, systems and services for the conveyance, treatment and disposal of sewage, disposal of trade and industrial waste and other connected purposes.	Develops a 30-year Strategic Plan to reticulate sewage and treatment systems in Honiara. The status for short term plans is to establish water treatment.

Institute	Mandate	Legal provisions for catchment management	Ongoing efforts
Ministry of Lands and housing	Land related issue for waste and pollution	Land acquisition under the Lands and Titles Act (Cap 133)	There are land acquisition and recordings throughout the Solomon Islands
Ministry of Infrastructure	Infrastructure Development	Infrastructure development and management	NA
Ministry of Fisheries and Marine Resources	Inland connectivity and aquaculture development	Fisheries Management Act 2015	Ordinance been reviewed and still awaiting accepting from Guadalcanal Provincial Government
Mataniko Community and resource owners	Advocate communal rights and manage impacts of environmental activities	Guadalcanal Environment Ordinance	Needs review and define roles with management measures

4.4 Traditional Governance and Tenure Systems

4.4.1 Barana Management and Business Plan

This community's management and business plan is one of the motivating factors to managing and sustainably developing their natural resources. Through proper planning and coordination, the vision is to realise the endless natural resource opportunities for improving lives through collaboration and empowering individuals to be good stewards of their environment. Gender and social inclusion have been included in the Barana Management and Business Plan's stakeholder engagement plans and community consultations.

The managed area stretches from Barana, Gifu ridge to Davigori ridge overlooking the Lunga River, with its grassland areas forming a circular rim 3-4 kilometres south to west, enclosing Horokene and Bao settlements and eventually including the Mataniko and Lunga head rivers.

Even though parts of this area are alienated land or owned by the state, the Barana community has a strong attachment to this land due to ancestral ties. The plan equips the community to withstand anthropogenic activities and natural changes in the present and future. The Barana community has emerged as a leader in the Solomon Islands' Ecosystem-based Approach to natural resource management.

4.4.2 Botanical Garden Management Plan

The Botanical Garden is one of Honiara's most well-known green spaces, and it has long provided a glimpse of the country's natural resources. Various development partners and NGOs have recently lent their support to the development of a Honiara Botanical Garden Management and Business Plan to restore the natural beauty of the garden.

The primary management strategy is Ecosystem-based Management, which aims to integrate the full range of interactions in an ecosystem, including humans, rather than isolating management within a small area or population.

The Honiara Botanical Garden will be an urban green space for conservation, a display of Solomon Islands natural and cultural connection and diversity, and a baseline of Solomon Islands ecosystem interaction, according to the management and business plan, which is based on 11 principles.

The Honiara Botanical Garden was refocused as one of the hotspots for promoting a green economy in the Solomon Islands through the plan demonstrating an alternative economy based on conservation, protection, and management.

Despite Solomon Islands' small contribution to global greenhouse gas emissions, the plan supports the need for the Solomon Islands to control or mitigate its carbon footprint in the global context.

5 Way forward for Mataniko River catchment

5.1 Community Perspective

The intention to develop an Integrated Management Plan for Mataniko watershed catchment is important, but for the plan to be effective, it must be an inclusive document that includes the customary landowners, the current residents and settlers, and other key stakeholders who associate themselves with the catchment. The people who reside within the catchment must contribute towards the development of the integrated management plan. They must play a crucial role and take ownership of the plan.

The inclusion of the communities will include a gender analysis of the situation, looking at the demography, disaggregated data of population, livelihood sources, employment, education, health of men and women and other members of the community. This must also include an assessment of the benefits and impacts off any planned interventions to men women, youth, and other community members.

It is paramount that the planning team spends time in conducting community consultation meetings to sit, listen and document the stories of the different communities. This process was participatory with men and women discussion groups and opportunities provided for everyone to participate freely. Gender discussion groups also help identified concerns, priorities need of the different sectors of the community and how management would benefit or impact them. This is an important process that helped identify how the residents of the Mataniko watershed catchment value the area.

It is evident that the communities are very concerned about the catchment, and they want to see changes for a clean watershed catchment that all community residents and the people of Honiara can enjoy. They are serious about actions that must take place now to avoid any further degradation to the remaining virgin areas.

The input from the communities and key stakeholders has enabled the development of the draft Integrated Mataniko Watershed Catchment Plan.

Robson Hevalao and David Boseto's draft Mataniko Watershed Catchment Management Plan will have to go back to the communities and key stakeholders for their review and final approval before it can be formally accepted and implemented. Stakeholder engagement and consultations are in the planning, validation, and implementation stages. The team hoped to take the plan back to the communities and key stakeholders in the first quarter of 2021 for the revalidation of the management plan. They can take the lead on implementation with support from key stakeholders once the validation with communities, residents and key stakeholders is completed. However, the revalidation of the management plan cannot proceed as planned due to lack of time.

Every effort will be made to ensure that stakeholder engagements, community consultations and interventions implemented are gender and social inclusive. What this means is that the different needs of men and women, impacts on any planned development, benefits to different sectors of the community are identified. It also means that the livelihoods of men, women and all other sectors of the community are considered. Gender and social inclusion will not be at the initial stages of the work only but will be part of the planning, development, advocacy work, awareness and training work, implementation, and monitoring. Gender inclusion work will be on-going, and all members of the community will be part of all management work planned.

5.2 Upper catchment protection and conservation

Due to intense harvesting of trees, which includes sawmilling, excavation, road construction, tipping of soil and quarrying in areas of Barana, an environmental impact assessment (EIA) process is required to ensure impacts of these activities are mitigated and that the development is monitored. A developer will have to comply with national and provincial laws to acquire approvals to carry out such activities/development. By scaling the activities, the MECDM will advise and support the developer with undertaking the EIA process and obtaining a development consent.

Communities need to be made aware of the impacts of various activities, including subsistence farming activities on flanks of hills, valleys, and flood plains, which has been exacerbated by rise of population and migration. Communities and state authorities need to dialogue over such issues to develop a land use management system with buffer strategy, etc.

The ecosystem services of Mataniko River catchment need to be valued to encourage support for protection and conservation of areas crucial to community livelihoods. The community has to be attentive to this idea, which will need time and effort.

5.3 Reforestation and River Ecosystem Rehabilitation

Due to the level of exploitation and felling, there is increased bare areas that will influence surface water flow, sedimentation and siltation transported into the river through the gullies, valleys, and streams.

These immediate exposed areas need reforestation of indigenous plant species or approved plant species. This requires surface stabilisation by planting vetiver grass, vines, and shrubs with advice of botany experts, to allow native species to germinate and establish slowly. Such reforestation and rehabilitation are possible by studying areas deforested by fires and seeing how such areas have regenerated over time.

5.4 Invasive Species Management

On land it is noticed that the giant African snail and the coconut rhinoceros beetle are increasing rapidly in the Barana village and Mt Austen and into the Mataniko River catchment. These organisms had been an obstacle to human livelihood in the area, attacking food gardens and crops, fruits such as coconuts, pawpaw etc. and the vegetation. A workable plan to implement management measures for these species could be developed by coordinating with the Ministry of Agriculture and Livestock and MECDM.

5.5 Waste Management and River Clean-Ups

Solid and liquid waste are eminent, causing pollution of the river and becoming a public nuisance. Honiara's waste includes commercial waste, industrial waste, construction waste and household waste (liquid and solid waste).

Sewage systems and liquid waste from residential areas and villages along the riverside is not treated and openly disposed on the riverbank, shoreline or in the waterways. State authorities need to work with supporting agencies to consider facilities to harness cleanup and management of waste in the Mataniko river catchment. To address the increase and accumulation of waste in Honiara and especially in the Mataniko river catchment, the following actions are needed:

(i) Sewage treatment and septic standards

- Work with Solomon Water to address sewage system outflow within the Mataniko river catchment to ensure conduits of sewage for treatment are maintained and rehabilitated.
- Enforce laws that govern planning processes that have no proper sewage management infrastructure
- Ensure sewage systems are treated to acceptable levels before discharging into water columns. In the absence of sewage treatment, all residential buildings must have septic tanks and soak-ways designed and approved by the town and country planning board.
- Prohibit direct disposition of such waste and increase penalties for infringement.

(ii) Public Awareness and Training

Raise awareness amongst the local community and Honiara at large on relevant laws and penalties (e.g., the litter ordinance). Educating and empowering the local community is one approach to sustainable waste management. This can be done through the use of television, digital apps, social media and via on-air talk back show platforms.

(iii) Disposal drums and bins

Communities, the HCC, and business investors can support waste management and river rehabilitation by providing drums, bins and timely collection services and resources to promote waste management.

(iv) Improved waste collection system

Encourage investment on waste separation and collection of reusable/recyclable items and timely removal of waste from collection points. The government and HCC need to procure and harness a waste management collection system for the local community. This can be done by channelling resources to the HCC and ensuring appropriate implementation.

5.6 Collaboration and coordination

Collaboration and shared understanding of the vision for Mataniko river catchment rehabilitation is important. Coordination is needed between the HCC, MECDM and other development stakeholders. This is important in enforcement, monitoring/inspection, and compliance. Collaboration at all levels is important with formal understating to define roles and a well-articulated implementation plan.

5.7 Land use planning and enforcement

Land use planning is an important process to ensure clear understanding between community and development partners. These planning processes, and the decisions taken, will impact the health of the watershed. Collaboration is thus needed between the community and state authorities in developing comprehensive plan for Mataniko River catchment that incorporates town expansion, population growth, economic development, and natural resources management.

In addition to the land use planning process, management issues for storm water management, sewage management, flood plain management, stream buffer, illicit discharges, infrastructure, public utilities, detailed hydrology geo-tech assessment and mapping must also be addressed.

This approach will also clarify enforcement through a process of developing or strengthening policies and ordinances and roles and responsibilities regarding management of the Mataniko River catchment.

5.8 Monitoring and Evaluation

Through the support of the community, the Environment and Conservation Division, HCC, and others, need to develop monitoring, evaluation and learning framework for the catchment that includes water quality monitoring, ecology monitoring, sediment quality assessment, waste management, hydrology, biodiversity and overall management plan with indicators and outcomes.

Every effort will be made to ensure gender inclusion in monitoring, and that men and women are part of the monitoring done and their different areas of work addressed.

5.9 Establish the Mataniko river catchment Foundation Committee

For better implementation of a framework for Mataniko river catchment and ensure ownership of the area concerned, establish a Mataniko river catchment Foundation Committee, which will consist of relevant stakeholders and the Environment and Conservation Division as the executing agency. This committee will involve a wide range of stakeholders, including women and youth.

The committee will ensure all necessary activities and objectives are met and reported for evaluation and monitoring.

6 Risks Assessment Review

6.1 Aims and Objectives

This study aims to quantify risks from the environment and climate within the Mataniko watershed and catchment boundary resulting from environment and climate hazards. The objectives are:

i. To identify potential environment and climate hazards within the Mataniko water catchment boundary

ii. To determine the spatial distribution of the potential hazards

iii. To quantify risks emanating from the potential hazards.

iv. To provide risk prioritising options to minimise the risks from potential hazards.

6.2 Rationale

The need to strike a balance between human development activities and the ecosystem with environment, climate and anthropogenic hazards requires quantifying the consequences of development activities within the catchment area as well as the potential risks posed by the environment and climate hazards to elements within the watershed and catchment boundary.

Mataniko watershed and catchment boundary is located on Guadalcanal which is known for frequent tropical cyclone as well as active seismic activities. Therefore, it is exposed to hydro-meteorological and geophysical hazards. Previous hazards events incurred the loss in millions of dollars from the Nation Government and aid donor's budget.

Quantifying the risks emanating from environment and climate hazards is important for the purpose of mitigating the expected risks posed by hydro-meteorological and geophysical hazards to humans and ecosystems within the watershed and catchment boundary.

6.3 Methodology

Environment and climate hazards identification and risk quantification were conducted for the entire Mataniko river watershed and catchment boundary. The assessment was conducted by 1) determining and identifying existence of potential environment and climate hazards; 2) collation and processing of variables; 3) risk assessment; 4) risk analysis and risk prioritisation.

6.4 Identifying potential hazards

Existence of potential environment and climate hazards within the catchment boundary were identified through community consultations and review of reports and literatures. Ground truthing was conducted to confirm, verify, and document other hazards that were not identified during community consultation and literature review. Potential environment, climate anthropogenic hazards identified were grouped into hazard types for reporting in the result section of this report.

6.5 Risk Assessment

The level of risk for each potential hazard was examined. This step was conducted by researching past occurrences and possible scenarios. The likelihood of the hazards occurring and the potential impacts of the hazards on people, properties, critical infrastructures, and environment were examined. Qualitative research approach was used to assess and analyse the information and available data.

Available datasets required to conduct the assessment were sourced and collated from MECDM risk information management systems. Other online portals such as relief web, PCRAFI, Pacific Data hub and the environment data portal were also consulted in the process of collating data.

6.6 Risk analysis

Risk analysis was conducted to determine the risk values associated with potential hazards. The general risk formula, *Risk = frequency x consequence* was used to determine risk values. The risk values were classified into five levels to prioritise potential hazard events within the catchment boundary.

Potential hazard events are identified and classified. The levels of risks associated with these hazards are qualitatively prioritised for management actions.

6.7 Potential hazards

Potential hazards identified within the Mataniko watershed and catchment boundary are classified into four classes as shown in the table (Table 3). Hazards are classified as hydrological, geological, climate and anthropogenic (first column). Column 2 of the table shows individual hazard events that fall under each hazard type in column 1. Potential hazards and events within the watershed were identified during community consultation and review of past reports on hazards in the Solomon Islands.

Table 4: Potential hazard events identified within the catchment of Mataniko River

Hazard Types	Potential Hazard Events
Hydrological hazards	- Riverine flash flooding - Landslide (wet ground movement) - Coastal inundation - Hydrological short circuiting
Geological hazards	- Landslide (dry ground movement) - Rock fall - Subsidence - Earthquake above 8 Mg - Erosion
Climate Hazards	- High rainfall events - High temperature events - Droughts or low water - Tropical Cyclone
Anthropogenic Hazards	- Ground movement - Fire - Chemical spill

The classification of hazard type is based on the mechanism that triggers the hazards. Excess water triggers riverine flooding, Landslide, coastal inundation, and hydrological short circuiting. These potential hazards events triggered by excess water are classified as hydrological hazard.

The formation and structure of rocks and soil and the processes within the earth's crust triggers landslide, rock fall, subsidence, and earthquake above 8 Mg. These potential hazard events are classified as geological hazards.

Short- and long-term condition of the atmosphere can trigger potential hazards. Hazard events triggered by the condition of the atmosphere such as high intensity rainfall, extreme temperature, droughts, and Tropical Cyclone are classified as climate hazards.

Human activities and negligence have the potential to trigger hazards. Human activities and negligence observed within the catchment boundary that can trigger potential hazard are ground movements from logging operation, fire, and inappropriate disposal of toxic liquid wastes. Potential hazard events resulting from human activities and negligence are classified as anthropogenic hazard.

6.8 Distribution of potential hazards

Distribution of potential hazards identify in this report varies throughout the Mataniko river catchment boundary. Occurrence and impact of hazards are either confine to a specific location or uniform throughout the entire catchment. The table (Table 4) showed the distribution of potential hazards in the catchment boundary.

Table 5: Potential hazards and their distribution within the catchment boundary

Hazard Types	Potential Hazard events	Distribution
Hydrological hazards	- Riverine flash flooding - Landslide (wet movement) - Coastal inundation - Hydrological short-circuiting	- Confine - Confine - Confine - Confine
Geological hazards	- Landslide (dry movement) - Rock fall - Subsidence - Earthquake above 8 Mg - Erosion	- Confine - Confine - Confine - Uniform - Confine
Climate hazards	- High rainfall events - High temperature events - Droughts - Tropical Cyclone	- Confine or uniform - Uniform - Uniform - uniform
Anthropogenic Hazards	- Ground movement - Fire - Chemical spill	- Confine - Confine - Confine

Distributions of hydrological hazards are confined to specific locations within the catchment. Riverine flooding and hydrological short circuiting are hazard events confined to the lowest point of the catchment boundary. Landslide (wet ground movement) hazard occurs on steep slopes along major rivers and streams and on aspect facing away from the sun. Coastal inundation is confined to coastal areas where the Mataniko catchment meets the ocean.

Distributions of geological hazards are confined to specific locations within the catchment boundary except earthquake. Occurrence of Landslide (dry ground movement), rock fall, subsidence and erosion are confined to steep slopes along Major River and streams and on riverbed and valleys within the catchment. Seismic waves generated by earthquake of magnitude above 8 Mg will uniformly propagate throughout the catchment.

The distributions of climate hazards are almost uniformed though out the catchment boundary. Occurrence of drought, Tropical Cyclone and extreme temperature events are distributed uniformly throughout the catchment. Distribution of high intensity rainfall varies throughout the catchment as it depends on the position of the rain clouds above the catchment.

The distributions of anthropogenic hazards are confined to specific points and locations within the catchment boundary. Ground movement as a result of logging operation occurs in the upper section of the catchment. Fire hazard is confined to grassland and build-up areas in the lower section of the catchment. Chemical spill is confined to river and streams.

6.9 Qualitative risk assessments

Qualitative risk assessments on potential hazards events analyses the frequency and consequence of hazard events identify and the impact pose on the ecosystem and human activities within the Mataniko watershed and catchment boundary.

(i) Frequency assessment

The table (Table 5) shows the output of qualitative assessment base on the frequencies of potential hazard events reviewed from reports and community consultations. Frequency is part of the general risk equation and determines the likelihood that the elements of human and ecosystem could be impacted by the hazards.

Table 6: Frequencies of potential hazards reviewed from reports and community consultation

Potential Hazard events	Category	Frequency	Descriptive notes
Riverine flash flooding	Rare	1	Less than 1 % chance of occurrence in any year
Landslide (wet movement)	Probable	4	10% - 50% chance of occurrence in any year
Coastal inundation	Probable	4	10% - 50% chance of occurrence in any year
Hydrological short-circuiting	Likely	5	50% - 100% chance of occurrence in any year
Landslide (dry movement)	Probable	4	10% - 50% chance of occurrence in any year
Rock fall	Unlikely	3	2% - 10% chance of occurrence in any year
Subsidence	Very unlikely	2	1% - 2% chance of occurrence in any year
Earthquake above 8 Mg	Very unlikely	2	1% - 2% chance of occurrence in any year
Erosion	Very unlikely	2	1% - 2% chance of occurrence in any year
High rainfall events	Probable	4	10% - 50% chance of occurrence in any year
High temperature events	Probable	4	10% - 50% chance of occurrence in any year
Droughts or low water	Unlikely	3	2% - 10% chance of occurrence in any year
Tropical Cyclone	Almost certain	6	100 % chance of occurrence in any year
Ground movement	Probable	4	10% - 50% chance of occurrence in any year
Fire	Unlikely	3	2% - 10% chance of occurrence in any year
Chemical spill	Very unlikely	2	1% - 2% chance of occurrence in any year

(ii) Consequence assessment

Consequences from the impacts of identified hazards on humans and ecosystems are placed into four categories. The four categories used in this report are social impacts, property damage, critical infrastructure impact, and environment damage. This will include measurements of natural hazards on properties, infrastructure and social livelihoods and ability of men and women to address or adapt to different situations. The table (Table 6) shows the output on the consequence of potential hazard events reviewed from reports, community consultations and expert judgment.

Table 7: Consequence of potential hazard events arranged into four categories

Hazards	Social Impacts	Property damage	Critical Infrastructure Impacts	Environmental Damage	Total Consequences
Riverine flash flooding	3	2	2	2	9
Landslide (wet movement)	1	2	0	2	5
Coastal inundation	0	2	1	1	4
Hydrological short-circuiting	1	2	2	1	6
Landslide (dry movement)	0	1	0	1	2
Rock fall	0	0	0	1	1
Subsidence	0	0	0	2	2
Earthquake above 8 Mg	1	2	1	2	6
Erosion	0	1	1	1	3
High rainfall events	3	2	1	1	7
High temperature events	0	1	0	0	1
Droughts or low water	0	0	0	1	1
Tropical Cyclone	2	3	3	3	11
Ground movement	0	0	0	2	2
Fire	1	2	0	1	4
Chemical spill	1	0	0	1	2

Table 7 shows ranking of consequence variables.

Table 8: Total consequence variable ranking

Variable Total	Consequence ranking	Descriptive notes
1 - 3	1	Minor
4 - 5	2	Slight
6 - 7	3	Moderate
8 - 9	4	Severe
10 - 11	5	Very Severe
> 11	6	Catastrophic

The consequence variables are summed up into groups that will give equal weights to consequence and frequency once multiplied to determine risk.

Table 9: The table shows consequence variables ranking

Hazards	Consequence total	Consequence Ranking	Descriptive notes
Riverine flash flooding	9	4	Severe
Landslide (wet movement)	5	2	Slight
Coastal inundation	4	2	Slight
Hydrological short-circuiting	6	3	Moderate
Landslide (dry movement)	2	1	Minor
Rock fall	1	1	Minor
Subsidence	2	1	Minor
Earthquake above 8 Mg	6	3	Moderate
Erosion	3	1	Minor
High rainfall events	7	3	Moderate
High temperature events	1	1	Minor
Droughts or low water	1	1	Minor
Tropical Cyclone	11	5	Very Severe
Ground movement	2	1	Minor
Fire	4	2	Slight
Chemical spill	2	1	Minor

6.10 Risk analysis and prioritisation

The output of risk analysis generated in this section is based on the risk equation

R = Frequency x Consequence

Information on frequency and consequence from qualitative risk assessment section is analysed to determine risk from potential hazards within the catchment boundary. The table (Table 9) highlights the output of risk analysis by multiplying frequency and consequence of potential hazards.

Table 10: The table shows the product of frequency and consequence based on the risk equation

Hazards	Frequency	Consequence	Risk
Riverine flash flooding	1	4	4
Landslide (wet movement)	4	2	8
Coastal inundation	4	2	8
Hydrological short-circuiting	5	3	15
Landslide (dry movement)	4	1	4
Rock fall	3	1	3
Subsidence	2	1	2

Hazards	Frequency	Consequence	Risk
Earthquake above 8 Mg	2	3	6
Erosion	2	1	2
High rainfall events	4	3	12
High temperature events	4	1	4
Droughts or low water	3	1	3
Tropical Cyclone	6	5	30
Ground movement	4	1	4
Fire	3	2	6
Chemical spill	2	1	2

Table 10 categorises risk values associated with potential hazards identify in the Mataniko watershed and catchment boundary in table 9. Prioritisation of risk values highlight hazards that should be considered a priority for human and ecosystems management within the catchment. These risks will be considered in a holistic approach, incorporating the welfare of men, women, and all other sectors of communities within the Mataniko catchment. The risk analysis, which provides a rating of the different risks, should help in identification of risk management alternatives that could be put in place. The table shows prioritisation of risks to determine hazards that should be considered and prioritised.

Table 11: The level of risk to potential hazards.

Level of risk	Descriptive notes
< 2	Very low
3 - 5	Low
6 - 10	Moderate
11 - 15	High
> 15	Very high

Table 10 identifies and sorts hazards based on the level of risk using the risk value prioritising table (table 11). Based on the categories assigned to the level of risk, climate and hydrological hazards should be considered as the highest priority for Mataniko watershed and catchment boundary management. In general, the level of risks above six should be considered as priorities for the management of human and ecosystems within the catchment boundary.

Table 12: The table defines the level of risks for potential hazards for the Mataniko catchment

Hazards	Level of risk	Descriptive notes
Tropical Cyclone	30	Very high
Hydrological short-circuiting	15	High
High rainfall events	12	High
Landslide (wet movement)	8	Moderate
Coastal inundation	8	moderate

Hazards	Level of risk	Descriptive notes
Earthquake above 8 Mg	6	Moderate
Fire	6	Moderate
Flash flooding	4	Low
Landslide (dry movement)	4	Low
High temperature events	4	Low
Ground movement	4	Low
Rock fall	3	Low
Drought or low water	3	Low
Subsidence	2	Very low
Erosion	2	Very low
Chemical spill	2	Very low

6.11 Discussion

The distributions of potential hazards identified in this report are either confined to specific geographic locations or uniformly distributed throughout the catchment boundary. The occurrence and impacts of hydrologic, geologic, and anthropogenic hazards are confined to specific geographic areas except earthquake. On the other hand, the occurrence and impacts of climate hazards is uniformly distributed throughout the catchment. Determining the distribution of potential hazards within the catchment provides risk reduction options to the catchment management plan for the identified hazards.

The risk assessment method used in the report, is derived from the risk formula, $R = F \times C$ where R is the risk to be determined, *F* and *C* are frequency and consequence. Frequency determines how likely; human and ecosystems elements could be impacted by the hazards. Consequence determines how severe; human and ecosystems elements could be impacted by the potential hazards. The frequency and consequence values are determined qualitatively based on reports, community consultation and expert judgments. Categories representing frequency and consequence are equally determined to maintain the same weight on both variables.

Sorting out the level of risk from highest to lowest values has simplified the choice of prioritising hazards that pose the greatest threat to human and ecosystems within the catchment boundary of Mataniko watershed.

Risk analysis and prioritisation identifies tropical cyclone to be the highest priority hazard for Mataniko water catchment. It is important to note that tropical cyclone can also trigger secondary hazards like flash floods, landslide (wet ground movement), coastal inundation and strong winds. Risk reduction measures for tropical cyclone also need to prioritise these hazards.

Hydrological short-circuiting and high rainfall events are high priority hazards. Hydrological short-circuiting is a type of flood hazard that gives little lag time between the onset of intense rainfall and the rise in flood water. This is common in the Mataniko catchment where rugged terrain and narrow river channel exist. High rainfall events used in this report can be a rainfall event greater than 200 mm over a 24-hour period.

It should be noted that hazards with moderate level of risk in table 9 should also be considered in any risk reduction management strategy for the Mataniko watershed and catchment boundary. This report identifies landslide (wet ground movement), coastal inundation, earthquake, and fire as hazards with moderate level of risk and should be considered. These are common hazards within the catchment boundary that pose certain degrees of threat to human and the ecosystems once these systems cross-path with these hazards.

6.12 Risks Conclusion

Potential hazard events and their distribution within the Mataniko watershed and catchment boundary have been identified in this study. A total of sixteen potential hazard events are identified and classified into four hazard types: hydrological, geological, climate and anthropogenic hazards. Identification of potential hazard events and their distribution is an important step in risk assessment and analysis conducted in this study for the Mataniko water catchment boundary.

Qualitative risk assessment approach is conducted by assessing frequency and consequence of potential hazard events within the catchment. The approach enables the analysis of risk levels associated with potential hazard events as frequency and consequence values are determined. The risk equation, R = f x c is used to calculate risk values associated with potential hazard events. Categorising risks values into five levels enables risk prioritisation, which is an important step in risk reduction management options.

This study has identified tropical cyclones to be the potential hazard event of highest priority, followed by hydrological short-circuiting and high rainfall events. It further suggests that risk levels from six and above should be considered in the risk reduction management plans of the Mataniko catchment as these hazards are common and may incur risks to human and ecosystems within the catchment.

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Appendices

Appendix 1 Mataniko Catchment Eco Status Assessment

ID	Site	Observed Impacts/ Threats	Ecological status	Proposed Mitigation Measures	Additional Mitigation / Enhancement Measures
FW1	**Head Water of Mataniko**	1. Logging Activities 2. Milling of Timber 3. Clearing for gardening	Good	1. Enforcement of logging code of practice to maintain the riparian vegetation on both sides of the bank 2. Gardening near the headwater should be discouraged	1. Employ community rangers to implement and enforce the Mataniko Catchment Management Plan 2. Conduct annual biomonitoring of water quality and terrestrial and aquatic invasives species 3. Proper waste Management Plan should be in place
FW2	**Waterfall Area**	No threats observed	Good	1. To maintain the riparian vegetation on both sides of the bank. 2. Proper disposal of waste at the waterfall for all waterfall users 3. Clearing for gardening near the waterfall is not recommended.	1. Employ community rangers to implement and enforce the Mataniko Catchment Management Plan 2. Conduct annual biomonitoring of water quality and terrestrial and aquatic invasives species 3. Proper waste Management Plan should be in place
FW3	**Tuvaruhu Area**	1. Modified riparian 2. Eroded bank areas 3. Riverbank gardening	Moderate-Good	1. To rehabilitate and maintain the riparian vegetation on both sides of the bank. 2. Riverbank gardening should be discouraged 3. Pig Fence should be located far from the riverbank 4. Gravel extraction should be discouraged.	1. Employ community rangers to implement and enforce the Mataniko Catchment Management Plan 2. Conduct annual biomonitoring of water quality and terrestrial and aquatic invasives species 3. Proper waste Management Plan should be in place
FW4	**Vara Creek**	1. Modified riparian 2. Eroded bank areas 3. Pig and Chicken keep near the Riverbank 4. Latrine house were built very close to the riverbank	Moderate-Good	1. To maintain the riparian vegetation on both sides of the bank. 2. Gravel extraction should not be encouraged. 3. Pig and Chicken fences should be removed from the riverbank. 4. latrine houses should be built away from the riverbank	1. Employ community rangers to implement and enforce the Mataniko Catchment Management Plan 2. Conduct annual biomonitoring of water quality and terrestrial and aquatic invasives species 3. Proper waste Management Plan should be in place
FW5	**Cana Hill**	1. Modified riparian 2. Eroded riverbank areas 3. Pig and Chicken keep near the Riverbank 4. Disposal of all types of wastes on the riverbank	Moderate-degraded	1. To maintain the riparian vegetation on both sides of the bank. 2. Gravel extraction should be discouraged 3. Planting of fruit trees and vetiver grass should be encouraged along the riverbank	1. Employ community rangers to implement and enforce the Mataniko Catchment Management Plan 2. Conduct annual biomonitoring of water quality and terrestrial and aquatic invasives species 3. Proper waste Management Plan should be in place
FW6	**Musona**	1. Modified riparian 2. Eroded riverbank areas 3. Pig and Chicken keep near the Riverbank 4. Untreated Sewage from Tuvaruhu discharge directly into the river 5. Gardening on the riverbank 6. Disposal of all types of wastes on the riverbank	Degraded	1. To maintain the riparian vegetation on both sides of the bank. 2. Gravel extraction should be discouraged. 3. Plant fruit trees and vetiver grass along the riverbank. 4. Discourage the disposal of waste on the riverbank 5. Implement Nature-based solutions (long-term) for the Solomon Water Asset directly opposite the village	1. Conduct monthly awareness and clean up along their zone 2. Proper Waste Management Plan should be in place 3. Community should employ rangers to implement and enforce the Mataniko Management Plan 4. Consider planting of fruit trees and vetiver grass on the riverbank

ID	Site	Observed Impacts/ Threats	Ecological status	Proposed Mitigation Measures	Additional Mitigation / Enhancement Measures
FW7	**Ngalitatae**	1. Modified riparian 2. Eroded bank areas 3. Pig and Chicken keep near the Riverbank 4. Latrine house were built very close to the riverbank 5. Disposal of all types of wastes on the riverbank	Degraded	1. Identify point and non-point pollution sources in the village and river 2. To rehabilitate and maintain the riparian vegetation on both sides of the bank. 3. Proper rubbish disposal. 4. Proper fencing for pigs to avoid access to the river.	1. Proper waste management plan in place. Employ Community Rangers to implement and enforce Mataniko Management Plan. 2. Define boundaries of the river rehabilitation project for impact (undercutting, bare bank areas) areas to limit socio-ecological disturbance. 3. Consider planting of vetiver grass, fruit trees, *Pandanus*, and Sago palm along the riverbank. 4. Conduct annual biomonitoring of water quality and invasives species
FW8	**Koa Hill Area**	1. Highly modified riparian 2. Eroded bank areas 3. Riverbank gardening 4. Dispose of all types of waste into the riverbank 5. Algal laden streambed substrate	Degraded	1. Identify point and non-point pollution sources to stream draining the village and into the river. 2. Proper rubbish disposal plans should be in place. 3. Proper fencing for pigs to avoid river access.	1. Proper waste management plan in place (including hazardous wastes). 2. Employ community rangers to implement and enforce the Mataniko Management Plan. 3. Define boundaries of the river rehabilitation project for impact (undercutting, bare bank areas) areas to limit socio-ecological disturbance. 4. Consider planting of vetiver grass, fruit trees, *Pandanus*, and Sago palm along the riverbank 5. Annual biomonitoring of water quality and invasives species
FW9	**Fijian Quarter**	1. Highly modified riparian 2. Eroded riverbank areas 3. Household rubbish and all forms of Rubbish were disposed in the river 4. Pigs were housed near the riverbank	Degraded	1. Identify point and non-point pollution sources that discharged directly into the river 2. Proper rubbish disposal. 3. Pig pen should remove from the riverbank.	1. Proper waste management plan in place (including hazardous wastes). 2. Employ youths as community rangers to implement and enforce the Mataniko Management Plan. 3. Define boundaries of the river that must be rehabilitated. 4. Consider planting of vetiver grass, fruit trees, *Pandanus*, and Sago palm along the riverbank 5. Conduct annual biomonitoring of water quality and invasives species 6. Conduct Climate Change Vulnerability Assessment due to sea-level rise
FW10	**Renlau/ Mamana Water**	1. Highly modified riparian 2. Eroded riverbank areas 3. Household rubbish and all forms of Rubbish were disposed in the river. 4. Pigs were housed near the riverbank	Degraded		1. Proper waste management plan in place (including hazardous wastes). 2. Employ youth as community rangers to implement and enforce the Mataniko Management Plan. 3. Define boundaries of the river that must be rehabilitated. 4. Consider planting of vetiver grass, fruit trees, *Pandanus*, and Sago palm along the riverbank 5. Conduct annual biomonitoring of water quality and invasives species 6. Conduct Climate Change Vulnerability Assessment due to sea-level rise