A Mangrove Management Guideline

Community-based Management Guideline for Mangrove Rehabilitation and Restoration in Fiji

October 2022

Ministry of Forestry

ITTO
INTERNATIONAL TROPICAL TIMBER ORGANIZATION

CONSERVATION INTERNATIONAL

USP
THE UNIVERSITY OF THE SOUTH PACIFIC

Pacific Community
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Credit and Citation

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ACRONYMS	DEFINITIONS
CEOs	Chief Executive Officers
CI	Conservation International
CO2e	Carbon dioxide equivalent
CP	Cabinet Paper
CSOs	Civil Society Organizations
DoL	Department of Lands
EIA	Environmental Impact Assessment
EMA	Environment Management Act
ERR	Emission Reductions and Removals
Ha	Hectare
IAS	Institute of Applied Sciences
ITTO	International Tropical Timber Organization
LRD	Land Resource Department
M&E	Monitoring and Evaluation
MESCAL	Mangrove Ecosystem for Climate Change Adaptation and Livelihoods
MoL	Ministry of Lands
MoEnv	Ministry of Environment
Mg	Magnesium
MMC	Mangrove Management Committee
NPK	Nitrogen (N), Phosphorus (P) and Potassium (K) fertilizer
NEC	National Environment Council
NGOs	Non-Governmental Organizations
SPC	Pacific Community
TC	Tropical Cyclone
TFRO	Traditional Fishing Rights Ownership
USD	United States Dollar
USP	University of the South Pacific
VC	Village Committee
VDC	Village Development Committee
VEC	Village Environmental Committee
VMMC	Village Mangrove Management Committee
YMST	Yaubula Management Support Team

Foreword

It is with great pleasure that I present to you the "Community-based Management Guideline for Mangrove Rehabilitation and Restoration in Fiji". The Guideline is the output for the project "Community Based Restoration and Sustainable Management of Vulnerable Forests of the Rewa Delta". Funded by the International Tropical Timber Organization (ITTO) in collaboration with co-funding by the Fijian Government through the Ministry of Forestry, the project aims to control and mitigate coastal erosion and degradation in mangrove systems in Fiji's largest catchment and mangrove area – Rewa Delta.

ITTO is an intergovernmental organization promoting the conservation and sustainable management, use and trade of tropical forest resources. In alignment with members' aspirations, ITTO is concerned with trade and industry and takes social environmental responsibilities to pay. Its members represent about 80% of the world's tropical forests and 90% of the global tropical timber trade. Like all commodity organizations, it is concerned with trade and industry, but like any environmental agreement, it also pays considerable attention to the sustainable management of natural resources. It manages its own program of projects and other activities, enabling it to quickly test and operationalize policy work. A total of 71countries are members of ITTO of which 33 is from producer countries and 38 from consumer countries. Producer countries include 12 from Africa, 9 from Asia and Pacific and 12 from Latin America.

The coastal and mangrove wetlands in the Rewa Delta harbor a diversity of species. The mangroves provide a nursery for fishes and other marine life on which the communities depend on for their livelihood. The mangroves also act as barriers to the direct impact of strong winds and waves, including the risk associated with climate change and sea level rise. Mangrove wetlands play a significant role in the socio-economic and cultural lives of coastal communities who are vulnerable to the effects of climate change.

The development objective of this project is aligned to the 2007 National Forest Policy, which aims at introducing an effective mangrove management framework for the Rewa delta with the specific objective of establishing demonstration sites that will showcase community-based management activities for biodiversity conservation and provide alternative livelihoods to ensure improved human wellbeing.

The community-based management guideline is the result of piloting activities and is developed to support relevant communities to better manage their mangrove.

I wish to acknowledge Conservation International (CI) for this commendable work. In conclusion, I hope village communities located across Fiji's mangrove areas could consider, adapt, and use this Guideline for proper management of their mangrove resources.

.....

G.N.P. Baleinabuli
Permanent Secretary for Forestry and Fisheries

Acknowledgement

The Guideline was made possible through the ITTO project collaboration between Fiji's Ministry of Forestry, Conservation International, the Institute of Applied Sciences (IAS) of the University of the South Pacific (USP) and the Land Resource Division (LRD) of the Pacific Community (SPC).

Conservation International (CI) acknowledges the expertise and guidance of key personnel during the review phase of the initial guideline: Dick Watling, Marika Tuiwawa, Sanjana Lal. Cenon Padolina is acknowledged for corroborating all institution stakeholders in the early inception phase of the project.

The guideline is one of the key deliverables funded by the International Tropical Timber Organization (ITTO) and Fiji government under the project *"Community Based Restoration and Sustainable Management of Vulnerable Forests of the Rewa Delta"* across the six ITTO project sites: Natila, Nasilai, Waicoka, Naivakacau, Narocake and Muanaira in the provinces of Tailevu and Rewa on the island of Viti Levu. We also acknowledge, the Director Operation Central/ Eastern together with the ITTO project staff for facilitating the community consultation phase of the project.

1. Background

1.1 What are Mangroves? Where do you find them?

Mangroves are a unique assemblage of trees and shrubs that occurs within the foreshore area (Mueller-Dombois and Fosberg, 1998). They are a highly resilient salt-tolerant group of plants with a complex root system that are capable of coping with saltwater immersion and wave action (UNEP, 2020).

Mangroves generally occur within the intertidal area due to the unique substrates that supports the system. Intertidal areas, also known as the foreshore region, comprises a mix of seawater and freshwater columns with high sediment loads that, generally, forms the muddy-clay substrate (Spalding and Leal, 2021; Windusari *et al.* 2014). Mangroves can also occur in areas with sandy substrate, having elements of sediments, as well as in rocky and limestone substrata (Windusari *et al.* 2014; Mueller-Dombois and Fosberg, 1998).

Mangroves are seen to thrive along the river mouths, estuaries, deltas, lagoons and fringes of locked saltwater lakes systems (Mueller-Dombois and Fosberg, 1998; Figure 1). They feature along the shorelines of many countries located in the tropics and sub-tropics (Ellison, 2000). Mangrove swamps, also known as mangrove forest, are typical examples of wetland systems[1] (Figure 1).

Figure 1: Example of mangrove wetland systems across Fiji

1.2 Global Mangrove Extent and Distribution

Globally, the extent of mangroves are restricted by specific environmental parameters. Extent is confined to sea-surface temperatures and temperature patterns that lie across the latitudinal positions of 25°N and 25°S[2] (Ellison, 1999a; Figure 2). These are areas essentially located within the tropics and sub-tropical regions (Ellison, 2000).

Because of the specificity in distribution, their extent of occurrence worldwide covers some 118 countries located across five major geographic regions: Africa, North America, South America, Asia, and Oceania (Figure 2). The area is estimated to cover a total of 181, 000km^2 (Ellison 2007). With reference to the Ramsar Convention on Wetlands,

[1] https://www.ramsar.org
[2] https://earthobservatory.nasa.gov

the largest of this extent resides in the mangrove forest of Asia (38.7%), followed by South America (20.3%), Africa (20%), Oceania (11.9%), North America (8.4%) and the European and Overseas territories at 0.7% (Bunting *et al.* 2018; Figure 3[3]).

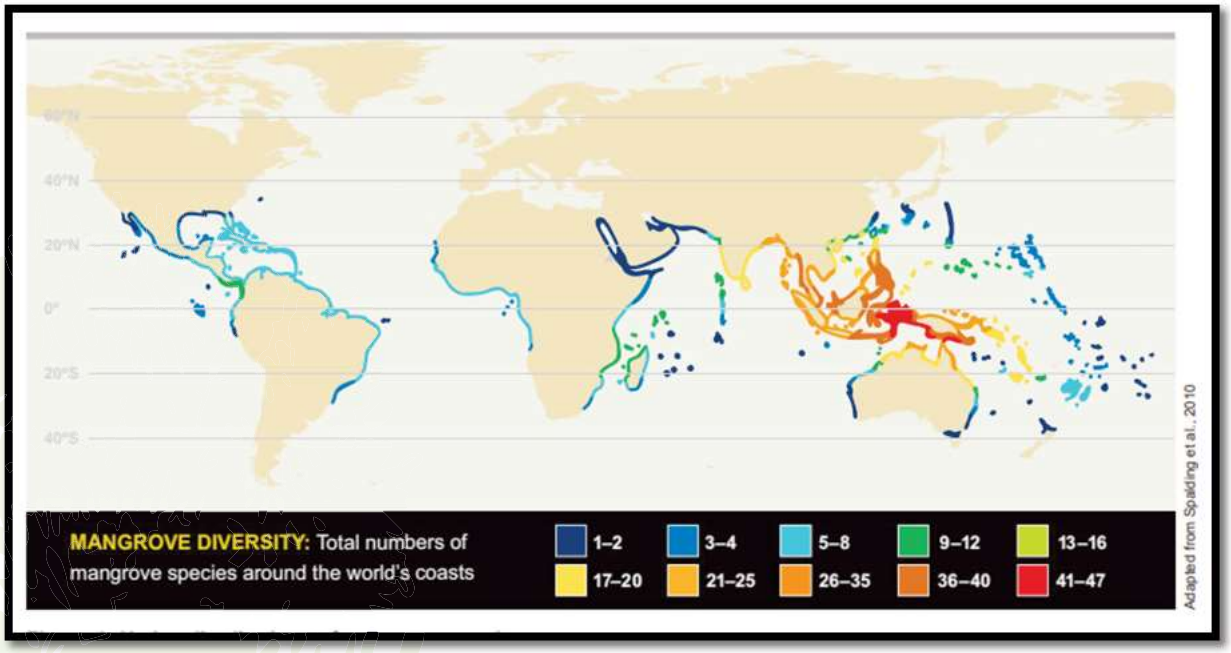


Figure 2: Global distribution of mangroves around the world's coastline

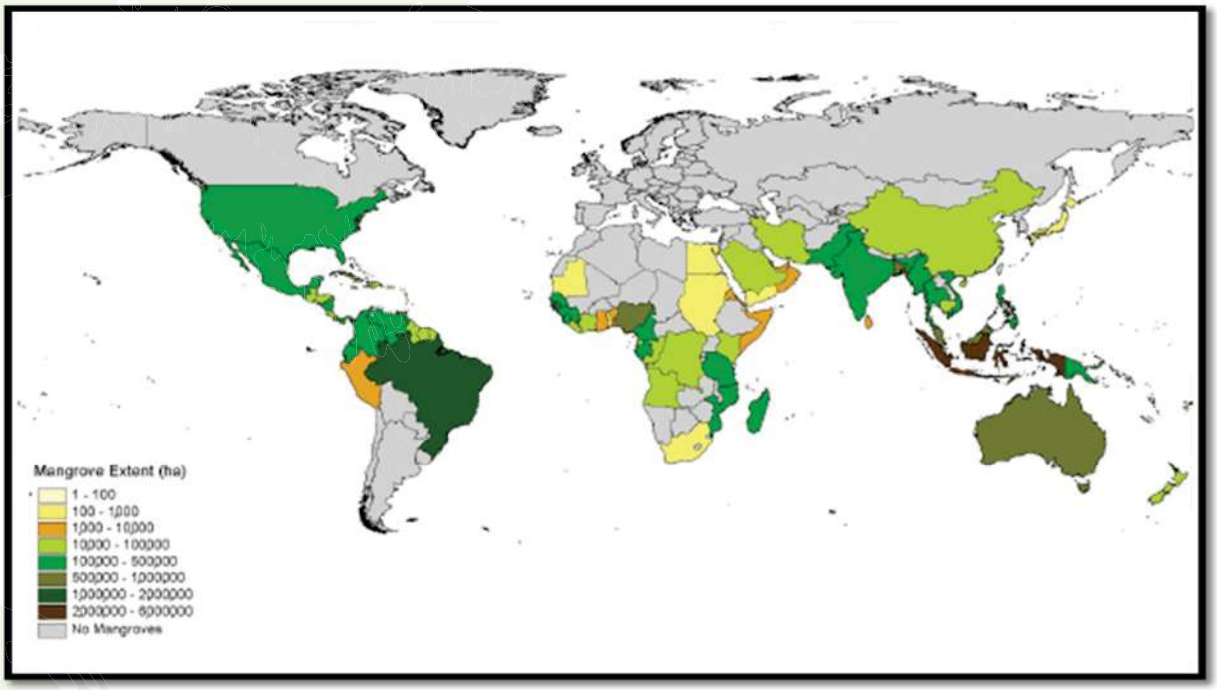


Figure 3: Global mangrove extent by hectare

1.3 Mangroves in Oceania

Oceania is separated into the regions of Melanesia, Micronesia, and Polynesia that spans over the western and eastern parts of the Southern hemisphere (Figure 4[4]). With the centers of mangrove diversity located in the regions of Australasia and the island of New Guinea (Ellison, 2007), there is at least more than five species of *Rhizophora* occurring in Australia alone, with more than 25 species of mangroves recorded from the smaller neighboring island

[3] www.fao.org
[4] https://www.paclii.org/maps/

countries including notable mangrove forest coverage (Ellison, 2007). Moving east, there is a declining number of mangrove species due to low successful chances of long-distance dispersal (Table 1; Ellison 2000; Duke *et al.* 2008). Other contributing factors include the age of the islands, coastal development, human habitation along the coastlines (informal settlement) (Ellison, 2000; Duke *et al.* 2008; Tuiwawa pers. com). The regions of Papua New Guinea, Solomon Islands, Vanuatu, and Fiji have the highest number of species diversity and the densest mangrove forest (Figure 4)[4].

Mangroves within the region are estimated to comprise about 2.42% of the world's entire mangrove area (Ellison, 2000; 2007). They cover a total area of 3437.35km^2 with the largest stands occurring in Papua New Guinea, Solomon Islands, Fiji, and New Caledonia (Ellison, 2000). These occupy sheltered shorelines, deltas, bays, and estuaries (Ellison, 2000). The regions of Melanesia have the largest of mangrove forest (Figure 4)[4]. Tabulated (Table 1) is an overview of mangrove extent, forest cover and species distribution throughout Oceania.

Figure 4: Map of Islands in the South Pacific

Some of the well-known mangrove areas in the Pacific region occur within:

- Papua New Guinea - significant mangrove stands can be seen in the Gulf of Papua and along the coast of the Central Province, in the deltas of the Fly, Ramu and Sepik Rivers (FAO, 2005a);
- Solomon Islands - there are extensive mangrove stands along the coasts of Malaita, New Georgia Island and Santa Isabel (FAO, 2005b) as there are also significant stands occurring in the islands of Guadalcanal, San Cristobal (Makira) and Choiseul (Pillai and Sirikolo, 1997);
- Vanuatu - the most significant mangrove stand occurs on the island of Malekula along Port Stanley and Port Sandwich (FAO, 2005c);
- Fiji - the largest mangrove stand occur on the island of Viti Levu (along the Rewa and Ba deltas) and Vanua Levu (along the Labasa delta) (FAO, 2005d).

Table 1: Mangrove area and the number of mangrove species across the South Pacific

Pacific Island Country	No. Mangrove species (no. hybrids)	Mangrove Area (km²)
Palau	13	47.08
FSM	14	85.64
Papua New Guinea	33 (2)	5509.42
Guam	11	0.7
North Mariana Islands	5	0.5
Solomon Islands	25	525.50
New Caledonia	14 (2)	202.50
Vanuatu	13	24.30
Marshall Islands	5	?
Nauru	2	0.01
Kiribati	4	2.58
Tuvalu	2	0.4
Wallis & Futuna	0	0
Fiji	7 (1)	410
Tonga	8	10
Samoa	3	12.7
American Samoa	3	0.52
Niue	1	0
Tokelau	0	0
Cook Islands	0	0
French Polynesia	1	?
Pitcairn	0	0

(Source: Ellison, 2007; Tuiwawa *et al*. 2013)

2. Introduction

Mangroves are one of the world's most unique forest that supports life to a wide range of organisms, including human beings. With a wide range of benefits, mangroves are considered more as a source of income rather than an avenue of conservation value, hence the system is constantly under threat with vast areas caving into the social and economic pressures of development and progress. Amongst the main reasons for mangrove degradation are deforestation, pollution, unsustainable harvesting, and various land use changes as well as climatic factors. In realizing their importance and full potential to add value and benefits to the well-being of both the coastal communities and the environment, there is the need to support initiatives and programs of restoration in efforts to mitigate and protect what remains of this critically important system.

Community stewardship is a widely accepted practice in efforts to protect and conserve mangroves. The approach provides the opportunity for local communities to take charge and handle matters concerning mangrove issues as best as possible, with the objectives of conserving mangroves and sustaining livelihood for the long term. It is an effective and sustainable method for attempting to safeguard the quickly disappearing mangrove forest. The approach has also been seen and proven to have a quicker recovery as local people are more effective in managing these resources.

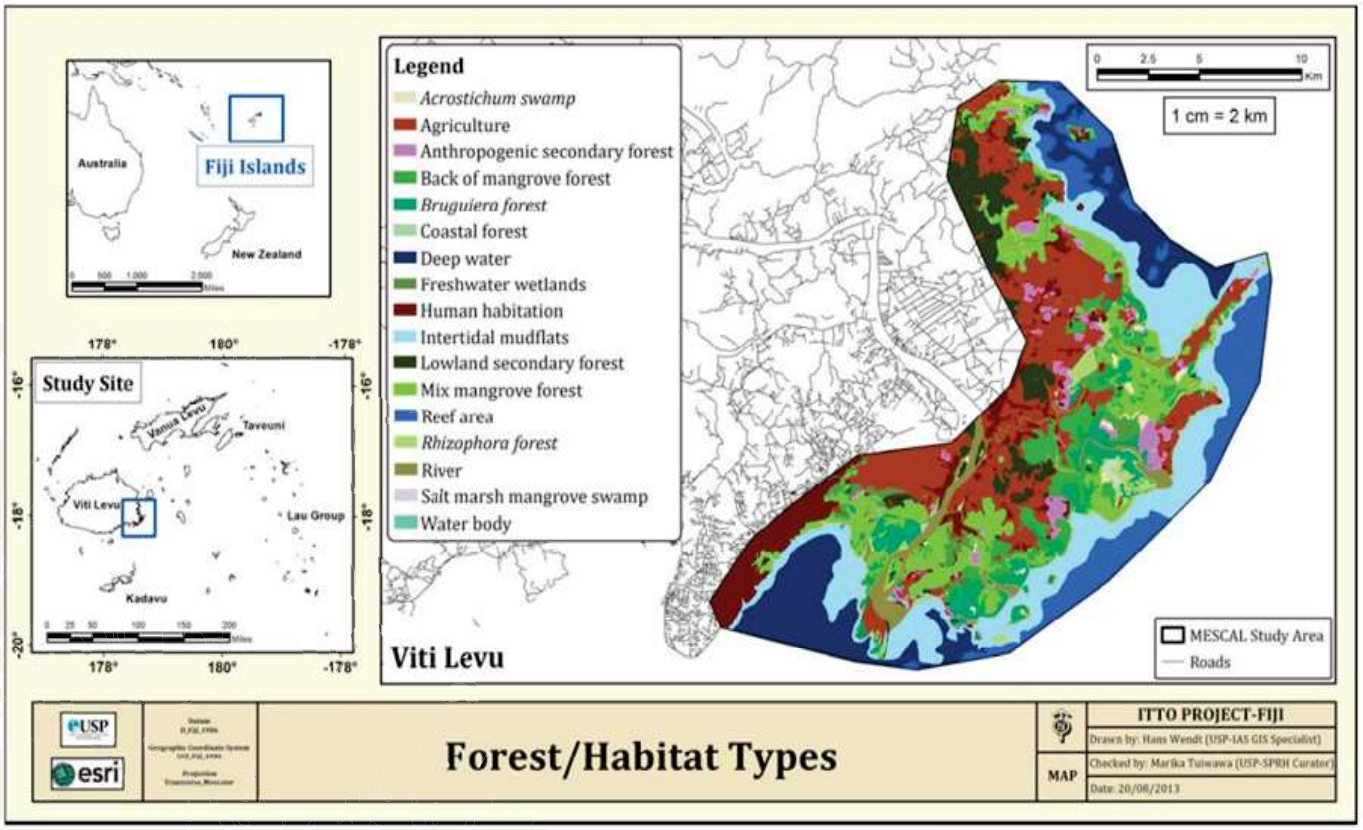
The Community-based Mangrove Management Guideline aims to involve local communities in efforts to mitigate the effects of degradation by being informed of the values and threats towards mangroves, identifying the drivers responsible for their demise, and having an overview of the regeneration techniques for reforestation, rehabilitation and restoration intervention across degraded mangrove areas. In becoming knowledgeable about the concepts and practices required, it is envisaged that a sense of empowerment is created to appreciate and support efforts of conserving such unique and valuable forest. By managing these efforts, the social, governance and environmental aspects, as well as the sustainable facets, are supported to ensure the success of these initiatives.

2.1 Scope of Work

The guideline is the result of a three-year "Community-based restoration and Sustainable Management of Vulnerable Mangrove Forest" project, funded by the International Tropical Timber Organization (ITTO) project and co-funded by the Fiji government. Its inception stemmed from the technical collaboration between the institutions: Land Resource Division (LRD) of the Pacific Community (SPC)[5], the Institute of Applied Sciences (IAS) of the University of the South Pacific (USP) and, Conservation International (CI). In 2013, the concept and development of the project focused on the gaps and areas of concern that were identified as a priority under the Fiji Mangrove Ecosystem for Climate Change Adaptation and Livelihoods (MESCAL) project in 2012-2013.

The MESCAL initiative is a regional project to which the Fiji project site is the Rewa delta. The delta is Fiji's largest mangrove system comprising an estimated area slightly above 350km^2 covering the provinces of Rewa and Tailevu that are located on the south-eastern parts of Viti Levu. Across the delta, there were four main Fiji MESCAL project sites namely: Natila settlement, Waicoka village and Nasilai village in the province of Tailevu; Muaicake and Muaira village in the province of Rewa. Under the project, priority areas of concern were identified as heavily impacted degraded sites located at the Back of the Mangrove Forest, including pockets of mangrove forest along the foreshore, and the immediate lowland forest habitats. These were specifically described as heavily degraded as the result of anthropogenic activities that accumulated over the years. As a recommendation, the 'Back of the Mangrove Forest' and lowland forest habitats became priority sites for rehabilitation and restoration across the Rewa delta.

[5] Formerly known as the Secretariat of the Pacific Community



Map: MESCAL Project sites along the Rewa Delta, Viti Levu, Fiji. Source: Fiji MESCAL Report, Tuiwawa *et al.* 2013

In 2015, some of the areas of concern identified under the MESCAL project was addressed in the ITTO project. The Fiji ITTO project focussed on recovery and enrichment interventions with the purpose of rehabilitating degraded habitats through reforestation of selected tree species. In alignment to strategic actions plans of the ITTO, the project supported initiatives to reduce the effects of deforestation and forest degradation and enhance the provision of environmental services to build and develop human resource capacity from sustainably managing forests. The Ministry of Forestry was the implementing agency of the three-year project with the responsibility of ensuring all project activities were delivered and completed successfully.

2.2 Objective and Aim

It is fundamental of any community-driven management guideline to have clear articulation of matters concerning the health of mangrove habitats and wellbeing of people that live in and around mangrove stands. The management guideline must also outline and define the social, governance, environmental and economic aspects of sustainably managing mangroves. Such management framework provides the reference structure for consultation and information by all interested parties.

The objective of the guideline is to:

- educate and strengthen the capacities of stakeholders and any other vested collaborative interests in the rehabilitation and restoration work across mangrove systems in Fiji;
- inform efforts and initiatives at the concept level that can outline available options and management approaches towards the successful planning, implementation and monitoring of rehabilitation and restoration activities;
- initiate dialogue and healthy discussions between stewards, all interested stakeholders and primarily the relevant government agencies that are mandated to support the conservation and protection of mangroves, through their respective policies, laws and regulations;
- raise awareness and encourage the involvement of other private and public institutions that can lend support and aid in the development of stakeholder and institutional relations.

In the Fiji context, the specific aim of the guideline is to highlight the:

- mandated governance infrastructure that protects mangroves by law, including stakeholder institutions with the resources and capacity that can support mangrove rehabilitation and restoration activities;
- social and economic aspects of managing mangroves by describing the value and threats affecting mangroves;
- management structures and operations within community boundaries;
- the importance of mangroves in the foreshore environment, with emphasis to the types of mangrove forest and mangrove species that are present;
- best practices and technical requirements for undertaking successful rehabilitation and restoration activities.

3 Governance Framework

Mangroves in Fiji is owned by the Government of Fiji by virtue of the fact that state land proceeds from the hightide water mark. In view of the diverse varieties of products and produce sourced from mangrove habitats, many sectors have interest in the sustainable management of mangrove systems. Government agencies responsible for managing mangrove resources comprises of the Ministry of Lands and Mineral Resources (State Lands Act 1978), Ministry of Forestry (Forestry Decree 1992), and the Ministry of Environment (Environment Management Act (EMA) 2005).

3.1 Policies & Agencies

Three government agencies are mandated to address matters relating to mangroves under various principal legal frameworks that oversee its use and management in the forms of Decrees, Legislations and Acts. In brief:

- **The Ministry of Environment** - is responsible for issuing Environment Impact Assessment (EIA) for development proposals that would determine the clearing or destruction of mangroves. In accordance with the EMA (2005), any development proposal of an area would require an EIA. The process of approval and delivery of decisions is decided and managed by the Ministry. According to Watling (2013), the MoEnv is also charged with monitoring the conditions of approval of EIAs, prevention of dumping and pollution, and monitoring the status of mangrove as a natural resource.

- **The Ministry of Forestry** - is responsible for declaring forest and nature reserves. The Ministry is also designated to issue licenses that allows for any extraction or felling of the mangrove within the declared reserve. According to Watling (2013), mangroves are considered 'forest' and managed under the Forest Decree (1992), to regulate extraction of timber and woody products as well as for the protection of mangrove habitats. Given that mangroves belong to the state, extraction of all products and produce sourced from mangrove habitats needs prior approval of the Ministry of Lands and Mineral Resources.

- **The Ministry of Lands and Mineral Resources** - is responsible for regulating the jurisdiction over all State land that includes the foreshore area, also known as the intertidal zones. Under the Crown Lands Act (Cap 132), all mangrove is owned by the State and regulated by the Department of Lands (DoL). Applications for use, conversion or development of foreshore land are decided by DoL (Watling, 2013). Consequently, State land cannot be sold but only leased. The decision of granting this lease is made by the Ministry of Lands and Mineral Resources.

3.2 Legal frameworks

Forest Decree 1992: "According to this decree, Forestry exists to manage forests and forestry products and it is assumed that this includes mangrove forests. Although 'mangrove' is not specified in the Decree, mangroves are a type of forest system. The Decree provides for the declaration and management of forest reserves and nature reserves. Forest reserves are managed as permanent forests to provide, on a permanent basis, the optimum combination of benefits of protection and production of which they are capable. Nature reserves are managed for the exclusive purpose of permanent preservation of their environment, including flora, fauna, soil, and water" Muldon *et al.* (2016).

Forestry Policy 2007: "According to this recent policy, the Government will consult with its departments and agencies involved in mangrove management and with qoliqoli owners and other stakeholders with a view to introduce an effective mangrove regulatory and management framework. The Government will consult widely and draw up guidelines or a plan to replace the current Mangrove Management Plan for Fiji (Phases 1&2-1985, 1986). One of the two actions identified as part of mangrove management is that "the Forestry Department will (Watling, 2013):

1. Contribute actively to a government review of mangrove management and will undertake the role assigned to it following the review;

2. Advocate permanent conservation of mangroves to provide for sustainable customary uses, the sustenance of coastal fisheries, the protection of shorelines, and as an adaptation measure against climate change impacts. Commercial harvesting of mangrove trees will be prohibited.

State Lands Act 1978 (formerly Crown Lands Act 1946):"According to this Act, all foreshore lands below the high-water mark, the soil under Fiji waters are state lands. In Fiji about 4% of land is state land. The department of lands is responsible for its administration. The Act talks about the reservation of the foreshore; lease of foreshore to be approved by the Minister; special provisions to be contained in leases of foreshore; saving of rights of the state to foreshore where land raised by execution of works and the application procedures to address any of these sections" Muldon *et al.* (2016).

3.3 Mandated Committees

Management committees exist to ensure that decision making process are well informed and transparent in order to obtain the best outcomes to manage mangroves effectively and sustainably. These committees are mandated to implement the polices, laws and regulations of the state under various legal framework. In Fiji, there are two main committees that oversee all mangrove issues and related matters.

3.3.1 National Environmental Council

The National Environment Council (NEC) is appointed under the Environment Management Act (EMA) and is made up of CEOs and or their equivalent in related ministries and other agencies including NGOs, academics, businesses and commercial interests (Watling, 2013). Their function is to make decisions on matters affecting the environmental protection and resource management of mangroves at the national level of governance (Watling, 2013).

3.3.2 Mangrove Management Committee

The Mangrove Management Committee (MMC) exists as a technical advisory group to National Environment Council (NEC) under the EMA 2005 and other regulatory authorities in Fiji (Watling, 2013). The NEC comprises of the following members (Watling, 2013):

- Ministry of Lands and Minerals (formerly known as the Department of Lands)
- Ministry of Environment (Formerly known as the Department of Environment)
- Ministry of Forestry (formerly known as the Department of Forests)
- Ministry of iTaukei Affairs
- Ministry of Fisheries (formerly known as the Department of Fisheries)
- National Trust of Fiji
- NGO Representative
- Academic/mangrove specialist

The chair of this committee currently sits with the Ministry of Environment.

3.4 Traditional Rights Ownership

While all inter-tidal and submerged land are owned by the State, i-Taukei communities have customary rights of access and use of resources in these inter-tidal areas (Watling, 2013). According to the Fisheries Act of 1942, i-Taukei communities have rights of access to all traditional fishing grounds. These rights are held exclusively by the chief of traditional clans known as the 'Yavusa' which consists of a group of clans. Several 'Yavusa' makes up the 'Vanua'. Traditional fishing areas (or Qoliqoli) can be owned by the 'Vanua'. While the Fisheries Act recognizes traditional fishing rights ownership (TFRO), there currently is no legal standing on the usufruct rights that is part of the TFRO which means, communities belonging in this category will lose resources and compensation benefits in the event those areas no longer exist as the result of development (Watling, 2013).

The main objective of the Fisheries Act is to make provision for the regulation of fishing within "Fiji fisheries waters" which means "all waters appertaining to Fiji that includes all internal waters, archipelagic waters, territorial seas and all waters within the exclusive economic zone". This legislation provides for the creation of protected areas within Fiji fisheries waters for sustainable fishery resources. However, although the jurisdiction for declaring protected areas

is wide, the protection of the fish species is restricted to fish within the meaning given under the definition in the Act, which is: "any aquatic animal whether piscine or not, and includes shellfish, sponges, holothurians, (bêche-de-mer), sea-urchins, crustaceans and turtles and their eggs" Muldon *et al.* (2016).

The Fisheries Act (Cap 158) regulates a wide range of activities pertaining to fishing and marine life within Fiji's waters and as such is relevant to mangroves. Watling (2013) notes that compensation for the loss of fishing rights to Traditional Fishing Rights Owners (TFRO) was endorsed via Cabinet Paper 74(204).

3.5 Traditional Authorities

Traditional authorities refer to Chiefs, head of clans and leaders who are custodians of traditional values and norms. Their role is to ensure the sustainable flow of benefits in the utilisation of mangrove resources by their communities. They have the authority to enforce by-laws, traditional rules and regulations and can influence community perception and action of proper mangrove localised operation practices.

3.6 Other Stakeholders

These stakeholders constitute of institutional set-up and organizational roles that can provide the technical support required to execute rehabilitation and restoration initiatives across Fiji. These organizations have specific technical skill sets at the national and regional scale with a history of successful community-based initiatives. Each also have a long-standing association in the field of practical and applied (forestry based) community development in Fiji.

3.6.1 Ministry of i-Taukei Affairs

By law, the Ministry of i-Taukei Affairs is mandated to protect the indigenous culture and the economic and social development of indigenous Fijians. The Ministry has vested interests in the economic and social well-being of the indigenous community.

3.6.2 Provincial Office

The Provincial Offices in Fiji are mandated by law to look after the welfare of the i-Taukei community and ensure good governance. They are influential in the administration and development strategy at the provincial governance level. They lead provincial development at community level, and they are a main partner in all community-based initiatives.

3.6.3 i-Taukei Lands Trust Board

The i-Taukei Lands Trust Board is mandated to determine and approve appropriate landuse on indigenous land. They too have vested interests in the economic and social well-being of the indigenous communities. They function to secure, protect and manage land ownership rights assigned to the indigenous landowners and to facilitate the commercial transactions around its use.

3.6.4 Institute of Applied Science, University of the South Pacific

The Institute of Applied Science of the University of the South Pacific is mandated to undertake mangrove research and assist in the management of its resources. They have the technical capacity to project the conservation and sustainable utilisation of natural resources, as well as the planning, design and implementation 'know how' of carrying out a rehabilitation and restoration framework.

3.6.5 Conservation International

Conservation International Fiji program works in strong collaboration with national and local governments with the capacity to mobilise communities. Their interest is in the sustainable resource base and improvement in the wellbeing of local communities. They have the capacity to provide advocacy and community-based conservation, terrestrial rehabilitation and restoration of degraded landscapes.

4 Social and Economic Aspects

Mangroves are important to people because they are a critical source of natural resources. They offer a broad range of social benefits to communities that lie in close proximity to the mangrove forest as well as those located beyond its peripherals. Mangroves contribute significantly to the well-being of communities living along the coast, some of whom have lived and occupied the location since time immemorial. Their value constitutes of subsistence livelihood and economic resources that provide alternative sources of income generating revenue streams to support local community well-being. These often entails the sales of fuelwood, dyes, fish, mud crabs and a whole range of crustaceans.

Communities often depend on the resources provided for by mangroves as a means to sustain their subsistence way of living. Amongst other ideals, mangroves are also valued for providing food security and coastal protection, creating awareness and education opportunities that includes learning about millennia of tradition, culture and history. At the same time however, mangrove resources are being threatened by the over-utilization and exploitation of resources to the extent where deforestation and degradation become a main concern. Factors contributing to the loss of mangroves and mangrove degradation are: effects of tropical cyclones, unsustainable development and establishment of urban infrastructures, overharvesting of mangrove trees for wood and other construction uses, clearance of land to accommodate increasing population. In the long-term, the effects of these destructive forces causes a lot of detrimental impacts affecting the well-being of many household communities.

4.1 Value of Mangroves

4.1.1 Traditional and Cultural Use

The connection between the history of people and the environment often lies evident with existing archeological sites that lie buried within mangroves (Nakoro *et al.* 2013). Unearthed artifacts often reveal a piece of the past that may be hidden, if not untold, or known by the local communities and the scribes of history. In some parts of Fiji, these records of culture and traditions can be traced to almost three millennium of history (Nakoro *et al.* 2013).

Across the Rewa delta, typical archeological sites are common in all types of mangrove forest (Nakoro *et al.* 2013). These are identified by remnants of house mounds (yavu), sacred site for carrying out traditional chants, ancestral burial grounds, old village sites, ring ditch fortification and installation sites (Nakoro *et al.* 2013). In some of the communities, the sites of occurrence become 'taboo' areas that are revered and left unscathed because of the historical footprints they hold and that has passed down from one generation to the next (Pillai, 1985; Lal, 1984, 1990; Nakoro *et al.* 2013).

Unfortunately, these legacies are being destroyed as the result of the many years of ongoing anthropogenic activities and destruction incurred from changing social and economic situation. Activities specifically in the forms of large-scale development and urbanization, unmonitored agriculture and forestry activities, including nature, are well established threats that places a lot of mangrove forest and habitats at high risk of significant and irreplaceable loss (Nakoro *et al.* 2013). Through successful rehabilitation and restoration efforts, those affected areas of significant loss and or damages now have a chance of being reinvigorated for many more generations and the long-term. It is also one way of ensuring that tradition and cultural associations and practices continue well into the future.

4.1.2 Source of Livelihood and Food Security

Mangroves are a source of livelihood and food security for significantly many coastal households. Recent study, across the Ba and Rewa delta, showed that 20-45% of community members visit the mangrove forest daily to source for food resources as part of their daily routine (Avtar *et al.* 2021). The value of these resources is mostly established from the availability and sales of wood, fish and mangrove invertebrates such as mussels, mud lobsters and mud crabs especially in the local markets (Fong, 2013; Figure 5, 6). Apart from the aquatic fauna, there are also associated plant species that share similar socio-economic values. These include coconuts *(Cocos nucifera)*, ivi nut *(Inocarpus fagifer)*, mangoes *(Mangifera indica)*, lemons *(Citrus limon)*, pawpaw *(Carica papaya)* and many others (Tuiwawa

et al. 2013). The sale of mangrove wood for firewood is also another source of income for mangrove households (Fong, 2013). Hence, the continual supply of these commodities is directly associated with conserving the diversity of mangrove habitats and holistically keeping intact the integrity of mangrove forests.

Further, the aesthetic effects of mangroves have led to life changing perception of existing resources that have contributed to changing lifestyles and dependency on mangrove resources over the years. The shift in perception and practices includes increasing opportunity for livelihood, basic amenity provisions, establishing an improved health and education infrastructure. With the added economic benefits of development especially in the tourism industry, there are now interests of local businesses venturing into the eco-tourism markets and other similar schemes whereby there is a lot of opportunity to economize mangrove resources.

4.1.3 Shoreline Protection

4.1.3.1 Habitat and nursery functions

Mangroves serve as "nurseries" for numerous species, sheltering them from predators and currents[6]. Site specific study by Lal (1984) along Wairiki creek showed they are the breeding ground for a diversity of fish such as the goatfish, mullets, pony fish, slipmouths, mangrove jack, trevallies, butterfly fish and barracudas, as well as crustaceans such as mangrove crab. Recent study by Rasalato *et al.* (2010) showed specific species of the Hammerhead sharks *(Sphyrna spp.)* and that other larger sharks, breed and feed in river mouths on Viti Levu and Vanua Levu; Marie *et al*. (2017) uncovered critical habitats for the young, scalloped hammerhead sharks *(Sphyrna lewini)* in the Rewa Delta; Vierus *et al.* (2018) documented multispecies of sharks in the Ba estuary. Mangroves occur as the nesting and feeding grounds, possible refuge, for the different fauna that occupy the aquatic space. This consequently means, the sustainability of mangrove habitats and nursery is critical to the long-term efforts of protecting and conserving the diversity of marine life.

Figure 5: Crustaceans, a source of livelihood and food security for many local mangrove household

In understanding the purposes of mangrove nurseries and the need to conserve and protect mangrove stands, there also lies the realization of ensuring the security and expansion of existing nurseries. This is achieved through rehabilitation and restoration that advocates sprouting of new vegetation structures across degraded mangrove sites. These vegetation structures will sustain the integrity of sheltering numerous species of mangrove fauna and associated aquatic mangrove habitats well into the future.

[6] https://www.conservation.org

Figure 6: Fish spawning ground in a brackish mangrove river swamp, Viti Levu

4.1.3.2 Coastal protection

The location of mangroves is strategically positioned to protect the coastal communities by buffering storm surges and reducing water levels and the height of winds and swells (Ellison, 2000). They are often seen as a separated land area from the lagoonal region and ocean where their functional role of protecting the shoreline from erosion and stabilizing sediments are largely significant. Accordingly, *"The above-ground roots slow down water flows, encourage deposition of sediments and reduce erosion. Erosion refers to the removal of sediments from the shore, resulting in the loss of land and a retreating shoreline"*[7].

In reducing the incoming tidal impacts against the shoreline and coastline, there also is the reduction in the chances of flooding of lowlands that impact communities who reside along the coast and within the mangrove forest (Ellison, 2000; Figure 7). These coastal functions can be maintained in the short and long term by reducing massive clearings of mangroves and support rehabilitation and restoration efforts of degraded mangrove sites.

Figure 7: Shoreline protection of mangroves are important to communities living along the coast, province of Ba, Viti Levu

[7] https://www.nature.org/media/oceansandcoasts/mangroves-for-coastal-defence

4.1.4 Mitigating effects of Climate Change

Blue carbon is an added value to the existing role and function of mangroves. It is a recently founded concept that was introduced for the purposes of mitigating effects of climate change particularly along the coastlines. The initiative shares the common interests amongst stakeholders of reducing carbon emission through investments in the carbon trading market. The platform is also an opportunity to raise awareness and become educated about the value of mangroves and the means of going about to restore and keep them viable for as long as possible.

4.1.4.1 Carbon sequestration

Mangroves store up to 10times more carbon than the terrestrial forest. They store a significant amount of carbon in both the above and below ground carbon pools. They are estimated to cover 13.7-15.2 million hectares worldwide and are able to sequester up to 31.2-34.4 million tonnes of carbon per year (Conservation International, 2020). The removal and or destruction of these carbon pools puts the risk of losing a significant amount of carbon having to be released into the atmosphere where the land areas of concern are lost or used for other purposes.

The blue carbon project currently underway by Conservation International (2018 to date) introduces an economically sound intervention of conserving and restoring mangrove loss across principal mangrove locations in Fiji. Recent study by Cameron *et al.* (2021) showed the soil carbon pool stores the highest amount of carbon in a mangrove forest (Figure 8). The potential to implement a blue carbon restoration intervention project to restore and conserve mangroves has an estimated project cost of USD 2.5 million, or an average of USD 57.3 per ha per year, with emission reductions and removals (ERR) projected at 553,013.4 Mg CO_2e over 30 years (or 4.2 Mg CO_2e ha per year) (Conservation International, 2020). Across the Ba delta, there is evidence of significant mangrove loss due to tropical cyclone damages (TC Evans) and post cyclone recovery. Blue carbon interventions are invested in the restoration of degraded and deforested mangrove sites along these regions.

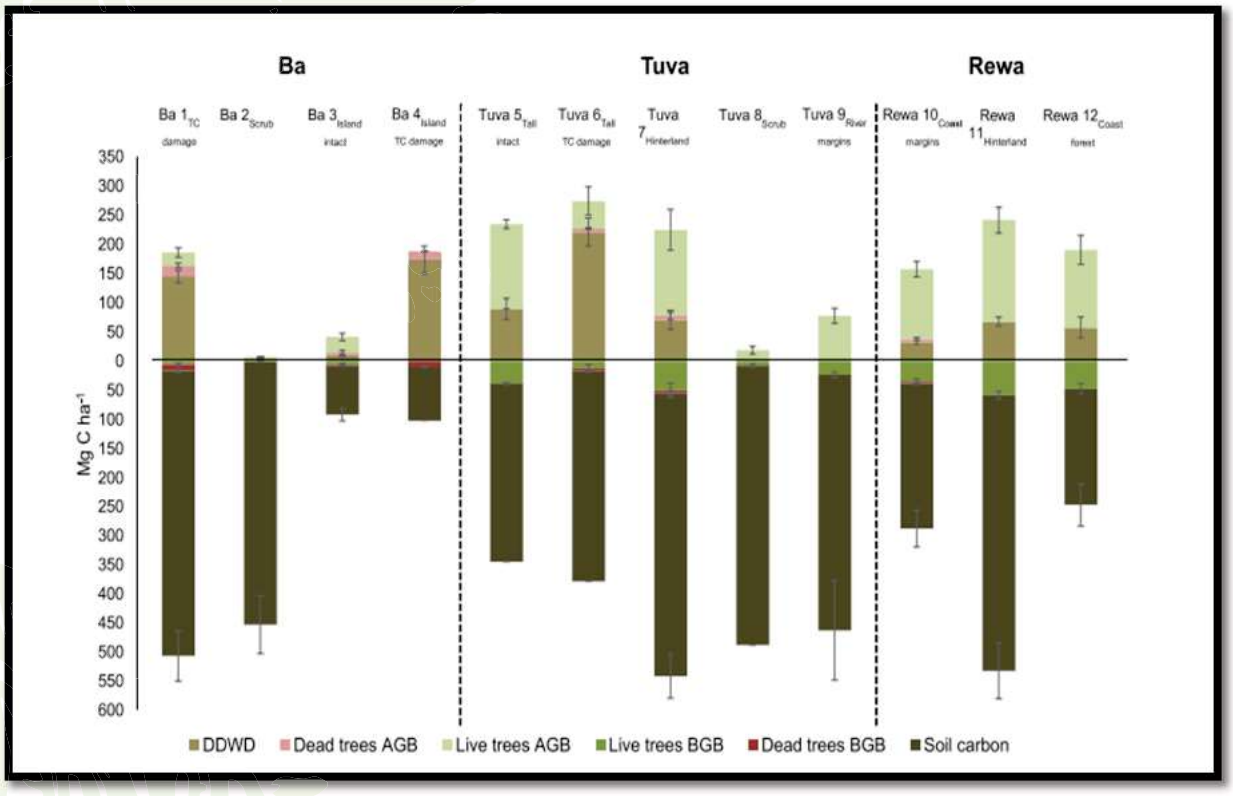


Figure 8: Mangrove ecosystem carbon stock across the Ba delta, Tuva mangrove forest and Rewa delta, Viti Levu

4.2 Drivers of Mangrove Degradation

Degradation of mangroves is defined as mangrove areas that are heavily impacted due to high disturbances within the area mangrove areas and that have no indication of natural regrowth of saplings and seedlings (Tuiwawa *et al.* 2013). These areas are subjected to similar drivers of degradation in the forms of dredging activities, large scale logging (includes clear felling and commercial logging) to list a few examples. These disturbances are sustained from anthropogenic activities and or natural disasters. Human induced activities are commonly defined by deforestation, human habitation, agricultural practices, urbanization, development, exploitation of resources, overharvesting of mangroves for wood and increasing population (Watling 1985; Pillai, 1985). As the result of these destructive disturbances, over time, some of the mangrove affected areas begin to show evidence of a secondary forest system (Tuiwawa *et al.* 2013). These areas can occur across low-lying undulating terrains that are generally muddy and occupied with brackish water during the high tide (Tuiwawa *et al.* 2013). In most instances, they have one to two individual species of *Rhizophora* (tiri) and *Bruguiera* (dogo) that more so often are absent. There also, intermittently occurring, are the other mangrove species: *Heritiera littoralis* (Kedra ivi na yalewa kalou), *Lumnitzera littorea* (sagale), *Xylocarpus granatum* (dabi) and *Excoecaria agallocha* (sinu, sinu gaga) including the mangrove fern, *Acrostichum aureum* (borete). On the relatively higher grounds that occasionally is inundated are the secondary succession species (e.g. *Elattistachys falcata* (marasa), *Morinda citrifolia* (kura), *Hibiscus tiliaceus* (vau), *Cocos nucifera* (niu) as well as the introduced species *Annona glabra* (uto ni bulumakau), *Mangifera indica* (maqo), *Artocarpus altilis* (uto), *Leucaena leucocephala* (vaivai) (Tuiwawa *et al.* 2013).

A common example of natural disasters is the mangrove dieback resulting from the effects of tropical cyclones (Cameron *et al.* 2020; Tuisese pers. comm). Under the Blue Carbon project, these areas of degradation are currently being identified as areas having no regrowth of *Rhizophora* and *Bruguiera* seedlings several years after a tropical cyclone (Cameron pers. comm.).

4.2.1 Tropical Cyclones

Cyclones are capable of displacing trees and removing branches and leaves (Cameron *et al.* 2021). In the last decade, Fiji has been subjected to a series of high-intensity tropical cyclones (Figure 9). While expectantly the social and economic ramifications of such natural disaster is high, there is concern that significant damages sustained during onslaughts of repeated cyclone will lead to structural damages of various mangrove forest and habitat types. This is brought about by the overall intensity of the cyclone with damages resulting from strong winds, flooding and sediment runoffs (Cameron *et al.* 2020, 2021).

Structural damages incurred from cyclones is evident from pockets of open forest mangrove canopy across the Ba delta and Tuva mangrove forest. Recent visitation and observations have shown extensive loss of the tall *Rhizophora* forest as the result of strong winds and flooding sustained from tropical cyclone Evans in 2012 and tropical cyclone Mick in 2009. Similarly, on the island of Yanuca off the coast of Ba delta, significant loss of mangrove forest has resulted from the damages incurred by tropical cyclone Winston in 2018 (Figure 10).

In spite of these damages, there also lies early signs of natural recovery of several mangrove sites, via significant number of seedlings and sapling growths in the understory in the few years that follow. Natural recovery however is not consistent in all damaged sites across all cyclone affected mangrove sites. In some parts of the Ba delta and Ra mangroves, there have been no regrowth of seedlings recorded since the cyclones were last reported (Cameron *et al.* 2021).

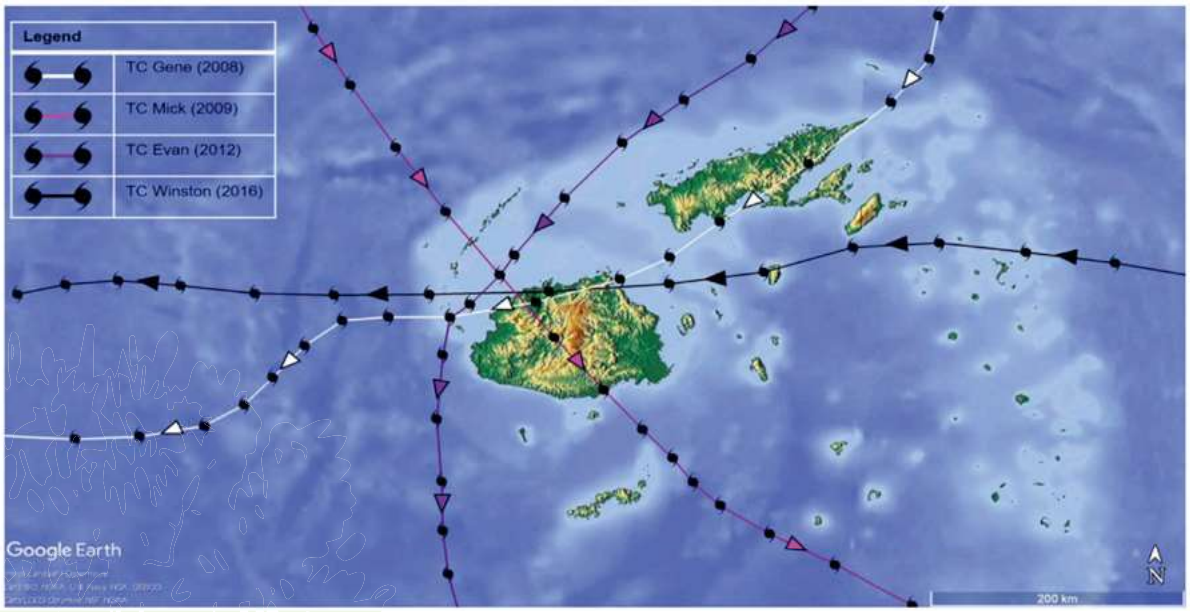


Figure 9: Pathways of recent tropical cyclones that have affected Fiji

The Rewa delta, on the other hand, have sustained a lot of the coastal erosion and flooding incurred by cyclone Bebe in 1972 and yet, these areas have recovered over time. The entire delta stands as a living robust and largest mangrove forest in Fiji, to date.

While it is anticipated that mangroves can recover from moderate impacts of cyclones, the projected frequency of cyclones is expected to increase in severity and intensity given the current global context of climate change.

Figure 10: Mangrove loss on the island of Yanuca as the result of Tropical Cyclone Winston in 2018, Viti Levu

4.2.2 Unsustainable Development and Infrastructure

Development to the extent of irreversible damages on mangroves are considered unsustainable and destructive. It comes in the form of large areas of mangroves having been cleared for various uses such as agricultural and aquaculture farming, road construction, building of rural and urban infrastructures, disposal sites of dredge spoils and dumping ground of local operations. Part of processing these operations involves the clearing of mangrove trees and disruption of the soil substrates from an area.

When mangroves are degraded, its ecological functions are also destroyed, and economic value compromised. These

can be observed by the loss of fisheries and nursery grounds, loss of native tree species, increasing flooding, increasing coastal damages from cyclones, high poverty rate within coastal households that depend on healthy mangroves. It is normally the people living in the urban areas that reap the benefits of development while those that primarily depend on mangroves (e.g. fisherman) are the ones bear the full brunt of losing livelihood opportunities (Tuiwawa *et al.* 2013; Conservation International, 2020).

The majority of development are incurred for commercial purposes i.e. conversion of mangrove area into industrial complexes for tourism, road constructions, the upgrade of drainage systems and other building facilities to accommodate business ventures (Cameron *et al.* 2021; Figure 11). Across the Ba delta and other western parts of Viti Levu, pockets of degradation are anthropogenically sustained throughout the foreshore (Cameron *et al.* 2020; Figure 11).

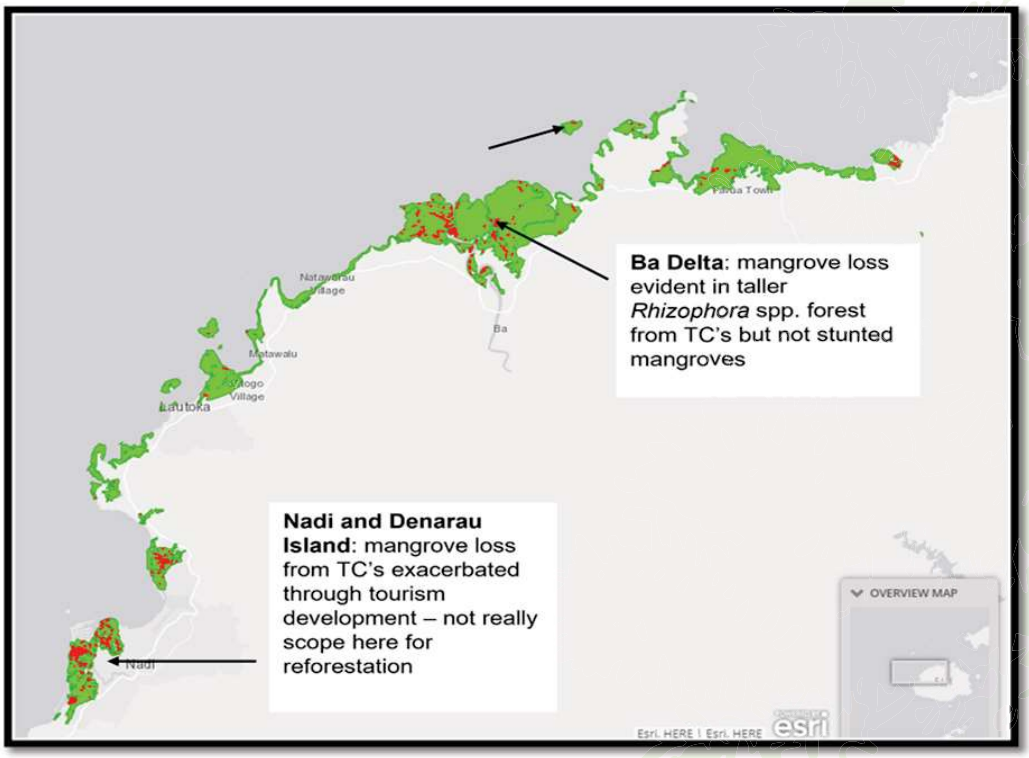


Figure 11: Pockets of development (highlight in red) across the Ba delta, Viti Levu

4.2.3 Overharvesting of wood for fuel and construction

With the knowledge and information that mangroves are the best fuelwood and better alternative to native species as fuelwood, it is not unexpected that mangrove forests are a targeted location for wood extraction, harvesting and unsustainable logging. Fong (2013) stated that the primary use of harvested mangroves, in the Rewa delta at least, is its use as firewood in that 92% of households that were interviewed, use dry mangroves as their primary fuelwood.

Mangrove firewood are used on a daily basis generally for domestic cooking (Fong, 2013). There would normally be an increase in their use of mangrove firewood when there are village gathering for traditional and religious purposes, especially in the festive and holiday seasons of the year (Fong, 2013). Other major uses are house posts, fence posts, traditional herbal medicine, and the construction of household furniture (Fong, 2013). As mangroves are another source of wood construction, domestic activities include its use as timber, scaffolds, heavy constructions, railroad ties, mining pit props, boat building, doc piling, beams and poles for building, floor, paneling, thatching, fence posts, water pipes, chipboards, and glues (Lal, 1984). Extraction of these mangrove trees for domestic purposes are mostly conducted by men in the villages and are carried out using knives and axes, with a few being able to afford purchased gadgets such as chainsaws (Fong, 2013; Figure 12). Across the Rewa delta, the most sought-after mangrove species for these purposes are the *Rhizophora* species (tiri) and *Lumnitzera littorea* (sagale). Preferences may differ in other mangrove locations in Fiji (Fong, 2013). Given that these mangrove species thrive and occur in abundance, it is understandable that the general perception of residing communities is that mangroves are the only available option within their reach to use for firewood, house-piles and other domestics uses (Fong, 2013).

Figure 12: Local harvesting and tree felling along the Rewa delta, Viti Levu

4.2.4 Increasing population

Increase in population means an increased demand for resources and support to cater the growing numbers. Urban and peri-urban mangroves, in particular, are the most vulnerable because of the demand from the high number of local population and the increasing level of urbanization and development in adjunct areas (Watling, 1985). An expansion of these factors means significant clearance of mangrove trees and land area to facilitate the needs of the increasing population. Such could mean clearing of land areas to establish building infrastructures, road construction and agricultural land for farming. This could also be the basis for expanding the boarders of existing settlements and mangrove peripherals to cater for the high population densities (Pillai, 1985; Singh, 1996; Figure 13).

Figure 13: Mangroves are often cleared to accommodate new infrastructure and development constructions, Rewa delta, Viti Levu

5 Community Management Structure

i-Taukei community stakeholders can be directly involved in the dialogue and discussion on all issues related to mangrove forests and mangrove habitats, particularly across sites that lie within their own community boundary. Individuals can be active participants and remain informed from the beginning to the end of all discussions. As stakeholders with legal access rights, their position as traditional stewards and co-managers for the protection, sustainable use and conservation of mangrove ecosystems is important and it must be undertaken in close collaboration with all Government agencies responsible for mangroves. To effectively execute the management of mangrove rehabilitation and restoration activities in village setting, these key infrastructures need to be in place:

5.1 Village Committees

It is common to have regular village meetings called by the village headman. Under such governance, there may be a village committee in place to address and resolve all issues pertaining to environmental issues and the well-being of the village. As an important forest, all issues pertaining to the health of mangroves can be discussed in the Village Environmental Committee (VEC). With the assistance of the village headsman, matters can be readdressed at the Tikina level or at the Provincial offices once presented by the Environmental Committee at the village meeting. In large villages, there may be preferences to set up a specific Village Mangrove Management Committee (VMMC) and Village Development Committee (VDC) that are sub-groups to the village environmental committee. In attending to resolve matters internally, their role is to oversee grievances, issues, and management of mangroves and try to resolve localized issues as best as possible.

The Ministry of iTaukei Affairs and the Provincial Councils across Fiji are also appointing Yaubula Management Support Teams (YMST) who are responsible for coordinating VEC or VMMC. The YMST are tasked to safeguard the environmental issues affective the wellbeing of village members. A guiding framework of the purpose of such committees is to:

- Maintain and promote the sustainable use of mangrove resources;
- Conserve and safeguard remaining mangroves through the collective and cooperative efforts of the community;
- Initiate and support training and awareness programs about mangroves and proper management practices for all members in the community. Programs and training are to cover the subject area of seed collection for replanting, value and threats to mangroves, rehabilitation, and restoration case studies from neighboring villages or the region;
- Coordinate initiatives between communities and supporting government institutions such as the Ministry of Forestry, Environment and, Lands and Mineral Resources.
- The Provincial Office through the Conservation Officers will collaborate and secure support where needed from partners and Civil Society Organizations (CSOs).

5.2 Communication Pathway

The communication pathway between communities and government institutions mandated to protect mangroves in Fiji. See Figure 14.

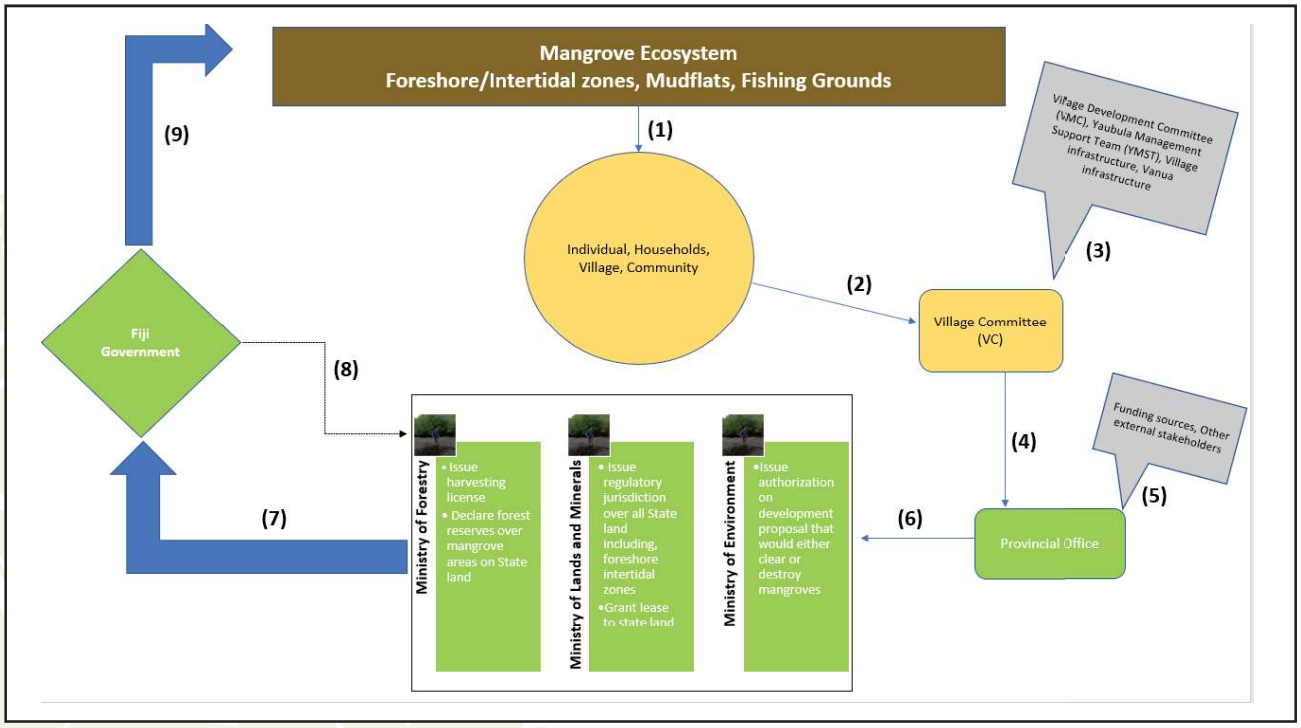


Figure 14: Communication pathway between communities and government

The narrative to the tasks represented in the flow-chart are as follows:

1. Issues and concerns regarding mangrove resources in the foreshore, mudflat areas and associated habitats are flagged by multiple users at the village and community settings;

2. Matter is relayed and presented to the VC;

3. An open dialogue of communication whereby the YMST, VEC/VMMC informs the VC, and other traditional infrastructure about the issues, required expectations and goals of mangrove restoration and rehabilitation;

4. The YMST/ VEC/ VMMC consults the respective provincial offices for advice on the issues raised and the course of actions to take;

5. Provincial Offices through the Conservation Officers will provide advice and direct YMST/ VEC/ VMMC to relevant technical and financial assistance. Conservation Officers in Provincial Offices are positioned to seek external consultation on environmental issues, including securing technical and funding resources to assist local communities;

6. Provincial office will advise and redirect matters to the relevant and mandated Ministries for further consultation;

7. Depending on the severity of the matter, the Ministry that has the power to take the matters into cabinet approval as and when deemed by leadership of respective government agencies. The primary policy, law or regulation on which the decision is made will dictate the lead agency that submits the issue for Government approval. For instance in the case of request by local communities for "no-take" protection of mangroves, this will trigger the use of Forest Decree 1992 hence the Ministry of Forestry will lead consultation and presentation of relevant proposition for Cabinet approval.

8. Cabinet can liaise with the respective ministry on the appropriate course of actions;

9. Given that mangroves are owned by the State, the State can execute courses of actions without written consent

or approval should they see it fitting to national goals and interest of the country.

5.3 Other Management Actions

Apart from the rehabilitation and restoration described (see Section 7), there are other actions that communities can involve themselves with directly as stewards for protecting and conserving mangroves. This could include communities forming some level of partnership with either government institutions or partner organizations from CSOs and other stakeholders with similar interest as described in Section 3. Some of the other management actions are:

- **Consented Mangrove Clearings:** Depending on the scale of clearing, some form of approval will be needed to ensure localized clearings are following appropriate harvesting guidelines. This is best overseen by the village committees who can assess risks against benefits to all community members. Should there be a need of extraction for commercial benefits, a license will need to be obtained from the Ministry of Forest and or the Ministry of Lands and Mineral Resources. If, on the other hand, the clearing be at a subsistence scale, then the quota consumed will need to be monitored against the acceptable volume set by the Ministry of Forestry.

- **Install Proper Rubbish Disposals:** Community wardens can be established to monitor and ensure the village bylaws are followed and that individuals avoid littering irresponsibly. More so, that disposable sites are safely located away from mangrove areas.

- **Demarcating Boundaries:** Through mapping exercises, traditional boundaries and government boundaries of authority need to be clearly established to avoid, essentially, social disputes. These areas can include traditional fishing grounds and buffer zones in a mangrove forest whereby signboards can be put up to notify communities. Government will also need to recognize and endorse these actions when setting up plans for development.

- **Advocating for Capacity Building, Awareness and Training:** This is an opportunity to upscale skills, knowledge and information on issues of interest. For instance: training on seed collection, raising of seedlings, skills on planting and replanting creates additional capacity and knowledge. As there is a lot of dependence in the lands to support commercial farming to sustain livelihood and sources of income, these learning activity assists with gained knowledge that can contribute to improving efficiencies through the creation of alternative livelihood. Alternative livelihood entails new opportunities that are introduced to generate new revenue streams such as the raising of sandalwood which can be sold or planted as a source of income. Communities are now able to take ownership of similar initiative and put this acquired lifetime skills into practice. Similarly, learning about the establishment of nurseries for reforestation using alternate species as well as knowing more about the values of coastal and mangrove wetlands, are equally empowering to finding more about the appropriate and alternate livelihood sources and resources.

5.4 Stakeholder Groups

These are community-based social groups constituting of a set-up whose function is to raise localised issues that require attention and community support. These groups can be voluntary, involuntary or delegated subjective to the capacity of resources that is available. Depending on the cause and purpose of their cause, these groups can assist the administration of activities within the village.

5.4.1 Social groups

Women/Men and their families are subsistent dependant on the coastal and mangrove resources. Both the men and women in communities are amongst the main beneficiaries of mangrove products sourced from timber tree and non-timber tree species/products. As a group, it is not unexpected that their interest would primarily focus on the sustainability of resources. They have every opportunity to share and communicate indigenous knowledge and actively participate in community development projects.

5.4.2 Youth groups

Youths in communities are also amongst the main beneficiaries of mangrove resources. They have every opportunity to improve sustainability values, strengthen capacity of resilience, and develop fundamental lifelong skills, as well as establish behaviour patterns advocating good practices of mangrove conservation.

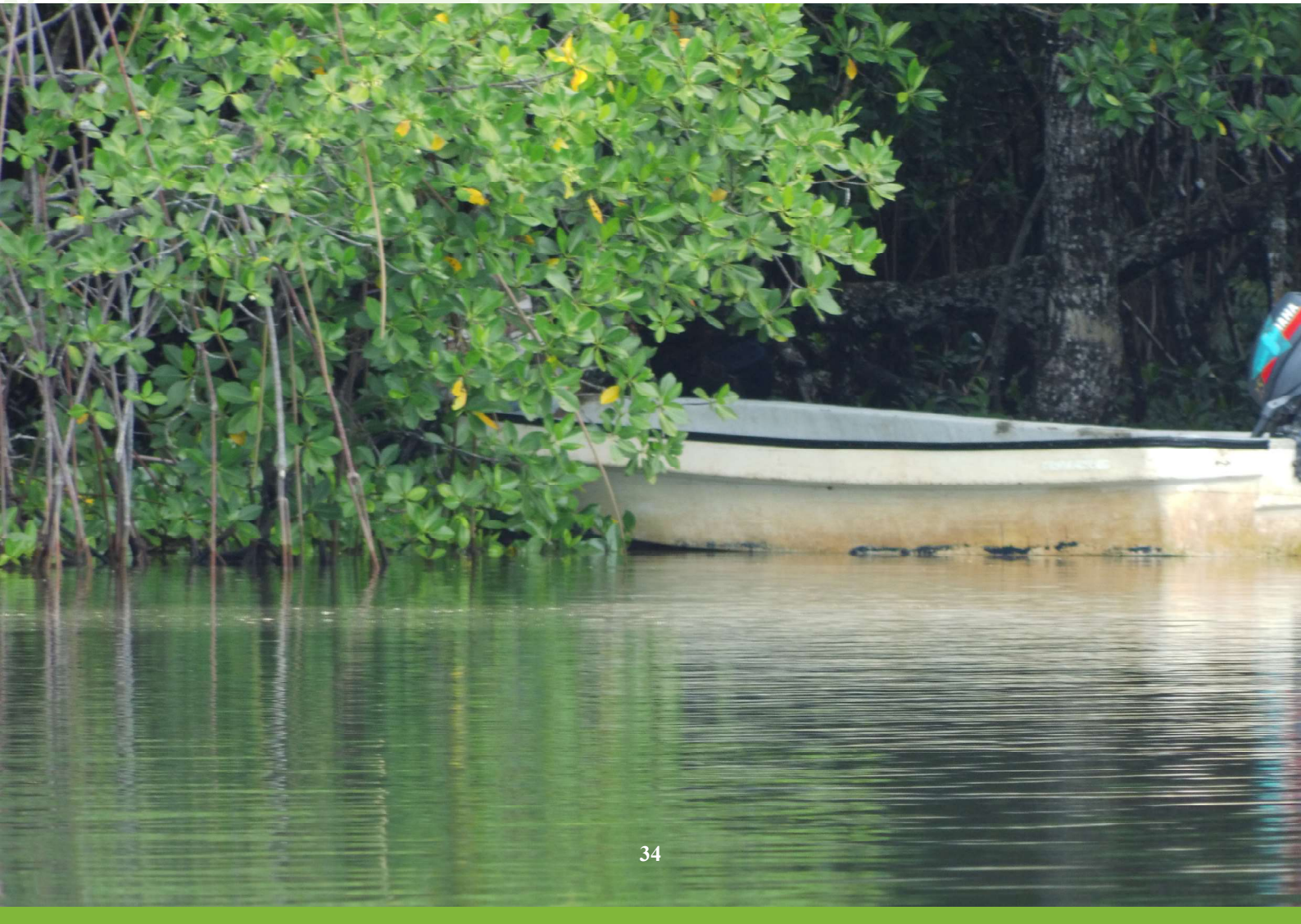
The goal of their involvement is to engage with other youths in their community and to come up with practical conservation activities in a safe and accessible informal setting. They will have every opportunity to build and design their own program, with the support of the broader community, while also developing a sense of communal belonging and participation. The purpose of their establishment is to foster the development of social and cultural goals of the community.

5.4.3 Women groups

Women forming a group within a community is an empowering aspect of development. This is an opportunity where women, as the centre focal point, have the opportunity to share and gain knowledge. As one of the main dependants and beneficiaries of mangrove resources, they have this platform to voice their opinions, raise concerns, receive support, gain accessibility to wider range of services, promote required changes and connect with other networking opportunities.

5.4.4 Non-community local users

This refers to individuals that are not part of the community however they too have access and use the coastal and mangrove resources that are readily available. Their livelihood depends on these resources on a commercial basis and for their benefit. They are also interested in the sustainability of these resource base and have the chance to actively participate in the project activities surrounding these interests.



6 Environmental Aspects

Mangroves is an integral component of the foreshore environment. Naturally, they have the ability to capture carbon dioxide from the atmosphere and store them in their roots and branches[8]. Because they carry out this function so well, they are able to store most of the carbon in the ocean floor in comparison to other types of terrestrial forest (Conservation International, 2020). In spite of their role as natural carbon sink however, mangroves are still being lost for all sorts of reasons. One of the main causes of mangrove loss is the direct and indirect effects of anthropogenic activities and naturally sustained events (see Section 4.2; Tuiwawa *et al.* 2013). The loss of mangrove habitats for instance, is associated with degradation while the loss of mangrove forests is often correlated with mangrove diebacks after tropical cyclones (Tuiwawa *et al.* 2013; Tuisese pers. comm.). These units of reference are equally subjected to deforestation that is linked to unsustainable logging and land development (Tuisese pers.comm.).

While there is the understanding of the need for mangrove conservation, the negative impacts of mangrove loss have only strengthened initiatives to focus more on various protection and conservation interventions. Rehabilitation and restoration are one such form, and it is a much-needed intervention that'll ensure the functional and structural roles of mangroves systems can at least be retained and sustained well into the near future. Through these efforts:

- Livelihood resources are maintained. Communities depend on mangroves as a constant source of daily resources and livelihood. The loss and removal of mangroves is likely to have a lot of social and economic repercussions in the overall well-being of communities that solely depends on mangroves for basic sustenance and survival.

- There is added value to securing the expansion of existing mangrove nurseries and sheltering of many species of mangrove fauna and associated species. Such is upheld through the regeneration of new vegetation structures that will stand to sustain the integrity of these aquatic habitats in the short- and long-term period.

- The conservation of mangrove ecosystem as a carbon sink is significantly supported. Reductions in carbon emissions is a global concern that requires every effort to reduce and halt loss of forest including mangrove stands. By planting trees in areas that have been damaged, we help to protect and preserve carbon sinks as well as reduce carbon emissions in the atmosphere.

6.1 Mangroves in Fiji

Mangroves in Fiji are an invaluable resource to not only the coastal communities but to all stakeholders with vested interests and accessibility. Mangroves are able to support multiple beneficiaries by providing many sources of livelihood, ecosystem services and coastal protection. They are also bring a wealth of resources for the fisheries, forestry and environment government sectors, including the tourism industry. These values help foster and establish the natural roles of mangroves in maintaining and continuing its functional and structural roles that have had multiple benefits over decades of generation. In fact, the loss of mangroves through various forms of degradation have raised concerns to the consequential impacts that would follow as a result of not implementing mitigation measures. The most commonly understood impacts of mangrove removal include demise of food source and livelihood for people residing within and in the vicinity of a mangrove forest; increase in soil erosion and associated flooding; disappearance of natural nurseries and feeding grounds of marine and other aquatic species; depletion in natural sources of carbon sinks; increasing carbon emission.

6.2 Mangrove Forest types

The types of mangrove forest described recognizes the forest classification adopted under the Fiji MESCAL project. The classification of mangrove forest and habitat types is based on the species structural traits - dominance (biomass) and their location (Tuiwawa *et al.* 2013).

[8] https://www.conservation.org/act/share-the-facts-about-mangroves

Mangroves located on the drier side of the islands tend to have a short, dwarfed assemblages of trees that can be found growing in riverine and estuary ecosystems (Cameron *et al.* 2021; Figure 15). This is typical of mangrove communities on the western side of the main island of Viti Levu for instance, mangroves in the Ba delta (Mueller-Dombois and Fosberg, 1998; Conservation International, 2020). Based on their growth form they make up elements of a coastal and fringing mangrove communities with stunted and largely dwarfed mangrove trees, some of which have a distinctive canopy height (Cameron *et al.* 2021; Conservation International, 2020).

Comparably, mangrove communities located on the wetter side of the island tend to have taller tree assemblages that are exposed to regular inundations of daily tide (Cameron *et al*. 2021; Figure 16). These deltaic mangrove community grow to a different canopy height because of the environmental conditions, substrate suitability and vulnerability to disturbances (Cameron *et al.* 2021; Tuiwawa *et al.* 2013). This is typical of the mangrove communities in the Rewa delta on Viti Levu and the Labasa delta on Vanua Levu (Cameron *et al.* 2021).

Listed are the four main forest types that are dominant and present throughout any mangrove system in Fiji. Also highlighted is a brief of how vulnerable each forest type is to the impacts of degradation and mangrove forest loss.

Figure 15: Short and dwarfed *Rhizophora* mangroves are common along the drier parts of Viti Levu

Figure 16: Tall *Rhizophora* and *Bruguiera* tree assemblages across the Rewa delta, Viti Levu

6.2.1 'Back of the Mangrove Forest'

The 'Back of the Mangrove Forest' is often located furthest from the riverbanks or coastlines and lies behind the *Rhizophora* forest, mixed mangrove forest and *Bruguiera* forest (Figure 17). Across the Rewa delta, 'Back of the Mangrove Forest' are estimated to cover over 2000 ha (Tuiwawa *et al*. 2013). The 'Back of the Mangrove Forest' is targeted site of anthropogenic developments such as agriculture farming and road construction. These have resulted in immediate forest and habitats being removed and or destroyed thus resulting to priority areas of concern for rehabilitation, restoration and reforestation (Tuiwawa *et al.* 2013).

Figure 17: 'Back of the Mangrove Forest' across the Rewa delta, Viti Levu

6.2.2 Mixed Forest

The Mixed Forest type does not have a single dominated species and instead is made up of a combination of two or more obligatory mangrove species, including mangrove associates, in Fiji (Tuiwawa *et al.* 2013; Figure 18). Where there is more than 10% each of the species present, the forest is classified a Mixed forest (Tuiwawa *et al.* 2013). Mixed forest is located at the transition zone between the *Rhizophora* forest and *Bruguiera* forest (Tuiwawa *et al.* 2013). Opportunistic observation and surveys have shown that these areas are subjected to hefty development, construction operations and urbanization over the years. They too are a priority area to carry out the rehabilitation and restoration activities due to the destructive effects of these anthropogenic activities.

Figure 18: Example of a Mixed Forest in the Rewa delta, Viti Levu

6.2.3 *Bruguiera* Forest

The *Bruguiera* Forest type consist of a single dominant species, *Bruguiera gymnorrhiza* (Tuiwawa *et al.* 2013; Figure 19). While the forest is a mono-dominated forest, there is evidence of other mangrove species present however these contribute to less than 10% of the relative biomass of the trees in the area (Tuiwawa *et al.* 2013). *Bruguiera* Forest is usually located behind the *Rhizophora* Forest and in some instances, are also observed to occur on the edges of a river or foreshore (Tuiwawa *et al.* 2013). These are vulnerable to dredging activities, road and infrastructure construction and are evident throughout the main islands.

Figure 19: Thickly dense *Bruguiera* forest along the Rewa river, Viti Levu

6.2.4 *Rhizophora* Forest

The *Rhizophora* Forest is made up of two species of *Rhizophora* that are present in Fiji, i.e. *Rhizophora samoensis* and *Rhizophora stylosa* and the one mangrove hybrid known as *Rhizophora x selala* (Tuiwawa *et al.* 2013; Figure 20). This type of forest is always located on the seaward end of any mangrove system (Tuiwawa *et al.* 2013). Like the *Bruguiera* Forest, they too are subjected to the same anthropogenic activities and intensity of development.

Figure 20: *Rhizophora* forest along the Rewa river, Viti Levu

6.3 Species of Mangroves

Mangrove species are informally recognized under three main groups: the Red mangroves; Black mangroves and White mangroves. In brief:

- Red mangroves are made up of all the *Rhizophora* species that can easily be identified by the aerial roots stemming off the tree trunks and branches.

- Black mangroves are the species of *Bruguiera* that have solitary trunk without stilt roots however have prop roots (pneumatophore) protruding from the soil surrounding the tree trunk. Both the red and black mangrove have specialized structures like salt secreting glands in their leaves that is unique to mangrove species (Tomlinson, 2016).

- White mangroves do not have the aerial roots that is conspicuously visible in both the red and black mangroves, yet they are obligatory to mangrove habitat. They are often seen growing sparingly all over the mangrove forest or in pure stands towards the back of the mangrove forest closer towards the inland area.

Outlined in table 2 are some of the obligatory mangrove species that are present in Fiji. The listed species are documented to occur only within the mangrove forest and mangrove habitat types and are not found elsewhere outside boundaries of a mangrove system. These cohort currently comprises a mix of trees and shrubs. A field illustration is provided (Annex 1) to assist with the identification of mangrove species. A few of the associated mangrove species are also listed in table 3.

[9] For ease of use, there are other species that have been excluded from the list. The species listed are the well-known and established group recorded in Fiji.

Table 2: Some of the Obligatory Mangrove species in Fiji

Species[9]	Vernacular Names	Common Names
Rhizophora stylosa Griff	Tiri	Spotted mangrove
Rhizophora samoensis (Hochr) Salvoza	Tiriwai/Tiridina	Red mangrove
Rhizophora x selala (Salvoza) Tomlinson	Selala	Mangrove hybrid
Bruguiera gymnorhiza (L.) Lamk	Dogo	Large leaf orange mangrove
Lumnitzera littorea (Jack) Voigt.	Sagale	Terentum merah, Red teruntum, Red-Flowered Black Mangrove
Heritiera littoralis Dryander	Kedra ivi na yalewa Kalou	Looking glass mangrove
Excoecaria agallocha L.	Sinu, Sinu gaga	Blind-your-eye mangrove, blinding tree, Buta buta tree, milky mangrove, Poison fish tree, and river poison tree
Xylocarpus granatum Koenig	Dabi	Cannonball mangrove, cedar mangrove, or puzzlenut tree

(Source: Tuiwawa *et al.* 2014; Tuiwawa *et al.* 2013; Smith, 1981)

Table 3: Examples of Mangrove Associate species in Fiji

Scientific Name	Vernacular Names	Common Name
Paspalum distichum L.	Kabuto	Knot/swamp grass
Scirpodendron ghaeri (Gaertn.) Merr.	Misimisi, Vulu	Mangrove sedge
Annona glabra L.	Uto ni bulumakau	Custard apple
Inocarpus fagifer (Parkinson ex F.A. Zorn) Fosberg.	Ivi	Tahitian chestnut
Derris trifoliata Lour.	Duva	Common derris
Barringtonia asiatica (L.) Kurtz.	Vutu rakaraka	Fish poison tree
Barringtonia racemosa (L.) Spreng	Vutu wai	Fish poison tree, Freshwater mangrove tree, Fish killer tree
Pandanus spp.	Vadra, Voivoi	Pandanus
Entada phaseoloides (L.) Merr.	Walai	Box bean, St. Thomas' bean
Cocos nucifera L.	Niu	Coconut

(Source: Tuiwawa *et al.* 2014; Tuiwawa *et al.* 2013; Smith, 1981)

[9] For ease of use, there are other species that have been excluded from the list. The species listed are the well-known and established group recorded in Fiji.

7 Guide to Restore Healthy Mangroves

7.1 Rationale to Restore Mangroves

Simply put, the concepts of mangrove restoration is intended to support the conservation and landscaping of mangrove areas; to promote the multiple use of the system for high sustainable yields and to protect the coastlines (Field, 1999). The idea is implemented through the selection of mangrove planting and techniques for regenerating mangroves (Field, 1999) that will eventually restore the altered conditions and situation of an area to its initial and original form and status, prior to its degraded state. The idea behind restoration efforts is defined as putting something, that has been compromised or damaged, back to its former condition (Field, 1999). It is through this implementation concept and process that restoration is perceived a form of management strategy that compensates for the degraded and loss of ecosystem structure and function (Field, 1999). These concepts and interventions are considered for sites that have undergone large scaled anthropogenic forms of degradation.

7.1.1 Mangrove Rehabilitation and Restoration

Mangrove rehabilitation and restoration efforts are essentially an approach to retract the degraded state of a mangrove ecosystem to its former or even natural status where it is able to carry on its multi-function and benefits (UNEP, 2020; Field, 1999). The products of success is measured in the protection in the coastline functions, enhancing the productivity of the fisheries and biodiversity sources, increase and sustain mangrove resources, as well supporting the livelihood of the local population (UNEP, 2020; Field 1999). In the planning, implementation, monitoring and evaluation phases, it is important to remember that mere efforts alone cannot succeed on technical involvement (UNEP, 2020). Cases in the past have been documented to show project failures stemming from (UNEP, 2020):

- the lack of community engagement and involvement;
- poor governance infrastructure and management;
- unclear objectives;
- the lack of basic understanding in mangrove ecology;
- the unfamiliarity of not knowing the normal hydrology of existing natural mangrove communities.

Rehabilitation and restoration initiatives are implemented through regeneration techniques involving natural regeneration and or direct planting and replanting of seedlings as well as propagules (UNEP, 2020).

7.1.2 Sites to consider

Mangrove restoration is necessary where there is evidence of mangrove degradation and deforestation (Figure 21). These are sites where secondary forest system are evident to the extent where there is evidence of high disturbances sustained from natural disasters, human habitation, agricultural practices and other anthropogenic activities (Tuiwawa *et al.* 2013). Degradation is especially common at the 'Back of the Mangrove Forest' with pockets to significant extent of occurrences also evident across the other types of mangrove forest. The types of intervention required, and the areas affected also need to be known and understood early on in the inception phase. Refer to Glossary (see Annex 2) for terms to know and understand in the conception stages of these interventions.

The definition of these interventions (reforestation, rehabilitation, restoration and afforestation) are important to understand from inception/planning phase to avoid potential mishaps of not using the appropriate planting approach. Unplanned interventions can end up potentially more problematic in damaging other types of habitats, than initially intended (Watling, 2021). Illustrated, in Figure 21, is a schematic representation (from Schmitt and Duke (2015)) that outlines historical analysis of mangrove planting.

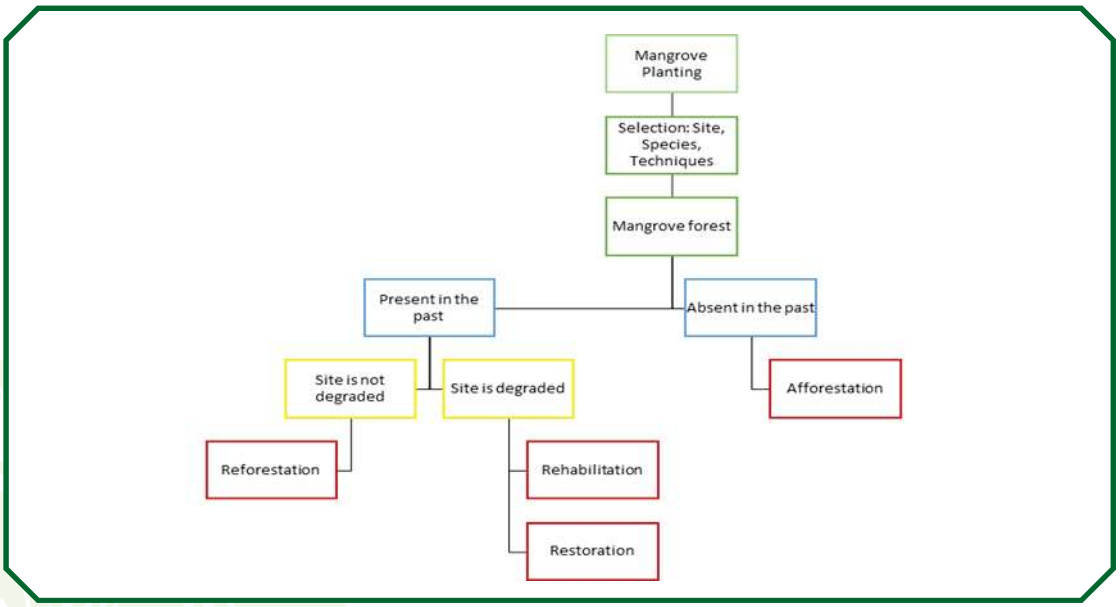


Figure 21: A roadmap to the types of tree planting intervention for mangrove management and conservation

The roadmap provides a navigation/process on the options to the types of conservation interventions appropriate to adopt and use taking into consideration the historical changes of affected sites. This may be useful to guide not only community stakeholders but planting initiatives and framework along the urban and peri-urban areas as well.

7.1.3 Planting Techniques

Planting practices is useful as an assisting or enriching mechanism to support the natural regeneration process. This, however, is only possible under the right environmental conditions (Numbere, 2021):

- accessibility of a hydro-channel or waterway to ensure the smooth inflow and outflow of river water carrying seeds;
- availability of a parent mangrove forest or stock to supply the seeds;
- availability to the right soil conditions to enable seedling germination and growth.

Watling (2021) provides a guiding list for mangrove planting which is recommended in the initial concept of thought, consultation and discussions prior to any on the ground planting activity:

- Planting should only be attempted in areas that naturally support mangroves and not in areas where mangroves are not known to have grown;
- Planting mangroves should not be undertaken in isolation but only after a full appreciation of the risk of any potential planting site in terms of hazard, exposure, and vulnerability;
- Planting in areas which never had natural mangroves may destroy other, equally important ecosystems such as sea grass beds and sub-surface invertebrate life, and a productive habitat for foragers - inshore marine fishery and migrating shorebirds;
- Local community involvement in planting initiatives should be through informed consent, equitable benefit and an understanding of mangrove planting rationale, potential and constraints, is an essential pre-requisite for planting projects;
- Damaged mangroves will usually regenerate naturally over time if left undisturbed;
- Planting is never as successful as natural regeneration. Wherever possible facilitate natural regeneration of mangrove systems.

It is also important to note the differences in the terms 'Planting' and 'Replanting' (see Annex 2). These are often synonymously used to express and relay the message of sowing seedlings for regenerating purposes. These, however, are two different terms that reflect the different stages of the plant itself prior to sowing. The following practices are key to the rapid expansion of mangroves, as they complement these recommended intervention for regenerating mangroves:

- Natural regeneration
- Artificial regeneration

7.1.3.1 Natural regeneration

This technique relies on the natural course of nature for propagules to replenish mangrove sites that have been severely impacted and even destroyed (UNEP, 2020). In this situation, the propagules are sourced either from what is left of the parent stock of the mangrove forest or from the adjacent forest where there is absolute reliance on the free-falling propagules to sow itself on the immediate mudflat and revegetate (UNEP, 2020; Figure 22).

Figure 22: Natural regeneration of *Rhizophora* forest, Rewa delta, Viti Levu

As a guiding framework, the advantages and disadvantages of adopting natural regeneration approach is listed in Figure 23 (UNEP (2020)). If regeneration of propagules is not evident after a certain time frame, then mangrove reforestation by means of direct planting of propagules is appropriate (UNEP, 2020). The propagules can either be sourced from nursery or collection from the mangrove forest (UNEP, 2020; Watling, 2021; see Section 7.2).

Advantages	Disadvantages
Cheaper to establish	Replacement may not be of the same species removed
Less subsidy is needed in terms of labour and machinery	Absence of mother trees may result in low/ or no propagule supply
Less soil disturbance	Genetically improved stock may not be easily introduced
Saplings establish more vigorously	Excessive wave action may cause poor establishment
Origin of seed sources usually known	Predation of propagules by macrobenthos
A naturally restored stand acquires site characteristics that are almost like the original forests	Less control over spacing, initial stocking and composition of seedlings
	May lead to loss of community employment

Figure 23: Advantages and Disadvantages of Natural Regeneration

7.1.3.2 Artificial regeneration

Artificial regeneration is by the far the most commonly adopted method of mangrove restoration. It is popularly used and recognized worldwide. The technique involves the use of propagules from the nursery for replanting selected species at a site (UNEP, 2020; Figure 24).

Figure 24: Artificial regeneration technique - (left) Transplanting mangrove seedlings for replanting; (right) planting mangrove propagules into polybags in a mangrove nursery

It is a much more controlled approach, and the success rate is dependent on the physical and ecological parameters of the site. More importantly, the normal hydrology pathway of the area being restored (UNEP, 2020) is a critical factor that will determine level of success in artificial regeneration. To some extent, it does support communal involvement and ownership of the replanted stock especially when replanting is undertaken on a large-scale operation. A list of the pros and cons of opting the artificial regeneration approach is outlined in Figure 25 (UNEP (2020)).

Advantages	Disadvantages
Promotes community employment during nursery establishment and out-planting	Direct planting of mangroves can be expensive particularly in areas where hydrological regime has been modified
Species composition and distribution can be controlled	May lead to introduction of wrong species
Genetically improved stocks can be introduced	Long-term loss of ecological productivity as evidenced by simplification of the systems from mixed to monoculture plantations.
Pest infestation can be controlled	Monoculture plantations may promote pest infestation
The established nurseries can be used for training	Nurseries may be affected by diseases and stress due to poor management
	Mangrove planting may lead to community disputes particularly when not fully involved

Figure 25: Advantages and Disadvantages of Artificial Restoration

7.2 Step by step actions

The basis of having a step-by-step action is to have a logical framework that will guide planning prior to any implementation activities (UNEP, 2020; Figure 26).

The process outlined in Figure 26 will ensure clear expectation of the outcome and a basis for evaluating the success and failure of the overall initiative. Each phase is made up of steps that could mildly vary at different geographic location of each targeted site (UNEP, 2020; Watling 2021). Each phase has its own action steps that needs to be carefully considered for every chance of success while also keeping in mind the conditions to avoid for every chance of failure (UNEP, 2020).

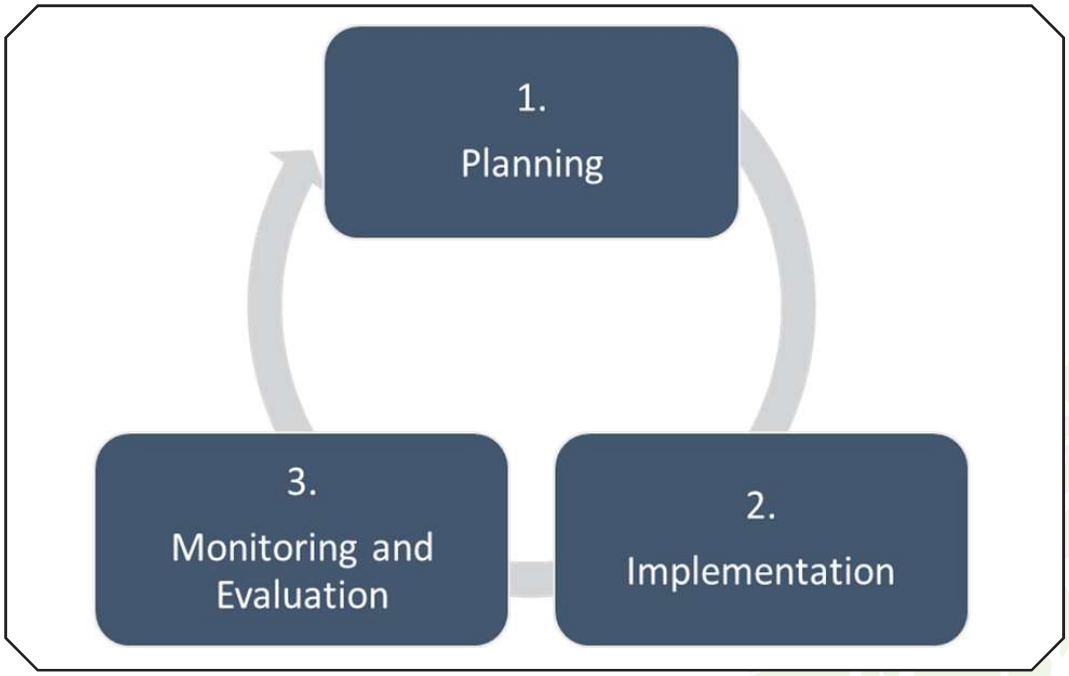


Figure 26: Technical phases for Rehabilitation and Restoration work

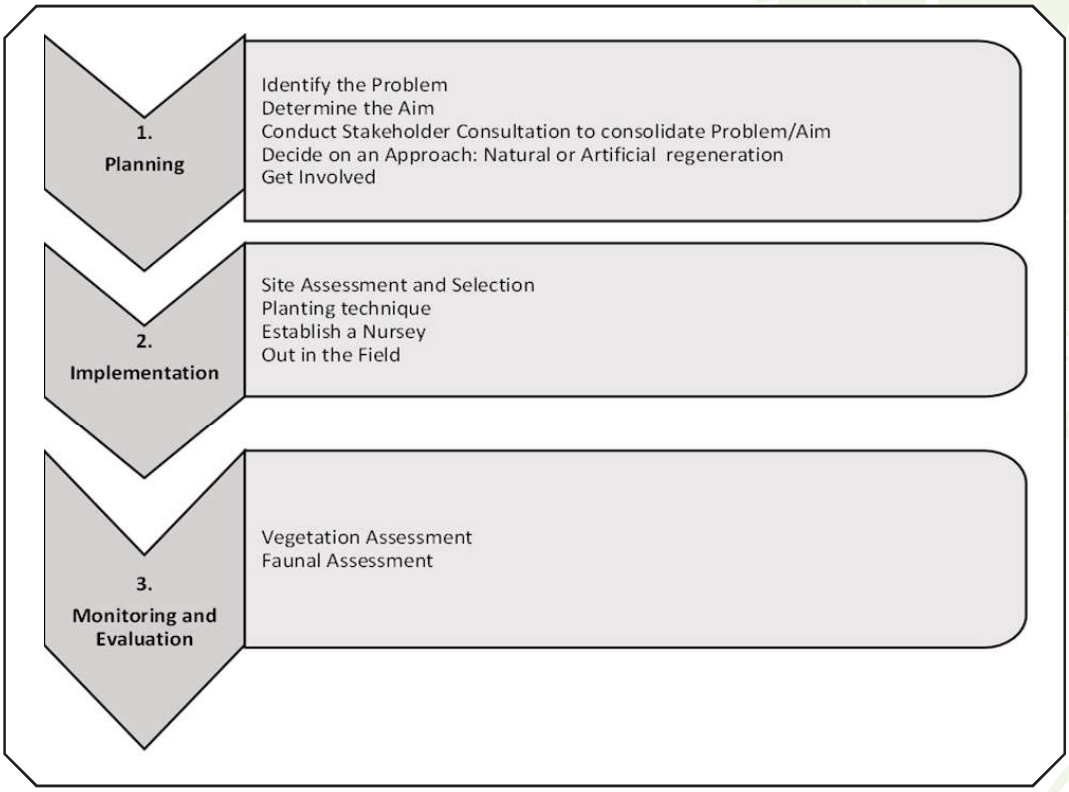


Figure 27: Step by step actions at different phases of the project

7.2.1 Planning Phase

7.2.1.1 Identify the problem

Problem identification focuses on recognizing and establishing that there are issues that requires an intervention at the mangrove site. In acknowledging problem/gaps in mangrove health, those affected will identify and appreciate the need to take some form of action at least to restore those resources and infrastructure that support sources of livelihood, protection, and survival (UNEP, 2020). In instances where the concept of mangrove degradation and mangrove loss, is new and foreign, the planning phase creates an opportunity for out-reach and engagement for awareness between communities, stakeholders in the government and non-government organizations (NGOs) and other relevant institutions (UNEP, 2020).

This step is important and sometimes overlooked but it is crucial enough to know as an available option that would ensure having a better sense of value and appreciation of the problems associated with mangroves and decide whether there is an actual need to undertake step by step action (UNEP, 2020). Important questions that stakeholders at community level need to take into consideration (adapted from UNEP (2020)) are listed as follows:

- Should we plant or not plant at the affected sites?
- Is there potential for natural regeneration or artificial intervention?
- What resources are needed to carry out restoration?
- Who should we consult or be involved in the restoration efforts?

7.2.1.2 Determine the aim of the work

This step involves determining the course of appropriate action to take towards addressing efforts of an intervention. In clearly identifying the aim of these efforts, it is imperative that the messages and lessons are clearly communicated, understood, and accepted by all members of the community as well as other stakeholders that may or may not be directly involved at the community consultation. The process of formulating what the aim is or should be is important enough to also reflect local and or national priorities to ensure concerted alignments and efforts by both the community members and external party (e.g. public and private stakeholders). It is one way to avoid the difficulties of evaluating the progress and outcomes of projects at the project level and even at the national scale (UNEP, 2020). Communities together with the institution stakeholders are advised to develop objective goals in alignment towards global rehabilitation and restoration goals. A few examples of these goals adapted from UNEP (2020) are listed below:

- Enhancement of natural regeneration, biodiversity, and ecological restoration;
- Sustained yield of both wood and non-wood forest products - poles, timber, and charcoal;
- Coastal protection, erosion control and channel stabilization of lagoons and estuaries;
- Support to fisheries resilience and enhancement.

7.2.1.3 Secure stakeholder consultation

Consultation needs to include a wide range of stakeholders each with their own capacities of expertise, knowledge and experience on rehabilitation and restoration of mangrove systems. It is to the benefit of all stakeholders involved that they are familiar with existing governance, institutional and legal frameworks, as well as mangrove infrastructure and administration at the national level (see Section 3, 4, 5). Some of the basic yet important questions stakeholders are to be asking (UNEP, 2020) at the consultation phase include:

- Who are the other stakeholders, apart from community stakeholders?
- Who benefits from mangrove resources and who is responsible for looking after mangroves?
- Do we have any legal rights in restoring degraded mangrove sites? What are those rights? Who do we consult to validate those rights?

7.2.1.4 Decide on the approach

In deciding which approach to implement, it is necessary and advised that collaboration amongst potential collaborators and project partners are identified, established and formalized. This step of engagement is critical because of the technical nature of the techniques, as well as the course of action to take as the way forward. These are required to ensure a successful outcome is achieved. Stakeholders may comprise the Ministry of Forestry, University of the South Pacific, Conservation International and other NGOs that share similar interests (see Section 3).

It is important to note, that while planting and replanting techniques maybe specific to respective institutions, the

options explained are widely accepted concepts that are being used to expand existing mangrove stands.

7.2.1.4.1 Natural regeneration

This is an effective technique that protects the mangrove area from the original stress and allows natural regeneration to occur. This may mean prohibiting human usage of the degraded mangrove area for a period of not less than 5 years (Ellison and Fiu, 2010).

In the natural course of natural regeneration:

1. Mangroves discharges the propagules;
2. Propagules get dispersed and can survive for months on end;
3. Propagules come to an appropriate location;
4. Propagule gets attached to the soil substrate;
5. Under the right conditions, propagule regenerates into a new plant.

The advantages of natural regeneration are that the resultant mangrove forest tends to be more natural, and it is less labour intensive (Ellison and Fiu, 2010).

7.2.1.4.2 Artificial regeneration

This involves active planting of seedlings in areas that are too degraded for natural regeneration to occur. The seedlings can be obtained either from wild sources elsewhere (wilding transplant) or they can be raised in a mangrove nursery (Ellison and Fiu, 2010; Figure 24, 28, 35).

When adopting this technique for regenerating mangrove seedlings and native trees seedlings, it is advised that familiarization of the following steps are carried out:

- Process of establishing planting and replanting techniques is carried out
- Source materials are identified
- Procedures for implementation when out in the field is carried through

7.2.1.5 Involve Community

In formulating the phases, steps, and actions, it is so important that the needs and interests of the local community is included and safeguarded, and if possible, addressed in the duration of the project. UNEP (2020) lists some important issues that must be considered in bringing in and addressing community interests (Figure 28). These include:

- Community perceptions and understanding on the comparative benefits of conversion to other uses versus maintenance of intact mangrove forest;
- Legal recognition of the mangrove resources in terms of rights to access and use; and
- Land use governance defined by the institutional, economic, socio-cultural dynamics.

Figure 28: Preparation of mangrove seedlings raised in a mangrove nursery for replanting

7.2.2 Implementing Phase

Implementing activities need to be effective in order to observe the successful outcomes of the initiative (UNEP, 2020). This means projecting plausible scenarios of all possible outcomes and assessing the capacity of the support system in place to see the activities through to the end (UNEP, 2020).

Prior to any implementing steps, the designated sites to be investigated to meet all criterion of a degraded site that only then can affirms the need and requirements of an intervention. Some of the questions (UNEP, 2020) that communities should consider at this phase are:

- What types of information is required or needs to be gathered that would help with steps of implementing restoration actions?
- What are the species or types of plants that we can use for restoration and where do I/we get them from?
- How can we restore mangroves that have been lost? What should we do? Are we familiar with the techniques of artificial and natural regeneration? Who can give us advice on this?

7.2.2.1 Site assessment and selection

It is not unexpected that communities are likely to want to participate in sites that lie within their own localities or communal boundaries. The four listed activities are step by step action to undertake when assessing the selection of sites at the community level and the steps that communities can also take on as part of the site assessment process. These however, will require verification through consultation with the technical arm of the collaborating institution/ organization (see Section 3.1 and 3.6):

Figure 29: Consultation with communities at the ITTO project inception workshop

7.2.2.1.1 Land-use mapping

This activity is a learning ground for both communities and corroborating partners. It is a consultation platform where there is an exchange in dialogues, information, knowledge and opinions about the resources available. Some key questions (UNEP (2020)) to consider in the discussions include:

- What resources are abundant or scarce?
- Does everyone have equal access to land?
- Who makes decision on land allocation?
- Where do people go to collect water and who collects water?
- What fuel do people use and where people go to collect firewood/fuel from?
- Who collects fuelwood/fuel?
- Which resource do you have the most problem with?

Figure 30: Landuse mapping exercise with the communities

In the process, participants are tasked into smaller manageable groups to develop the content of mapping out resources, landmarks and other areas that has some consideration of importance, in the least, within the communal boundaries. Upon regrouping, these findings are then shared in a form of presentation along with other participating groups (Figure 30).

7.2.2.1.2 Transect walk

This is another tool that is used for describing and showing the location and distribution of resources, features, landscapes, landmark areas from the community perspective (Figure 31).

Figure 31: Transect walk with members of the community

It is an opportunity to identify and explain the relationship between topography, soils, natural vegetation, cultivation and other production activities, human settlement, identifying problem sites, natural resources, present land use, vegetation, changes in physical features and cropping systems. This is where members of the communities are given the opportunity to walk through communal land and talk about the significance and distribution of their resources (Figure 31). In the process, they will be able to confirm and validate the different features and stations highlighted in the land-use mapping exercise.

The impact of this activity is very important when it comes to the broader discussions of site. Discussion would include species preference and agreed selection for the purposes of planting, simply because in the very least, consulting individuals will have had some prior idea of where species should most likely be planted/replanted with some successful measurable outcomes.

7.2.2.1.3 Locating Site Areas

Degradation within and along the peripherals of the four mangrove forest types (see Section 7), are the most suitable areas to carry out planting and or replanting of mangrove propagules/saplings and seedlings (Tuiwawa *et al.* 2013). It is important to plant species according to its natural habitation. For instance:

- **'Back of the Mangrove Forest':** The forest comprises of secondary succession species such as marasa *(Elattostachys falcata)*, kura *(Morinda citrifolia)*, vau *(Hibiscus tiliaceus)*, coconut *(Cocos nucifera)* including some introduced species such as uto ni bulumakau *(Annona glabra)*, mango *(Mangifera indica)* and uto *(Artocarpus altilis)* (Tuiwawa *et al*. 2013). It is often located furthest from the riverbanks or coastlines (Tuiwawa *et al.* 2013). When planting or replanting, it is suggested that a recovery and enrichment intervention program be implemented that would rehabilitate the degraded habitats through reforestation of selected species (Tuiwawa *et al.* 2013).

- **Mixed Forest:** The forest comprises of a mix of species of both the *Bruguiera* and *Rhizophora* and the other obligatory mangrove species i.e. *Xylocarpus granatum*, *Heritiera littoralis*, *Excoecaria agallocha*, *Lumnitzera littorea*. It is located at the transition zone between 'Back of the Mangrove Forest' and the *Bruguiera* and *Rhizophora* forest (Tuiwawa *et al.* 2013). When planting or replanting, saplings to anyone of the species mentioned is recommended.

- ***Bruguiera* Forest:** usually located behind the *Rhizophora* forest and in some instance, they are also observed to occur on the edges of a river or foreshore. This forest comprises solely of the species *Bruguiera gymnorrhiza*. When planting and or replanting, only the saplings and seedling of the species, *B. gymnorrhiza*, is recommended for rehabilitating and restoring this type of forest.

- ***Rhizophora* Forest:** located on the seaward end of any mangrove system and comprises of the two species and the one hybrid of *Rhizophora* found in Fiji. The species to use when restoring and rehabilitating this forest types are the saplings and seedlings of *Rhizophora samoensis* and *Rhizophora stylosa.*

Figure 32: Pre-assessment of degraded Mangrove forest

Pre-assessment of each site in the context of the four mangrove forest types are to feature any one of these combination criteria (UNEP, 2020), if not all of the following conditions:

- Evidence of habitat loss and fragmentation;
- Forest is degraded, has low forest canopy cover;
- Presence of an existing or parental mangrove stand with active hydrological system;
- Poor vegetation cover and plant composition;
- Area is aerially detected as a gap or discontinuity in forest cover in the mangrove system. Such images can be sighted on Google Earth (Figure 33).

Figure 33: Aerial image showing gaps incurred from the effects of Tropical Cyclone in 2017 on Viti Levu Bay, province of Ra, Viti Levu

7.2.2.1.4 Informed Consent and Technical Consultation

Community stakeholder must seek consultation of technical expertise within the public sector (e.g. Ministry of Forestry, Ministry of Lands & Mineral Resources, Ministry of Fisheries, University of the South Pacific) prior to affirming sites for rehabilitation and restoration (Figure 34). These public offices are legally mandated to provide technical assistance and legal advice as project partners and or collaborators in moving the initiative forward. Given that mangroves are state owned, consent for site access must be obtained through the Ministry of Lands & Mineral Resource while advice on planting and rehabilitation techniques are best sourced through the Ministry of Forestry (see section 3.1 and 3.6).

Figure 34: ITTO project steering committee comprising of technical expertise from the University of the South Pacific, Conservation International, Ministry of Forestry and other stakeholders

7.2.2.2 Planting and Replanting technique

7.2.2.2.1 Mangroves

These techniques in principle are applicable to undertaking reforestation, rehabilitation and restoration interventions. Here the techniques referenced are from the Fiji ITTO project that used Ellison and Fiu (2010) approach as a guiding reference:

7.2.2.2.1.1 Propagule/ Seed planting

This involves active planting of mature seeds in areas that are too degraded for natural regeneration to occur due mostly to lack of suitable propagules.

On site:

- Propagules are planted at 1m x 1m spacing and in each planting pad, 3 mangrove propagules/seeds are planted to increase the chances of survival;
- Seeds or *Rhizophora* and *Bruguiera* can be planted by inserting the tip into the mud, so that 1/3 to 1/2 of the propagule length is buried. This must be done gently;
- Seed planting can only be done soon after the fruiting season, and mangrove seeds/propagules cannot be stored for long.

7.2.2.2.1.2 Seedling planting

This involves active planting of seedlings in areas that are too degraded for natural regeneration to occur.

- Generally, the seedlings can be planted at 1m x 1m apart. Spacing proximity of seedlings for replanting are to be advised by the Ministry of Forestry and or other technical expertise;
- Seedlings can be obtained either from wild sources elsewhere (wilding transplanting) or it can be raised in a mangrove nursery;
- Seedlings are to be taken gently out of potting bags and planted during low tide.

7.2.2.2.1.3 Propagule/Seed Collection

Propagules/seeds can either be collected from the tree, or beneath the tree. Seeds are usually in better condition if collected from the tree, with less physical damage or insect/ fungal infestation. They must be unblemished, free from insect attack, and handled carefully in transit. The seeds must not be allowed to dry out but kept in moist conditions. The ideal condition will ensure good growth and makes them vulnerable to insect or fungal attack. It is best to transport and store them in small horizontal bundles covered with banana leaves/ palm fronds or sacking. Commonly woven coconut baskets can also be used in Fiji.

Seeds for direct planting or raising in nurseries must only be undertaken when the seeds are ripe, which in Fiji is during late summer (January-March). If seeds are collected too young, they will not germinate (Hong, 1996). The following notes must be considered carefully:

- *Rhizophora*/*Bruguiera* seeds must be handled gently;
- *Rhizophora* and *Bruguiera* seeds are viviparous (already germinated) so have to be replanted within a few weeks. They cannot be dried and stored like normal seeds, they do not remain viable because they are already germinated before they leave the parent tree. This is adaptation mangroves have to their wet and saline habitat;
- *Excoecaria* seeds are not viviparous, and several occur in each fruit. The seeds retain their viability for about a month, and can either be sown directly onto suitable areas, or raised in nurseries. *Excoecaria* seeds should fall in late summer and can be collected from the mangrove mud surface beneath the parent trees. They are <1 cm in size, a fused 3 seeded pod.

7.2.2.2.1.4 Wilding collection and transplanting

Mangrove seedlings for replanting can be collected from large, mature mangrove ecosystems where natural regeneration is occurring. The mangrove mud must be firm, and seedlings can only be taken from within the mangrove forest. Sediment is removed with the seedling, so in a narrow, degraded or sea margin source site then erosion and degradation of the source area may occur.

- Seedlings chosen for transplanting should be 0.5-0.8 m tall, with a straight trunk, an intact growing tip. Each seedling should have several leaf pairs;
- Seedlings, with over 15 leaf scars on the trunk should be avoided as they already developed prop roots or side branches. Older seedlings are less likely to survive transplanting, probably due to root disturbance (Hamilton and Snedaker 1984);
- Seedling collection is best done at low tide.

A simple technique involves removal of seedlings using a length of 100 cm diameter PVC pipe. The PVC pipe is slid over the seedling and cut into the mud around the seedling and pushed to 20-25 cm depth. The PVC pipe is twisted and the seedling with a plug of sediment removed from the ground. A little water poured down the pipe, and shaking, will remove the plug out of the corer. During transportation the seedling plug should be protected from drying out and exposure to direct wind drafts must be avoided.

7.2.2.2.2 Native Species

The planting and or replanting of native tree species is intended for the back of the mangrove forest and the immediate vicinity of the lowland habitat area (Tuiwawa *et al.* 2013). Targeted species include: Fruit trees such as Breadfruit *(Artocarpus altilis)*, Rose Apple *(Syzygium jambos)*, Dawa *(Pommetia pinnata)*, Kumquat *(Citrus japonica)*, Soursop *(Annona muricata)*, Thailand Guava *(Psidium guajava)*; Native Species that occur in these habitats include sandalwood *(Santalum yasi)*; Coastal Species include Coconut *(Cocos nucifera)*, Beach Almond Tree *(Terminalia catappa)*, *Acacia spp*., *Calliandra calothyrsus* (Tuiwawa *et al.* 2013; Ramulo pers. comm.).

Stakeholders are advised to seek consultation with the Ministry of Forestry regarding the selection of tree species to plant as well as the potential sources of planting materials. The process of tree seed collection, in the sections below, is adapted from the Fiji ITTO project.

7.2.2.2.2.1 Tree Seed Collection

Seed collection is to be carried out during the fruiting season. Seeds can be collected and stored in a temporary bamboo thatched nursery before germinating. Communities can be trained through series of workshops to be able to identify different trees, flowering and fruits to be collected for germination. This training can be carried out by the Ministry of Forestry in collaboration with the University of the South Pacific.

7.2.2.2.2.1.1 Pre-Treatment

Seeds of some native species usually need to go through a pre-treatment process after collection to help catalyze the germination process. The Ministry of Forestry can provide appropriate technical advice to local communities on species pre-treatment requirements.

7.2.2.2.2.1.2 Seed Germination

- Using a seed tray or old containers, spread moist germination soil evenly in the tray and spread seeds (evenly) over the surface area of the seed tray using your hand;
- Ensure that seeds are spaced apart about 5mm from each other;
- Bury the seeds with the germination soil/potting mixture and water the seed box after sowing. Soil must be kept moist at all times;

- Seed trays must be labeled with date and species;
- Generally, the seeds will need to be transplanted to potting bags once three-four leaves sprout from the seeds;
- Seedlings may be kept in the nursery up to nine months before they are ready to be transplanted to a permanent spot to grow.

7.2.2.2.2.2 Planting of Seedlings

This is the process of actually planting seedlings in the soil to revegetate. There are 4 main steps: Polling, Line Cutting, Planting pit also known as hole digging, and planting of seedlings.

7.2.2.2.2.2.1 Poling

Poling is carried out after selecting and demarcating the boundary for the planting areas.

- Collection of poles (stick) about 1.5m in height and depending on the selected spacing.
- Generally, native species are planted at 9m x 4m
- Pine species are planted at 3m x 3m
- Mahogany, Fruit Trees, Fuel wood are planted at 6m x 6m
- Teak and Sandalwood are planted at 4m x 4m
- Baseline of the polling is set in the direction of the sunrise and sunset (east to west directions).

7.2.2.2.2.2.2 Line Cutting

Planting lines are set at 1m on either side of the lines poled. The current pattern of line clearing will permit a clearing of 2 meter within the plot. Poling and line cutting must be done in one operation and is less complex in mangrove systems.

7.2.2.2.2.2.3 Planting pit/Hole digging

Pit digging is the first pre-planting soil preparation work.

- Pits of size 20 x 20 x 20 cm should be dug in the proposed planting spot;
- Post hole spade/shovel should be used to dig holes. Alternatively, PVC pipe can be used to project the propagule into the planting spot.

7.2.2.2.2.2.4 Seedling Planting

- The hole should be big enough (size 20 x 20 x 20 cm) to accommodate the earth ball around the seedling root in potted mangrove seedlings;
- The potting material (polyethylene bag) is removed carefully so that the earth clod is not broken, and roots are not exposed;
- The soil around the root ball is then gently pressed for compaction;
- Care should be exercised to ensure that the seedling is planted perpendicular to the ground, not leaning to any side. Polyethene bags must be disposed carefully.

Three months after planting the seedlings, the survival rate of the seedlings must exceed 70-80%. If it is lesser than this, the land-owning agency may re-plant dead seedlings.

7.2.2.3 Establish a nursery

A nursery establishment is where plant seedlings are propagated and grown to an expected size for transplantation (Figure 34). The steps described below are sourced from the Fiji ITTO project, under the Ministry of Forestry.

7.2.2.3.1 Nursery set-up

A simple cost-effective community nursery is practical and recommended. This can be constructed from materials available near the village. They can be dismantled when all the seedlings are transplanted into the field (Tuiwawa *et al.* 2009). Materials needed include Walai (rope)[10]; Potting bags; Watering can; Labels or tags; Cane knife; Spade; Bamboo; Fork; and Shading materials (tree branches, coconut palm leaves). See Figure 35, 36.

Figure 35: Nursery establishment for housing seedlings

These factors are important to consider when deciding the location of the nursery (Tuiwawa *et al.* 2009):

- Must be close to a water source e.g. stream, tap water, river;
- Suitable potting soil should be available close to the nursery;
- Should be sheltered from strong winds which could dry out the plants and the soil;
- Should receive sunlight for the major part of the day;
- Close proximity to planting area.

[10] Alternative to potting bags can be old plastic bags, milk cartons, bottom half of water bottles with holes punched at the bottom to enable the direct drainage of water

Figure 36: Setting up a nursery using readily available materials, Rewa delta, Viti Levu

7.2.2.3.1.1 Temporary Nursery

In establishing a temporary thatched bamboo nursery, these are the steps used by the Fiji ITTO project (Ramulo pers. comm.):

1. Establish the availability of land areas with enough space to surround the nursery;

2. For a 6m x 8m nursery, erect nine bamboo stands. These will make up the outer frame of the nursery. There should be indents at the open, upper ends of each bamboo stand to allow for fitting of bamboo for roofing frames. This nursery size is estimated to facilitate about 1000 potted plants. (Note: the height and specific measurements of this nursery will be entirely your decision to make and will be dependent on the scale of the planting programme you are aiming at);

3. For roofing frames, fit bamboo stands along and across the open, upper ends erected frames of the nursery;

4. At the bamboo joints, "Walai" is then bound around to secure the joints. Additional bamboo strips (sliced in half) are lined across the frame of the nursery for temporary shading;

5. Coconut fronds are placed above the bamboo shelter for added shade effect;

6. To create shelving for the potted plants, bamboo cut into 1.5m lengths are placed linearly about one metre from the left outer frame of the nursery. Two long bamboo stands are then placed to fit perpendicular to the 1.5m bamboo lengths for the shelve frames. "Walai" is wound around the bamboo joints for security;

7. Cut bamboo into 1.2m lengths and split these into two halves. Align bamboo strips across the shelving frame. Use "Walai" to secure each bamboo strip to the frame;

8. Place two long bamboo stands on either side of the completed shelf stands and secure with "Walai" to the shelf frame. This will prevent the potted bags from falling over the side of the shelves.

7.2.2.3.1.2 Permanent Nursery

For a permanent nursery, use all the materials for the construction for building a temporary nursery frame and cover with 70-75% shylon shade. Shylon shades assemble rainforest understory suitable for forest trees and protects the seedlings from the high heat during dry season (Ramulo pers. comm.).

7.2.2.3.1.3 Raising and Prepping Seedlings

The next step is preparing the soil mixture that is to be filled into the potting bags in which seedlings will be planted (Figure 37). These are the steps used by the Fiji ITTO project:

- Mix six parts of humus-rich soil, 4 parts of forest floor topsoil (sandy loam), one part of fine river sand and 250 grams of NPK fertilizer. An alternative to NPK fertilizer that can be used is compost material.

- The humus-rich soil is the thin layer of topsoil found under trees in the forests. Adding humus to the potting mixture will enable it to hold moisture over a long time. It also improves the nutrition capacity of the mixture. The topsoil has most of the nutrients for the plants and must neither be too porous nor too sandy. Sand will allow for the drainage of water.

Figure 37: Example of seed germination beds

Transplanting: When the seeds have germinated and produced their first pair of leaves, use the same method of transplanting for wildings. Seedlings are transferred from seedling trays to potting bags filled with germination soil and placed in a potting nursery (see Figure 37).

Figure 38: Example of potting sheds

Hardening-Off: This is the process of gradually exposing the plants to outside conditions to get them used to the harsh climatic conditions. Between 4-6 weeks after transplanting, remove part of the shade so that the plants receive more light. Completely remove shade within the period of one month. Cut down on watering from twice a day to once a day. Seedlings should now be ready for planting in the field. See Figure 39.

Figure 39: Hardening of germination beds

7.2.2.3.2 Filling pots/Potting

For most species, raising seedlings in polybags is most appropriate.

To ensure maximum germination percentage and survival of potted seedlings, the following should be considered (UNEP, 2020; Figure 40):

- Fill potting bags with soft clayey mud from the mangrove forest;
- Avoid water stagnating on the top of the pot by filling the soil firmly to the bream;
- Allow the pots to harden;
- The pots should be arranged in a dug-through such that at least ¾ of the height of the bags is below the ground level. This ensures that moisture is preserved;
- Proper drainage to ensure no water stagnation within the nursery bed.

Figure 40: Soil mix filling in the potting bags

7.2.2.4 Out in the field

Planting can be done merely by digging a hole, taking the plastic bag off, and placing the seedling in the hole. It is very important that the mud level in the polythene bag becomes the same level as the mud in the mangrove swamp - if the seedling is buried deeper it will die (Ellison, 1999b). In loose substrates footprints are easily used for making a hole, digging tools are rarely necessary in the mangrove environment (Ellison and Fiu, 2010; Ellison, 1999b). Seedlings should be clumped in open areas at 1m intervals, as this provides mutual protection (Ellison and Fiu, 2010).

Figure 41: Replanting of *Rhizophora* seedlings (tiri) from the nursery shed onto the inter-tidal mudflats area, Taveuni

Basic instructions for practitioners when out in the field planting (Ellison and Fiu, 2010; Figure 42):

- Understand why natural regeneration is not occurring or is not sufficient;
- Imitate nature as close as possible by planting close to where that species is naturally occurring;
- Try planting two or three propagules or seedlings close together in clumps or groups;
- Space out mangrove sampling and do not plant mangroves too densely covering the entire area as this will restrict the opportunity for natural regeneration and higher biodiversity;
- Plant as many species as how they are naturally occurring on your site;
- Do not plant in any water channels, seagrass beds, mudflats, or on the raised sand flats;
- Plant seedlings and propagules collected as close as possible to the restoration site.

Figure 42: Field planting mangrove seedlings, Taveuni

7.2.3 Monitoring and Evaluation Phase

Monitoring and Evaluating (M&E) phase is crucial to determining the level of progress towards either the success or failure of the entire rehabilitation and restoration efforts. This has to be incorporated as some form of indicator (e.g. survival rate, growth rate over certain time period) perhaps in the initial inception stage of the planning.

As part of the M&E phase, communities and stakeholders alike need to be informed and be made aware of the reasons why restoration may or may not be successful. This is often difficult to assess and measure because of the amount of time that is required to measure the outcomes of the activities involved. In most cases, it takes at least a couple of months to see actual outcomes of progress and in attempts to avoid unsuccessful mishaps, evaluators have to be aware of the possible reasons why intervention efforts sometimes is not successful.

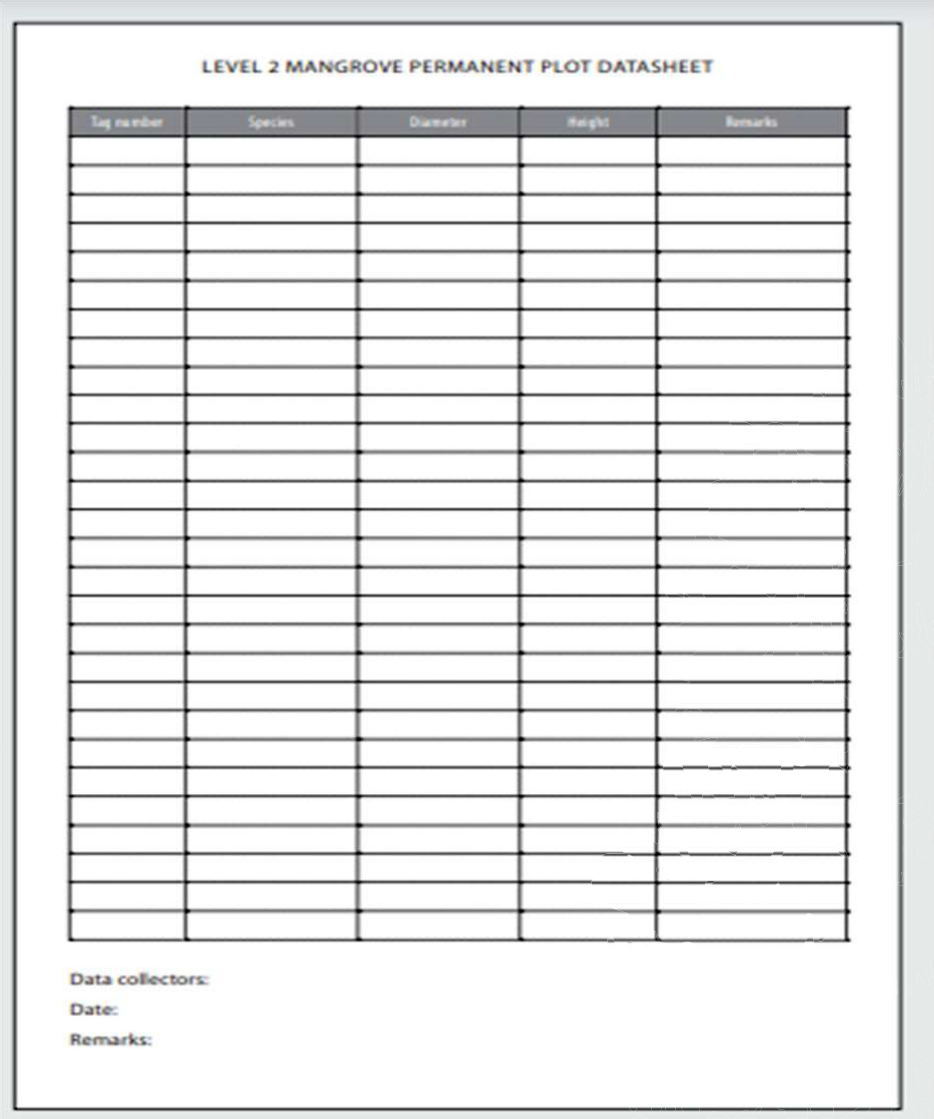
A list of known reasons why efforts are ineffective (UNEP, 2020) is outlined in Figure 43. If and when possible, practitioners should attempt in their very best capacity to avoid the following conditions as these have been seen to be the cause of failure.

Reasons why restoration efforts lead to failure	Lessons to learn
Use of inappropriate methods	Diagnostic studies on socio-ecological aspects of mangroves
Insufficient information	Embracing a more holistic approach
Failure to involve communities	Engaging multiple experts and stakeholders
Inadequate monitoring of seedlings after planting	Linking local language to expertise of the scientific community
Poor habitat selection without adequate site assessment	Monitoring and assessing success
Faulty selection of mangrove species for replanting	Early identification of problems and taking corrective actions
Improper planting of mangrove seedlings at a substrate depth beyond the natural range for mangroves in the area	Sharing knowledge and experience
Poor coordination among the institutions involved	Importance of mangrove valuation studies
Poor understanding of the ecological role of mangrove forests among policy and decision makers at different levels of government that result in weak support of restoration initiative	Continued awareness and advocacy on mangrove conservation
Non-removal of the stress that causes mangrove decline	Replanting of mangroves will only be successful if the stress that caused the mangroves to decline in the first place is removed.
Undecided on the approach to reforestation	Use either natural regeneration, propagule/ seed planting, or seedling planting. Rehabilitation programme such as natural regeneration or active replanting techniques, in which case use of local sources of seeds or juveniles will reduce loss of genetic variation across Fiji.
Introducing new genetic stock with no consideration and anticipation of the ramification on the existing population	

Figure 43: Reasons for restoration failure and lessons learnt

For an overall effective impact on restoration work, both the monitoring and evaluation framework as well as key parameters need to be clearly identified and defined. More importantly, indicators must be measurable and achievable within the duration period of the work. It is recommended that communities seek the advice of relevant government institutions and that accessibility to a standard framework of M&E is provided for communities to use. An example of a typical M&E form used in restoration/rehabilitation is outlined in Figure 44.

This step is an important platform of communicating progress to navigate and detect trends of ongoing pressures that can negatively affect success if not a positive trend that suggest currently effective interventions. This phase is often missing in restoration efforts which could be also one of the main reasons of unsuccessful restoration works.



LEVEL 2 MANGROVE PERMANENT PLOT DATASHEET

Tag number	Species	Diameter	Height	Remarks

Data collectors:

Date:

Remarks:

Figure 44: Example of a Monitoring and Evaluation form

7.2.3.1 What to Monitor and Evaluate?

Upon consultation with technical institutions, it is recommended that a control site (preferably in a non-degraded forest) be established to measure the progress of monitoring. Over time, this can then be used as an indicator to assess either the success or failure of the activities.

7.2.3.1.1 Vegetation Assessment

Monitoring of assessment units is a specialized activity that requires a quantified level of training and skills. Because of the technical nature of assessment, communities and other key stakeholders are strongly advised to collaborate with the technical units of collaborating institutions in country such as the Ministry of Forestry, University of the South Pacific and Conservation International and other partners. Effective involvement of communities through these institutions can be achieved through capacity building workshops, trainings, and consultation. Content of learning through these consultations can revolve around learning:

- how to take height measurements of mangrove seedlings and native tree seedlings for monitoring assessments over time and at the same time assess the tree health using a grading scale;
- measuring of the average height (in cm), number of internodes and leaves and lateral branches;
- measuring the length and width of leaves;
- assessing the branching habit using a grading scale.

An example of a template to monitor and measure the vegetation assessment is provided (Figure 45). Under the guidance of the technical institution, stakeholders are encouraged to develop one of their own or otherwise use an existing framework that may be available outside the scope of the guideline but remains in alignment with the purposes of rehabilitation and restoration initiatives.

7.2.3.1.2 Faunal Assessment

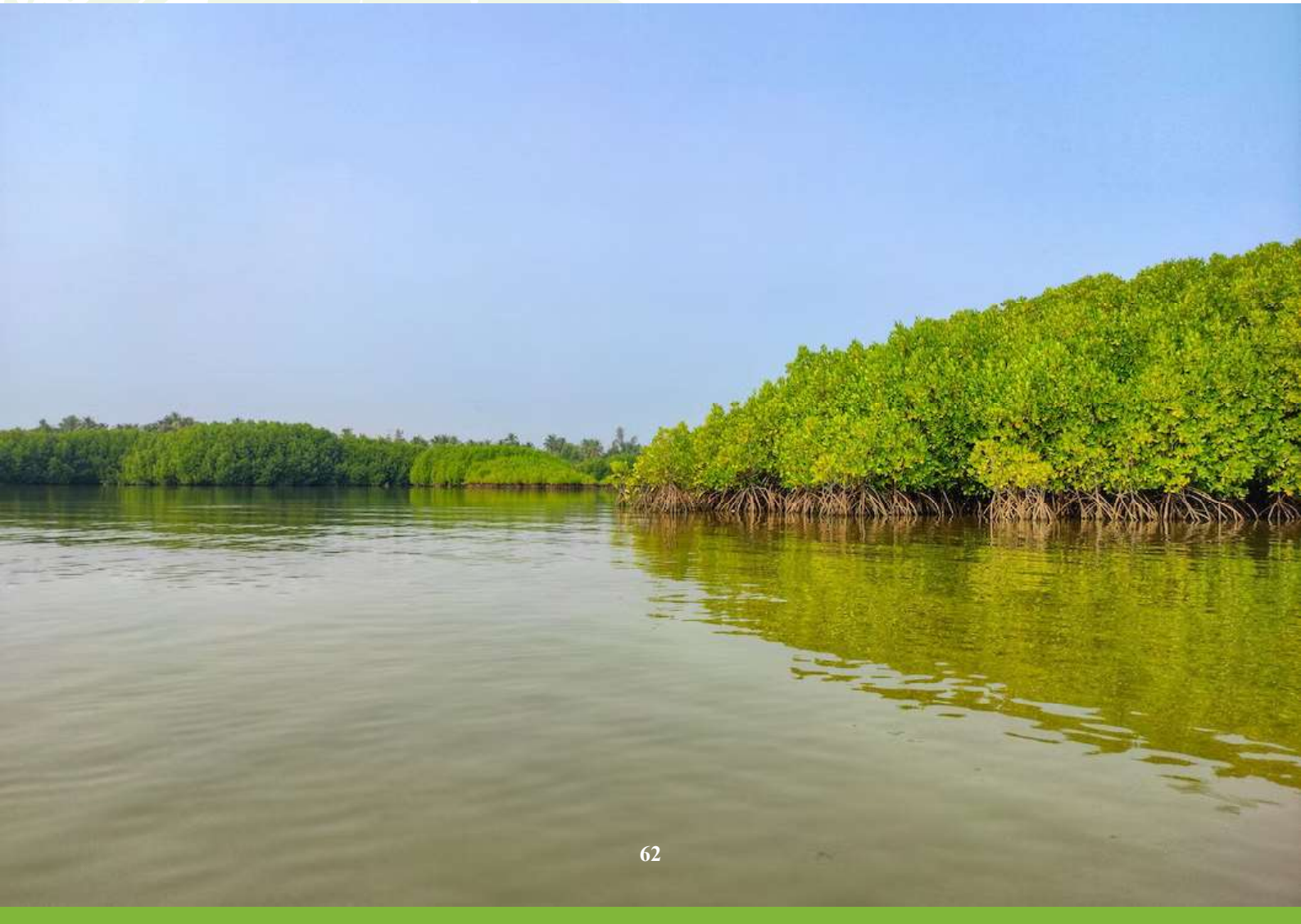
Within units of assessing the vegetation, assessing of associated fauna can mean the simple count, the presence and absence of fishes, crabs, and mollusks over a fixed period of time. Bats and birds are also included given the nesting and foraging grounds along the coastlines and mangrove forests. Through consultation with technical institutions, communities can effectively be involved through capacity building workshops, trainings, and consultation. Content of learning through these consultations can revolve around understanding:

- identifying different fauna species in a mangrove forest;
- simple counts and accurately recording presence and absence of individual species.

An example of the type of information collected for absence/presence of species is outlined in Figure 46. Under the guidance of technical institution, participating stakeholders are encouraged to develop one of their own or otherwise use an existing template that may be available outside the scope of the guideline but remains in alignment with the purposes of mangrove rehabilitation and restoration.

7.2.3.2 Who to carry out the Monitoring and Evaluation?

Communities can use this opportunity of engagement to take ownership of the project by looking after the planted trees and mangroves through systematic monitoring and evaluation of the rehabilitated sites. As evident from the ITTO project, a lot of planted trees and mangroves are thriving and even fruiting within community boundaries.



	ACTIVITY	REMARKS/PARAMETERS TO MEASURE
0+3 months	a) Preparing report of nursery and out planting phases b) Survival assessment c) Gap filling d) Pest control e) Debris removal	- Survival % - If survival is low attempt to identify cause of problem - Note source of debris - Note any form of disturbance, or damages
6	a) Assessment – seedling survival and growth performance b) Surveillance	- Survival % - Height (from the ground to the base of top-most leaves), number of leaves for randomly selected individuals (tag them for subsequent monitoring) - Note any form of disturbance, or damages
9	a) Assessment – seedling survival and growth performance, recruitment of wildlings b) Surveillance	- Survival (%) - Height, diameter (between 1st& 2nd internode for *Rhizophora*, *Bruguiera* and *Ceriops*; at 30 cm from ground for other species), number of leaves for tagged individuals - Note number and species of natural recruitments - Note any disturbance
12	a) Assessment – seedling survival and growth performance, recruitment of wildlings b) Assessment - animal types and abundance c) Surveillance d) Annual report	- Survival (%) - Height, diameter, no. of leaves for tagged individuals - Note number and species of natural recruitments - Note emerging challenges and propose appropriate plan of action to address them - Make a report of all activities done during the first year
18	a) Assessment – growth performance, recruitment of wildlings b) Assessment -animal types and abundance c) Surveillance	- Height, diameter, number of leaves for tagged individuals - Note number and species of natural recruitments - Note any form of disturbance, damages
24	a) Growth performance, wildings, animals b) Environmental factors c) Annual report d) Surveillance	- Same growth parameters as in previous measurements (but may need to revise point of diameter measurements as seedlings grow older, if internodes are no longer visible, take measurements at ~ ½ the tree height) - Note also survival of wildings - Note changes in soils
36	a) Growth performance, wildings b) Surveillance c) Annual report	
48	a) Growth performance b) Surveillance c) Annual report	
60	a) Growth performance - general forest assessment, including natural regeneration b) Pruning/or thinning c) Detailed report – baseline for subsequent assessment (e.g. every 5 years) d) Detailed financial report – documenting the cost of planting and other operations	- Forest assessment using standard techniques – measure DBH at 130 cm above the ground - Natural regeneration – seedlings/saplings grouped into three regeneration classes – Class 1: < 40 cm height, Class 2: 40-150 cm and Class 3: >150 cm - Pruning & thinning depend on the objective of planting i.e. preferably for replanting for wood production. Determine appropriate spacing – usually between 1 to 2 m

Figure 45: Example of the vegetation parameters for monitoring progress of restoration activities

SPECIES	SEX		BURROWS		
	MALE	FEMALE	< 1CM	= 1CM,	>1CM

Figure 46: Example of faunal assessment for monitoring restoration activities

7.2.3.2.1 Internal Monitoring and Evaluation

With the assistance and or guidance of project partners or collaborators, groups within the communities (see Section 5.4) can take up the role of M&E of planted trees and mangroves across affected sites. The ITTO project has been successful because of the involvement of community groups such as the women group, who have taken up the role of monitoring planted mangroves across the foreshore. With enough incentive and empowerment, other groups, such as youths and men in the community are encouraged to take up similar initiatives.

7.2.3.2.2 External Monitoring and Evaluation

Projects can also be monitored by non-community stakeholders that includes government stakeholders and even funders. For instance, the ITTO Project Coordinator together with the Ministry of Agriculture and Ministry of Fisheries continues to monitor alternative livelihood intervention that was established in the six project communities such as Bee Keeping, Pig farming and prawn farming. Similarly, the Ministry of Forestry's planning and accounts department together with a representative from the Ministry of Economy monitors the six project sites every quarter after the submission of the ITTO Project quarterly report. The M&E covers planted trees and mangroves and also the establishment of alternative livelihood and permanent nurseries in the six project sites.

8 Using the Guideline

In deciding to adopt and implement a community-based mangrove management approach, it must be clearly understood that the interventions of rehabilitation and restoration are applicable across mangrove affected areas that are degraded. Degradation of mangrove areas, in its simplest definition, refers to mangrove areas that are highly disturbed and do not show any signs of natural regrowth. These areas are subjected to similar drivers of degradation in the forms of dredging activities, large scale logging (includes clear felling and commercial logging) to list a few examples. For the purposes of rehabilitation and restoration, there needs to be an understanding and awareness of the causes and sources of mangrove loss to the extent where sites that have attained a degraded status, requires some form of conservation intervention.

In practice, the guideline is essentially meant for communities as managers and stewards with the intent of developing their own projects steered towards the rehabilitation and restoration of affected mangrove sites. The audience is also inclusive of the broader generic stakeholders that may more or less have some interest in mangrove protection and conservation. Other interested stakeholders are also welcomed to use the guideline as reference, particularly with the content of information that is available. The guideline is useful as a reference point to develop individual projects and or community projects, keeping in mind the necessary information one needs to know before any implementation activities is carried out.

As a component of a good management strategy, Section 3, 4, 5 and 6 of the guideline is essentially what communities must know before-hand prior to any implementation phase of project they are taking on. Section 7 of the guideline is essentially the technical aspects of what communities must learn to do and achieve in order to successfully manage a mangrove rehabilitation and restoration project. In brief, it is recommended that participating community members:

1. identify and establish the community structure within a village setting
2. have an idea of the communication pathway that exists and the relationship between focal points within the community to voice their ideas, opinions and other concerning matters that is seen important
3. know of the other management actions that they can adopt, apart from rehabilitation and restoration efforts in place
4. identify other stakeholder groups within the community that can champion if not advocate mangrove conservation
5. have a read through with proper consultations of the guideline to place all efforts into context.

Further, this guideline is divided into four significant components that managers need to know in navigating projects forward and making informed decisions each step of the way. These components comprise the:

- **Governance aspects of mangroves:** this section (see Section 3) serves as a reminder of what legal frameworks and institutions exists that are mandated to lawfully protect mangroves in Fiji. These are in the form of Policies and Acts that specific to the three government ministries: Ministry of Environment, Ministry of Forestry and the Ministry of Lands and Minerals. They form the focal points of consultation that communities can refer to for information and guidance, to safely move the project forward, including other related initiatives.
- **Social and Economic aspects of mangroves:** this section (see Section 4) looks at the role of mangroves in the socio-economic context of communities. It elaborates on the value of mangrove to the community and the environment at large and at the same time, addresses the causes and sources of its loss to the extent it attains a state of degradation. We also identify what the state, response and benefits are when efforts of rehabilitation and restoration across these affected sites later become successful.
- **Environment aspects of mangroves:** this section (see Sections 6 and 7) is the practical guideline that navigates steps and actions to take when implementing rehabilitation and restoration techniques. The concepts behind each procedure are highlighted for the purposes of a better understanding and appreciation of these intervention.

Moreover, participant/stakeholder must at least be aware and informed of the management aspects that are required to see the conservation interventions through. The guideline briefly elaborates on the key concepts and information that community stakeholders, as managers, must equip themselves with before moving forward with a proposed project. It plays an important role of framing the relevant information, knowledge and actions needed to sustain the integrity of mangroves, particularly across areas that are affected. It is also recommended, that stakeholders alike have a read through the guideline for the purposes of familiarity and having a sense of proper direction for consultation and decision-making. With sufficient support of consistent monitoring and evaluation, these affected mangrove sites can be invigorated over time.

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10 Annexes

10.1 Annex 1: Identifying Mangrove species in the Field

Vernacular name	Main features	
Tiri		
Selala		
Dogo		
Kedra ivi na yalewa Kalou		

Sagale

Sinu, sinu gaga

10.2 Annex 2: Glossary

Afforestation[11]: establishing a forest in an area that had no previous forest standing. This intervention is carried out through tree planting and seeding, naturally or artificially.

Mangrove degradation: In the Fiji context, this is with reference to mangrove areas that have a secondary forest system (see Section 4.2) (Tuiwawa *et al.* 2013). Degraded sites is especially common at the 'back of the Mangrove Forest' with pockets to extent occurrences evident along the other mangrove forest types across the foreshore. At The back of the mangrove forest, on the slightly higher grounds, there is evidence of secondary succession species, and the substrates are not always inundated except during the king tide or very heavy rain (Tuiwawa *et al.* 2013).

Mangrove Rehabilitation: Refers to the coordinated efforts of attempting to recover or re-instate the former state of degraded and deforested mangrove sites (Jong, 2010). Across degraded sites, rehabilitation efforts is carried out through planting and or assisted regeneration with the intent of conditioning the area towards restoration state. This intervention is undertaken through mangrove seedlings from greenhouses and transplanting them to the site.

Mangrove Restoration[12]: is the regeneration of mangrove forest in areas where they have previously existed. Across degraded sites, restoration efforts is carried out through planting and or assisted regeneration. The intervention involves the collection of seeds, planting them in a nursery and then transplanting the seedlings to the site. It follows the same principles as restoration of terrestrial forest. Natural regeneration can also occur across degraded and non-degraded sites.

Mangrove seed[10]: It is different from other plant seeds because the propagules germinates while still on the tree. This is an adaptation mechanism that supports its development when it has fallen to the soil substrate.

Planting: refers to the propagation of plants while it is still in its dormant seed state[13].

Propagule[10]: the technical term used for a mangrove seed. It is the vegetative structure that when detached from the parental tree grows into a new plant.

Reforestation[14]: refers to the process of replanting an area with trees. It can take place in any type of mangrove

forest along the foreshore and even inland. The intent is to restock forest areas that no longer have an existing forest or have only a few trees standing. The intervention of altering a non-forested area to forested is undertaken through tree planting and seedlings[15].

Replanting[16]: refers to the propagation of an established shrub or tree with roots attached. In other words, it is the sowing/planting of a young seedling or growing plant.

Saplings[10]: a young seedling of a tree with a trunk and roots.

Seedlings[10]: a young plant that is grown from a seed. They are smaller in diameter than saplings, and usually do not have soil around its roots.

Transplant[10]: to move or remove a plant from one location to be planted in another.

Wildings[10]: sapling found in the wild or grown in a nursery without the use of nursery pots.

[11] https://www.forestry.gov.fj/
[12] https://www.stowa.nl/deltafacts/waterveiligheid/het-kustsysteem/mangrove-restoration
[13] The term 'replanting' is not synonymous with the term planting.
[14] https://www.sappi.com/reforestation-deforestration-afforestation-and-their-differences
[15] https://energyeducation.ca/encyclopedia/Afforestation
[16] https://www.merriam-webster.com/dictionary

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