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# Ecosystem-Based Adaptation (EbA) Project Implementation Plans Port Vila, Vanuatu



**A report prepared for the  
Port Vila Pacific Ecosystem  
Based Adaptation to  
Climate Change Project  
August 2017**



## **Ecosystem-based Adaptation (EbA) Project Implementation Plans, Port Vila, Vanuatu**

Report prepared by Victoria University of Wellington for the Pacific Ecosystem-based Adaptation to Climate Change Programme (PEBACC) of the Secretariat of the Pacific Regional Environment Programme (SPREP).

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# Ecosystem-Based Adaptation (EbA) Implementation Plans Port Vila, Vanuatu

## 1.0 Introduction

A detailed description of the methodology used to select the EbA projects proposed in this report and overview of aspects of the selected projects can be found in the accompanying project report (Blaschke et al., 2017, section 3.3).

The following five projects were identified as being of high priority for the Port Vila ridge to reef context in terms of addressing urgent ecological issues and increasing community resilience to vulnerabilities related to climate change and to wider development issues.

1. Riparian corridors regeneration plan
2. Restoration and protection of coastal vegetation
3. Intensification of suburban and peri-urban village and settlement home gardens
4. Urban trees: The strategic introduction of more multi-use trees and vegetation into built up areas of Port Vila
5. Sustainable housing development



Figure 1.1 Port Vila, Vanuatu

## 2.0 Ecosystem services increased or supported by proposed EbA projects

As part of the process of selecting the proposed EbA projects, an analysis was done of how each project could potentially increase or support the provision of ecosystem services in Port Vila. Figure 2.1 illustrates the findings.

Ecosystem Services		Riparian Corridors	Coastal Regen.	Home Gardens	Urban Trees	Sustain. Housing
Provisioning Services	Food	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
	Biochemicals	Light Red	Light Red	Light Red	Light Red	Light Red
	Raw materials	Light Red	Dark Red	Light Red	Dark Red	Light Red
	Fuel / Energy	Light Red	Dark Red	Light Red	Light Red	Dark Red
	Freshwater	Dark Red	Light Red	Light Red	Light Red	Dark Red
	Ornamental resources	Light Red	Light Red	Light Red	Dark Red	Light Red
	Genetic information	Dark Red	Dark Red	Dark Red	Dark Red	Light Red
Regulating Services	Pollination / seed dispersal	Dark Red	Dark Red	Dark Red	Dark Red	Light Red
	Biological control	Dark Red	Dark Red	Dark Red	Dark Red	Light Red
	Climate regulation	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
	Decomposition	Dark Red	Dark Red	Dark Red	Light Red	Light Red
	Purification	Dark Red	Dark Red	Dark Red	Dark Red	Light Red
	Prevention of disturbance	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
Supporting Services	Soil health	Dark Red	Dark Red	Dark Red	Dark Red	Light Red
	Fixation of solar energy	Dark Red	Dark Red	Dark Red	Dark Red	Light Red
	Nutrient cycling	Dark Red	Dark Red	Dark Red	Dark Red	Light Red
	Habitat Provision	Dark Red	Dark Red	Dark Red	Dark Red	Light Red
	Species maintenance	Dark Red	Dark Red	Dark Red	Dark Red	Light Red
Cultural Services	Artistic / spiritual inspiration	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
	Aesthetic value	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
	Creation of a sense of place	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
	Cultural diversity & history	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
	Education and knowledge	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
	Psychological wellbeing	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
	Recreation and tourism	Dark Red	Dark Red	Dark Red	Dark Red	Light Red

**Figure 2.1 Ecosystem services provided or supported by EbA projects**  
Estimated impact: dark red = high, medium red = medium, light red = low  
(as justified by literature provided in each implementation plan).

## 3.0 Tagabe Riparian Corridor Regeneration Project Implementation Plan

### 3.1 Abstract

The Tagabe Riparian Corridor Regeneration Project is an integrated catchment management programme of activities focused on the riparian margins of mid to lower catchment streams in the Tagabe catchment. The purpose of this project is to build resilience into the riparian system to safeguard human wellbeing in the face of current and future climate change challenges. A more resilient riparian system in this catchment will reduce risks and impacts associated with floods, droughts and cyclones, and will improve water quality for human consumption and the habitat for freshwater and inshore marine fish stocks. This project encompasses three activity types: a) riparian revegetation and stream bank protection; b) sustainable land management of adjacent farmlands; and c) point source pollution prevention and remediation. The programme of activities is structured through replicable projects over a series of 5-year management periods until the long-term outcome has been delivered, viz. a resilient water catchment system that supports human wellbeing and the local economy through protection and enhancement of ecological infrastructure capable of maximising the delivery of provisioning, regulating, supporting, and cultural ecosystem services.



Figure 3.1 Typical river in urban reaches of Port Vila (near Mele)

### 3.2 Tagabe riparian corridor regeneration project aim and purpose

Enhancing human wellbeing in the context of a river catchment system necessitates building and maintaining the ecological infrastructure capable of delivering such resilience. This means protecting and enhancing existing ecological infrastructure, and restoring degraded infrastructure as much as possible and practicable.

The aim of this project is to develop a resilient water catchment system that supports human wellbeing and the local economy through the protection and enhancement of ecological infrastructure

capable of maximising the delivery of provisioning services (food, fresh water, and raw materials such as wood & fibre), regulating services (prevention of disturbance such as flood, cyclone, & drought regulation), supporting services (species maintenance, or biodiversity conservation) and cultural services for the Port Vila population.

Specific aims and outcomes:

- Protection and enhancement of woody vegetation along stream banks and on adjacent lands.
- Sustainable land management practices on adjacent lands delivering reduced sedimentation and reduced non-point source pollutants.
- Reduction / elimination of point source pollutant delivery to streams.

### 3.3 Background

Degradation of riparian ecosystems can result from the removal of woody vegetation, combined with land management practices that degrade the integrity of the riparian system.

The physical degradation of riparian ecosystems, and the loss of woody vegetation along stream margins increases the impact of extreme weather events such as flooding, cyclones and droughts.

- In a degraded catchment, flooding can cause much greater damage to downstream streambanks, land and infrastructure (e.g. housing, roads and bridges). This escalates the financial and human cost of flood events.
- During cyclones, forested areas reduce the localized impact of high winds by slowing ground level wind speeds and buffering the land surface. A degraded catchment will be less resilient to high winds thus increasing the financial and human cost of cyclones.
- A degraded catchment will also be less resilient to the impact of drought events, due to a reduction in soil water holding capacity, and a reduction in water delivery to streams. This also increases the financial and human cost of drought events.



Figure 3.2 Livestock in river

Catchment degradation also includes a reduction in water quality resulting from point source and non-point source pollutants. Such pollutants can arise from:

- Livestock and human defecation in or near waterways.
- Sewerage and industrial discharge into streams.
- Fertilizer application on adjacent lands.
- Sediment discharge into streams.

The resulting degraded catchment will deliver a lower quality water supply for human consumption. This can have a consequential negative impact of public health through an increase in water-borne and communicable diseases. In addition, fertilizer runoff into streams leads to increased stream nutrient levels and consequent eutrophication resulting in a reduction in stream oxygen levels and reduced habitat quality for freshwater and inshore marine fish and other aquatic life. These two broad factors can increase the financial and human cost of dwelling near a river system. The financial cost can be associated with:

- A reduction in availability of local wild-capture fish resources and other freshwater, intertidal and inshore ecosystem resources.
- An increase in the public-sector cost of health service provision.
- A reduction in human productivity due to ill health.

The human cost of such degradation relates to a reduction in the quality of life for people dwelling in this water catchment and associated coastal areas.



Figure 3.3 Port Vila river after rain

### 3.4 How would a riparian corridor regeneration project reduce the degradation of local ecosystems?

The project justification is presented in table 3.1.

**Table 3.1 Causes of ecosystem degradation and climate change vulnerabilities that a riparian corridor regeneration project could reduce**

Black text = Local human caused drivers of change. Blue text = Climate change drivers of change.

L = low, M = medium, and H = high in terms of how effectively the project might address these causes of change. First grade is catchment level, second is at localised site.

\* = low level of certainty based on literature reviews, precedents, and common sense. \*\* = medium level of certainty. \*\*\* = high level of certainty. Note: All assessments made on the assumption that project is successfully implemented.

Riparian corridor regeneration targets these drivers of change:		Justification:
Causes of Degradation of Terrestrial Riparian Ecosystems	Reduced and degraded woody vegetation on stream margins and adjacent lands <b>H/H</b>	Loss of biodiversity habitat for riparian species.***
	Unsustainable land management practices <b>M/M</b>	Loss of biodiversity habitat for riparian species**
	High rainfall events leading to increased flood risk <b>M/H</b>	Reduced flood protection from stream banks and increase in heavy debris carried downstream in flood events.**
	Cyclone events leading to increased wind <b>M/H</b>	Reduced forest cover reduces shelter from high winds.**
	More severe drought events leading to increased water security risk <b>H/H</b>	Reduced forest cover reduces water holding capacity of soils and consequent reductions in the volume of water feeding into streams.**
Causes of Degradation of Freshwater Ecosystems	Reduced and degraded woody vegetation on stream margins and adjacent lands <b>H/H</b>	Reduced riparian woody vegetation leads to increased stream sedimentation and increased debris flows during flooding.***
	Non-point sources of water pollution from direct livestock access to streams <b>M/H</b>	Livestock defecating in and near streams deposits sewerage directly into stream water and increase bacterial content and faecal coliform concentrations of water.***
	Non-point sources of water pollution from fertilizer application to adjacent farmlands <b>M/H</b>	Soluble fertilizer is mobilised in surface runoff, increasing stream nutrient load. This leads to reduced stream oxygen levels (eutrophication), reducing habitat quality for fish and invertebrates in the fish food chain.***
	Point source water pollution from discharges to streams <b>M/H</b>	Liquid contaminant discharges to streams from industrial or residential properties directly reduces water quality. Wide variation in impact depending on volume and toxicity of contaminants discharged.***
Causes of Degradation of Coastal Ecosystems	Inshore marine sedimentation from stream bank and soil erosion <b>M/H</b>	Riparian sediment discharges to inshore marine environment causing degradation of inshore marine water quality, and leads to degradation of inshore marine environments (e.g. corals, sea grass beds).**
	Reduced water quality resulting from stream delivered pollution <b>M/H</b>	River borne contaminants discharge to inshore marine environment and can enter marine food chains, reducing marine productivity and/or reducing the health of consumers of contaminated fish.**

### 3.5 What issues or vulnerabilities does a riparian corridor regeneration project address?

The key issues and vulnerabilities riparian corridor regeneration and regeneration in a Port Vila context would address include reduction of urban run-off pollutants entering rivers and therefore oceans, erosion and sedimentation reduction, and protection against storm surge, inundation, and flooding increased. Addressing these issues translates to increased freshwater ecology health on rivers targeted and to increased reef health, through reduced sedimentation, turbidity, and pollution. This in turn has positive impacts for people in terms of food security, physical health, tourism opportunities, and recreational use of rivers and reefs and connected ecologies.

Increased resilience of the Port Vila community to other climate change induced vulnerabilities, particularly increased dry periods, and increased intense rain events may also occur through riparian corridor regeneration. Key impacts and vulnerabilities targeted by a riparian corridor project are illustrated in table 3.2.



Figure 3.4 Tagabe river (source of image: Imagicity, Graham Crumb)

**Table 3.2 Impacts of ecosystem degradation that a riparian corridor project could reduce or address**

L = low, M = medium, and H = high in terms of how effectively the project might address these impacts.

\* = low level of certainty. \*\* = medium level of certainty. \*\*\* = high level of certainty. Note: All assessments made on the assumption that project is successfully implemented

	Impacts on ecosystems:	Impacts on human wellbeing and resilience:	Justification:
Degraded Terrestrial Ecosystems	<ul style="list-style-type: none"> <li>Reduced fresh water quality <b>H</b></li> <li>Increased risk of flash flooding <b>H</b></li> <li>Increased erosion and soil loss <b>H</b></li> <li>Increased silting / sedimentation in rivers <b>H</b></li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to drinking water for people / livestock <b>M</b></li> <li>Reduced access to, or more expensive food (fresh water) <b>M</b></li> <li>Reduced physical health and increased health care costs <b>M</b></li> <li>Reduced or more expensive access to raw materials (fire wood, building materials) <b>L</b></li> <li>Reduced access to plants that are culturally significant <b>L</b></li> </ul>	<ul style="list-style-type: none"> <li>Protecting and regenerating riparian corridors means the river banks are more stable and therefore that they erode less. This translates into better fresh water quality, and healthier freshwater ecologies. ***</li> </ul>
Degraded Freshwater Ecosystems	<ul style="list-style-type: none"> <li>Changes to productivity of food webs <b>H</b></li> <li>Degradation of coastal systems (mangrove, seagrass, reef) <b>M</b></li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to, or more expensive food (marine) <b>M</b></li> <li>Increased flooding of homes, infrastructure, crop and garden land <b>H</b></li> <li>Increased costs of storm damage <b>M</b></li> <li>Negative impact on tourism (income) <b>M</b></li> <li>Loss of recreational use of rivers <b>H</b></li> </ul>	<ul style="list-style-type: none"> <li>Because polluted rivers, or those with high levels of sedimentation reach the ocean eventually, degraded rivers effect coastal ecologies such as mangroves, seagrass, and reef. This in turn impact on food security. ***</li> <li>When riparian zones are degraded in urban areas or upstream of urban areas the increased instance of flooding impacts people directly. Revegetation addressed this. ***</li> </ul>
Degraded Coastal Ecosystems	<ul style="list-style-type: none"> <li>Changes to productivity of food webs <b>M</b></li> <li>Increased coastal erosion <b>M</b></li> <li>Reduction of sediment stabilising and water quality regulation <b>M</b></li> <li>Reduced nursery / feeding ground for some important fish species <b>M</b></li> <li>Decline of habitat of cultural important species (e.g. dugong and turtles) <b>M</b></li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to, or more expensive food (marine) <b>M</b></li> <li>Negative impact on tourism (income) <b>M</b></li> <li>Loss of recreational use of lagoon / reef / beach <b>M</b></li> </ul>	<ul style="list-style-type: none"> <li>Protection of riparian areas directly increases the health of coastal ecosystems, particularly reefs and seagrass. ***</li> </ul>

### 3.6 Key benefits of a riparian corridor regeneration project

River catchment systems comprise important ecological infrastructure that deliver a wide range of ecosystem service benefits for human wellbeing. The main tangible potential benefits for residents of Port Vila are illustrated in figure 3.5.



Figure 3.5 Potential benefits to the people of Port Vila of riparian corridors regeneration project

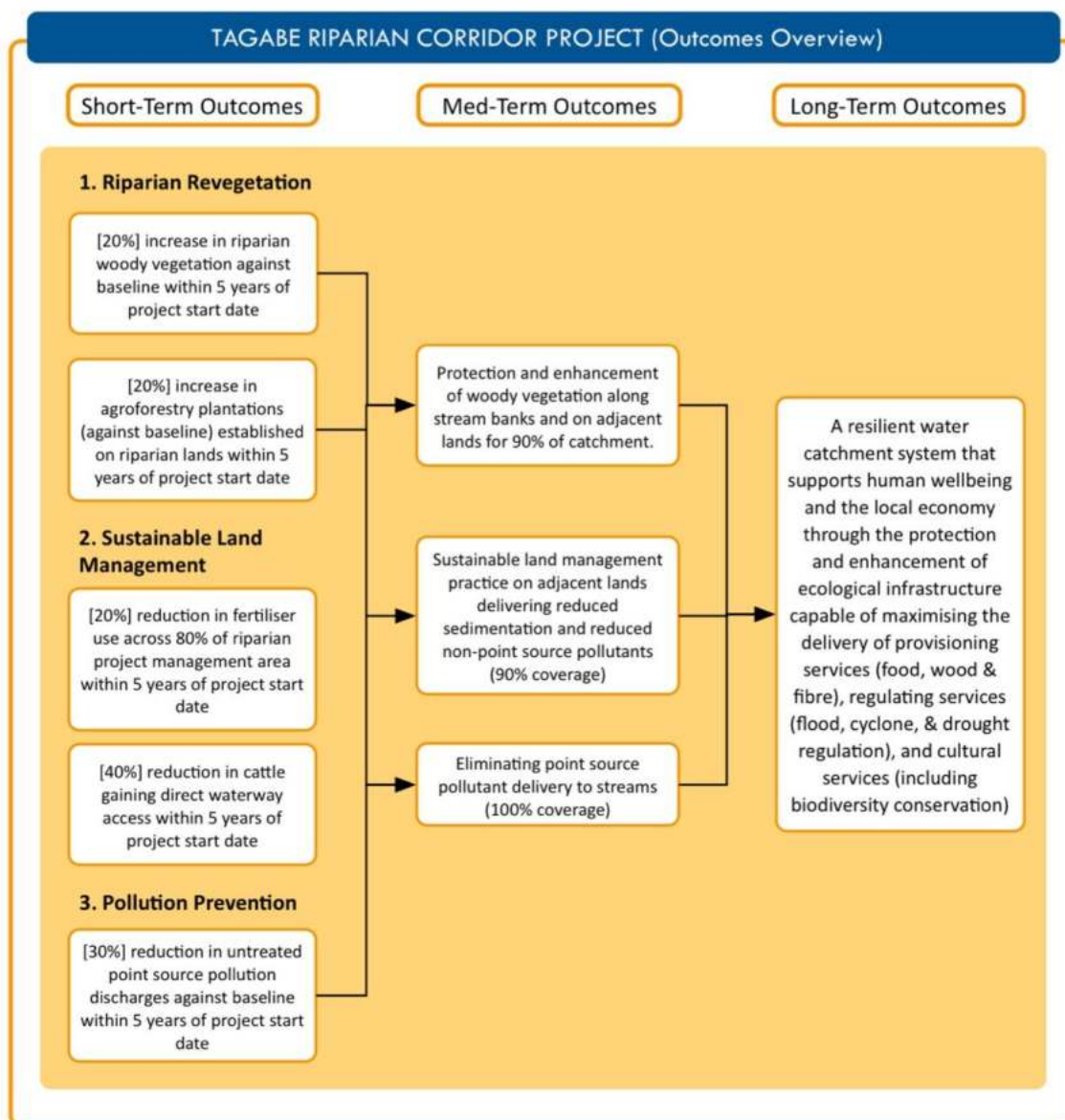
Figure 3.6 illustrates which ecosystem services a riparian corridors regeneration project would protect, add to, or regenerate in the context of urban and peri-urban Port Vila.



Figure 3.6 Ecosystem services benefits of a riparian corridors project

### 3.7 Intervention Logic

The intervention logic for this project (overview; activities, outputs and outcomes; and performance measurement model, as described in Blaschke et al., 2017) is summarised in Figs 3.7 - 3.9.



**Figure 3.7 Outcomes overview for Tagabe Riparian Corridor project**

Note that suggested performance levels are given but these may be varied under detailed project planning

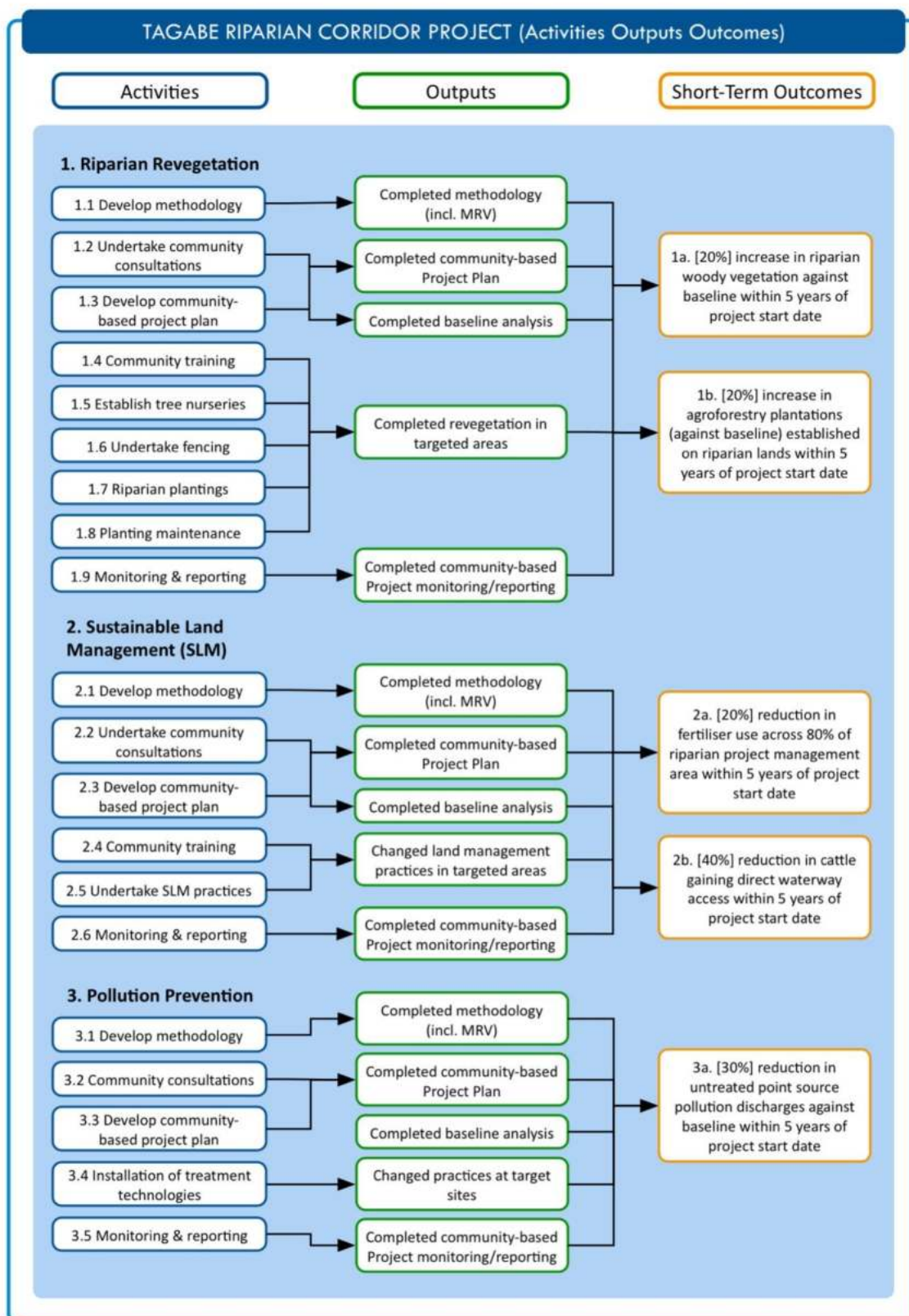


Figure 3.8 Activities, outputs and outcomes for Tagabe Riparian Corridor project

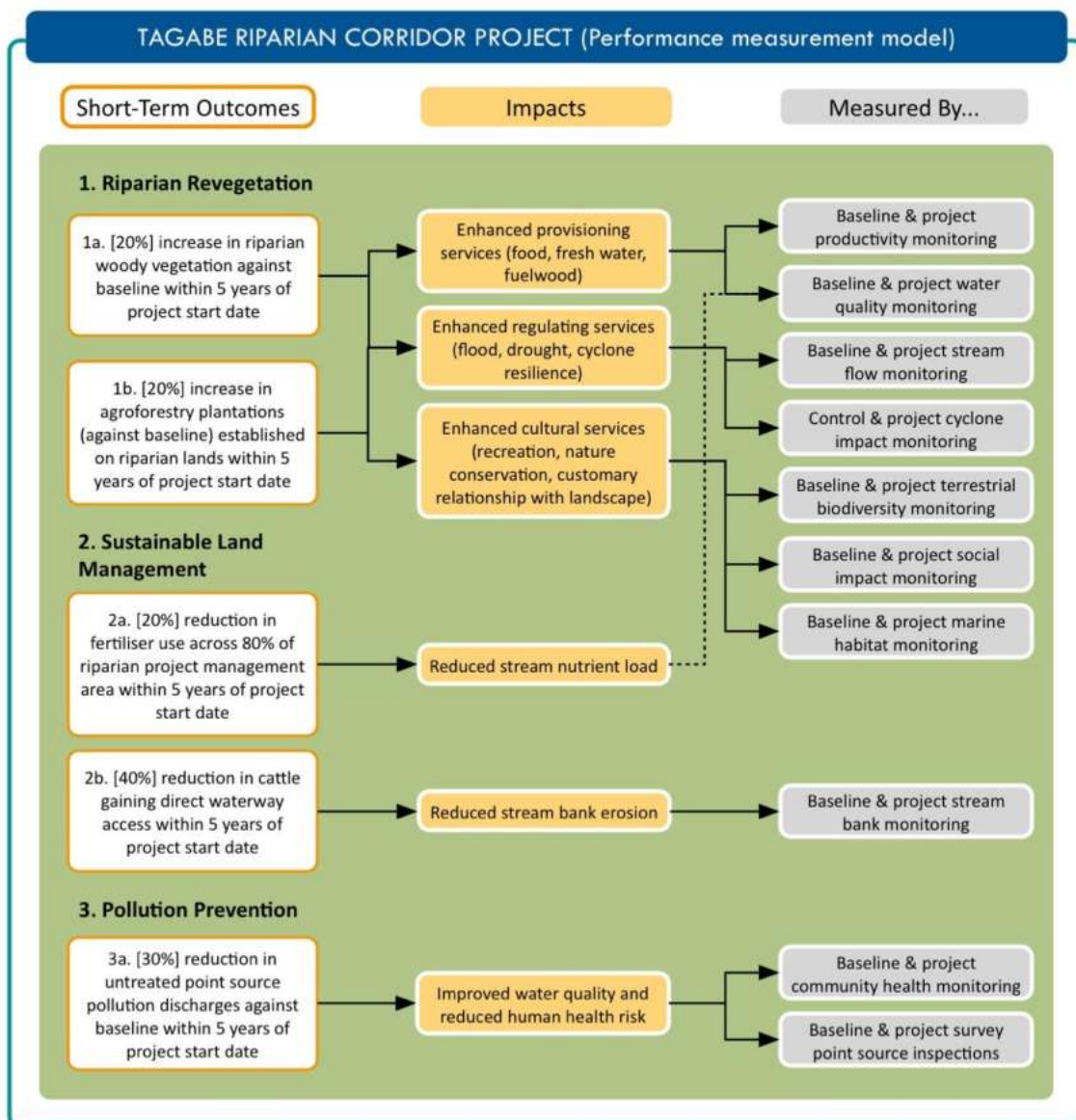


Figure 3.9 Performance measurement model for Tagabe Riparian Corridor project

### 3.8 Project location, ridge-to-reef position

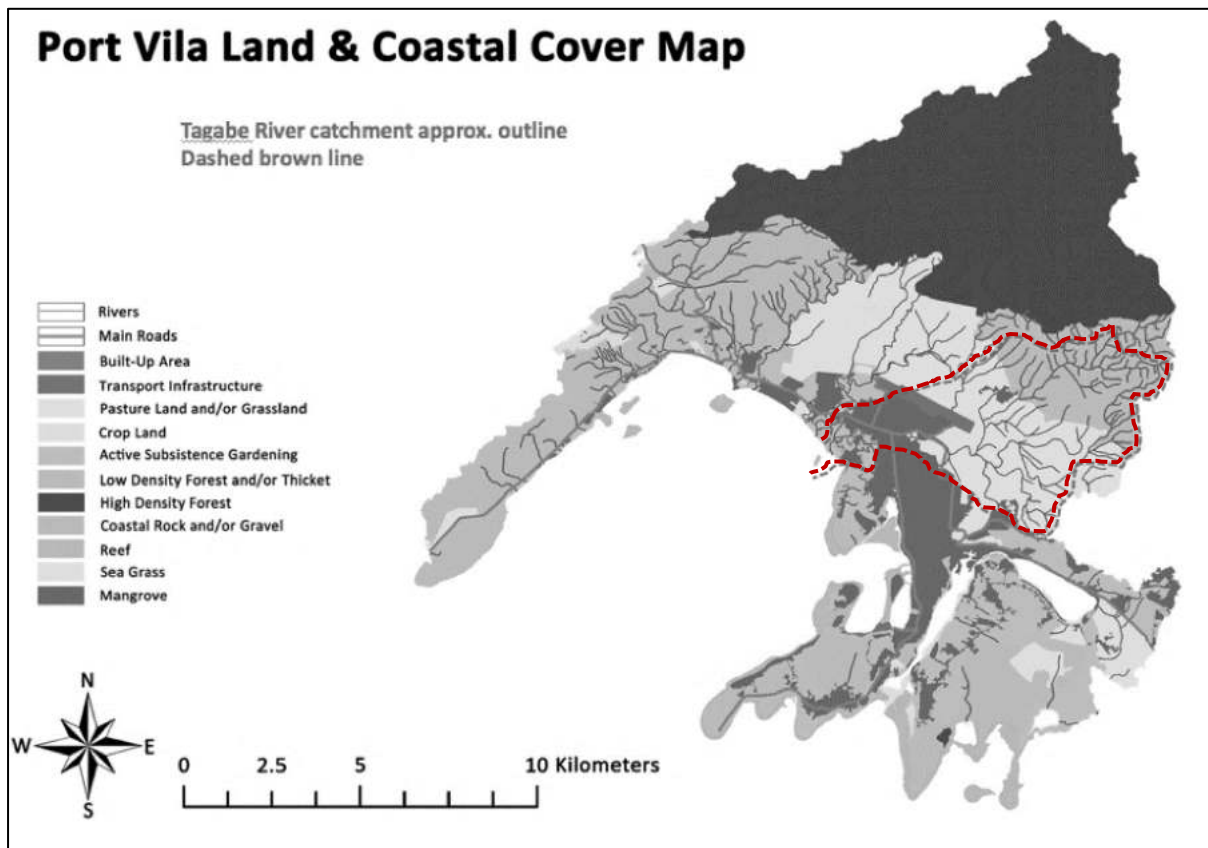


Figure 3.10 Demarcation of Tagabe catchment (dashed red line)



Figure 3.11 Left. Children playing in Tagabe River (source of image: Vanuatu Eco Tours)  
Right. People interacting with river in Tagabe area (source of image: Free Your Mind Travel)

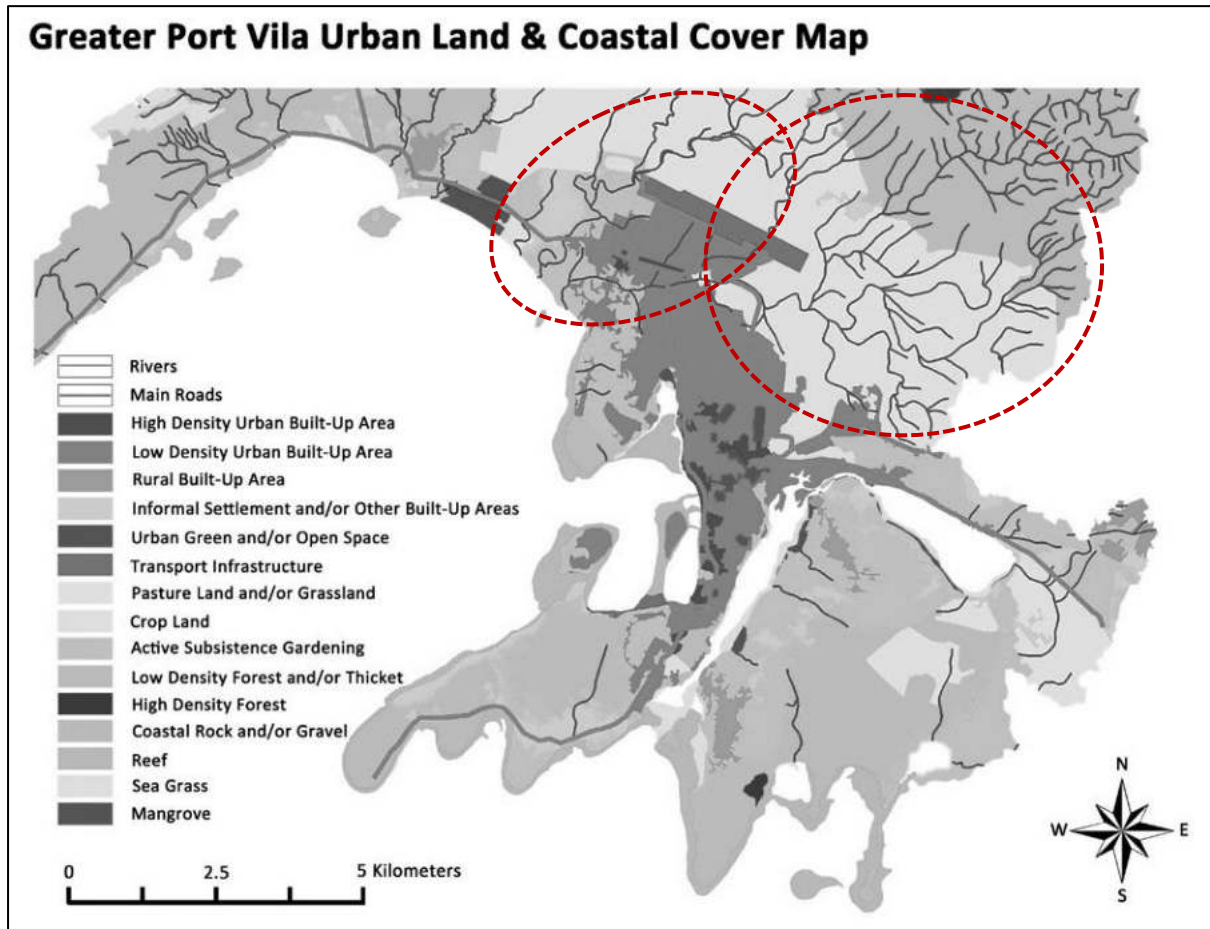


Figure 3.12 General locations of Tagabe catchment riparian corridor project



Figure 3.13 River within the Tagabe catchment (source of image: Island Life Magazine)

### 3.9 Approach

Project sequencing follows a programmatic approach whereby the overall project is broken down into smaller specific project activities as determined by project plan development and community consultations. These activities are summarised in table 3.3.

**Table 3.3 Specific project activities: Riparian corridor project**

Management Activity	Detail
Community Consultation 1: Project Inception Workshop (Supply)	Presentation of aim and purpose of project to all relevant community stakeholders. Outputs: Community education and awareness; community contributions to project design; project capacity building needs assessment.
Funder Consultation 1: Project Inception Workshop (Demand)	Presentation of aim and purpose of project to all relevant demand side (funding) stakeholders. Outputs: Demand side criteria defined for a) project outcome priorities, b) measurement, reporting and verification, and c) communications (story telling via various media).
Design project methodologies for each project activity type	Refine methodologies for a) project governance and (financial) management arrangements, b) specific project management interventions, c) measurement, reporting and verification protocols, d) sequencing of activities, and e) communications. Include contributions from community stakeholders to enable locally informed methodology design and enable enhanced community participation in project implementation and monitoring.
First draft Project Plans	Apply project methodologies to each specific sub-project providing details specific to those contexts.
Community Consultation 2: Project plan finalisation	Present first draft Project Plans to participating communities. Receive feedback on how to refine Project Plans to fit local contexts.
Project implementation	Project implementation activities undertaken according to Project Methodology and Project Plan in appropriate stages for each sub-project. Project implementation activities undertaken by stakeholders assigned key roles as per Project Plan.
Project monitoring & reporting	Project monitoring & reporting undertaken according to Project Methodology and Project Plan. Project monitoring & reporting activities undertaken by stakeholders assigned key roles as per Project Plan.
Project verification	Verification of project reporting and monitoring outcomes as per Project Methodology and Project Plan.

#### 3.9.1 Programmatic Approach

Under a programmatic approach, a “programme of activities” is defined that enables individual projects to be undertaken and then replicated to other locations within the programme area. A programme of activities in the context of the Tagabe Riparian Corridor Project would include three scopes:

1. Riparian revegetation, on selected sites throughout catchment.
2. Sustainable land management, upper catchment emphasis as in figure 3.10.
3. Pollution prevention, lower catchment emphasis as in figure 3.10.

The first project for each scope is the ‘pilot project’ that informs the programme, and enables lessons learned to be incorporated into an upgraded version of the methodology and project plan. Subsequent projects can then be deployed either sequentially (one after the other) or in parallel (at the same time) to enable the programme to scale up rapidly and efficiently.

Criteria for selecting the first project for each scope should ideally be based on the following criteria:

- Minimum complexity.
- Pre-existing community governance and management conditions to enable rapid deployment.

- Pre-existing community willingness to participate.
- Evaluated as having a relatively high impact per unit effort.
- Targeting a high priority location.
- Selected as a result of Community Consultation 1.

The private sector have a potential role in this project through both the supply and demand side of outcome delivery.

On the supply side private landowners can participate in the project through allowing/supporting this activity on their land. Private businesses could also provide project development and implementation services as riparian management entrepreneurs. When entrepreneurs get involved in project development and implementation, the private landowner does not need to put in any effort to have their land managed in a way that builds overall catchment resilience. If there is an opportunity cost (e.g. from the removal of grazing land from the overall grazing area) then there may be opportunity to calculate the opportunity cost and build this into project costing and unit pricing (if some form of unit is issued by/to the project to facilitate syndicated private sector financing support).

Reductions in riparian resilience through less sustainable riparian management commonly occurs as an external cost to private land and riparian management (e.g. including river banks as grazing land, and using rivers as the source of stock water supply but not experiencing the down-stream water quality, sedimentation and flood risk effects). Internalising these costs (e.g. excluding stock from rivers) comes at a real and tangible cost to the landowner (see section 3.15). Unless these real costs are addressed through project financing, the rate of voluntary project participation (particularly by larger commercial landowners) will be low. This is where incentives can be incorporated into project design to take adequate account of landowner needs as part of a voluntary programme.

On the demand side, private businesses can play an important role in co-financing a site or the project more generally by purchasing outcome units (if units are issued to/by the project e.g. 'Adaptation Benefit Units' or 'Riparian Revegetation Units').

### 3.10 Timeframe and Sequencing

The project timeframe will partly depend on the finalised milestone deadlines for short-term, medium-term and long-term outcomes targeted by the project. Placeholder milestone deadlines for short-term outcomes (see: intervention logic model in section 3.7) are as follows:

- 1a. [20%] increase in riparian woody vegetation against baseline within 5 years of project start date.
- 1b. [20%] increase in agroforestry plantations (against baseline) established on riparian lands within 5 years of project start date.
- 2a. [20%] reduction in fertiliser use across 80% of riparian project management area within 5 years of project start date.
- 2b. [40%] reduction in cattle gaining direct waterway access within 5 years of project start date.
- 3a. [30%] reduction in untreated point source pollution discharges against baseline within 5 years of project start date.

A project timeframe for full project delivery to deliver these short-term outcomes would require integration into a programme plan as summarised in table 3.4, assuming an early 2018 start to the programme.

Project sequencing follows a programmatic approach with one pilot project for each scope undertaken in parallel, followed by subsequent project replication. Whether replication of individual projects takes place sequentially or in parallel will partly be determined by financial and human resource capacity. But if key milestones are to be reached within the project implementation will need to be undertaken in parallel where possible.



Figure 3.14 Point source of pollution entering river

Table 3.4 Project timeframe

Task	Recommended Deadline
Detailed programme design	Q1 2018
Community consultation workshop 1 preparation	Q1 2018
Funder consultation workshop 1 prep	Q1 2018
Community consultation workshop 1 delivery	Q2 2018
Funder consultation workshop 1 delivery	Q2 2018
First draft project methodology and project plans	Q2 2018
Community consultation 2 delivery	Q3 2018
Project Plan finalisation	Q3 2018
Project A1 implementation	Q4 2018 – Q4 2019
Project B1 implementation	Q4 2018 – Q4 2019
Project C1 implementation	Q4 2018 – Q4 2019
Project A1 monitoring and reporting	Q1 2020 – Q2 2020
Project B1 monitoring and reporting	Q1 2020 – Q2 2020
Project C1 monitoring and reporting	Q1 2020 – Q2 2020
Phase 2 implementation planning	Q1 2019 – Q3 2020
Community milestone reporting workshop 1	Q3 2020
Funder milestone reporting workshop 1	Q3 2020
Project A2,3,4,... implementation	Q4 2020 – Q4 2022
Project B2,3,4,... implementation	Q4 2020 – Q4 2022
Project C2,3,4,... implementation	Q4 2020 – Q4 2022
Project A2,3,4,... monitoring and reporting	Q4 2020 – Q4 2022
Project B2,3,4,... monitoring and reporting	Q4 2020 – Q4 2022
Project C2,3,4,... monitoring and reporting	Q4 2020 – Q4 2022
Community reporting workshop	Q1 2023
Funder milestone reporting workshop 2	Q1 2023

### 3.11 Description of project components for the Tagabe riparian corridor project

Specific projects are to be situated in the context of a programme of activities within a programme area. Key programme level components are described in table 3.5.

**Table 3.5 Programme components**

Component	Description
Define programme area	This involves determining the exact areas within the Tagabe catchment that will be targeted for project interventions across all three scopes.
Baseline study	All quantitative outcome delivery metrics are dependent on comparing a baseline situation with outcomes attributable to project interventions. This necessitates a baseline study of the programme area to determine the quantitative extent of baseline conditions (e.g. area of riparian corridor without woody vegetation; area extent of non-sustainable land management practices; point sources of pollution discharges).
Programme-scale monitoring	Key indicators of beneficial change will need to be monitored across the programme area.
Project priority areas	Hotspots of high need for project interventions will need to be identified for the programme area to enable strategic location of specific project activities.
Programme support infrastructure	E.g. programme-scale plant nursery

Individual project-level components will vary depending on specific project types. Given that the core targeted outcome is an improvement in water quality, flood protection, and general riparian resilience, the type of vegetation that can deliver these outcomes in a riparian revegetation activity can include a combination of woody and non-woody vegetation. Plan nursery development will therefore need to include the cultivation of suitable woody and non-woody riparian species for planting.

### 3.12.1 Project Component 1a

**[20%] increase in riparian woody vegetation against baseline (across entire programme area) within 5 years of project start date.**

Specific activity components will be determined by means of methodology development in consultation with landowners and local communities, but will need to include the following:

- Baseline survey
- Site preparation (including fencing where necessary)
- Determining species to plant including blend of woody and non-woody species
- Securing a reliable supply of woody species to plant
- Determining minimum width of riparian margin to plant
- Determining the density of plantings
- Post-planting site maintenance (including watering, weeding, fence maintenance)
- Monitoring and reporting

### 3.12.2 Project Component 1b

**[20%] increase in agroforestry plantations against baseline (across entire programme area) established on riparian lands within 5 years of project start date.**

Specific activity components for Project Type 1b will replicate those activity components for 1a but with the plantings comprised of agroforestry species. This will also necessitate additional activity components as follows:

- Determine agroforestry benefits sought by landowners and local community
- Training for agroforestry management, product processing and marketing (where relevant)
- Agroforestry production infrastructure support (e.g. purchasing bee hives, or nut processing technologies)



Figure 3.15 Bees to support agroforestry initiatives

### 3.12.3 Project Component 2a

**[20%] reduction in fertiliser use across 80% of riparian project management area within 5 years of project start date.**

Specific activity components for Project Type 2a will result from methodology development through consultations with landowners and land managers. This will include:

- Baseline survey (e.g. recording fertiliser usage prior to project intervention)
- Training in more sustainable agricultural practices
- Trialling alternative management (e.g. reducing fertiliser input; changing fertilizer type; replacing fertilizer application with application of different nutrient cycling practice)
- Determining whether co-financing is required to enable an effective transition to more sustainable land management practice.
- Potential provision of performance-based incentive financing during period of transition towards more sustainable land management practice.
- Planning for post-incentive payment period to increase the probability that behaviour change will endure beyond incentive payments (if the latter is undertaken)
- Project monitoring and reporting.

### 3.12.4 Project Component 2b

**[40%] reduction in cattle gaining direct waterway access (across entire programme area) within 5 years of project start date**

Specific activity components for Project Type 2b will result from methodology development through consultations with landowners and land managers. This will include:

- Baseline survey and site mapping. This will include recording pre-project extent of cattle gaining direct access to streams, and streams targeted for cattle exclusion.
- Determining water supply requirements of cattle husbandry on project site and determining whether additional water supply solutions are required (e.g. stream-fed piped water to water troughs)
- Calculating the cost of water supply and fencing solutions and determining whether existing farm cash flow can cope with additional capital expenditure, and/or the extent to which co-financing is necessary.

- Project plan for water trough and fencing installation.
- Performance-based disbursement of funds for water trough and fencing installations. This could include partial payment to enable technology purchases, followed by full payment after fence and water trough solutions have been successfully installed.
- Preventive maintenance plan (for water trough and fencing) integrated into performance-based financing model.
- Project monitoring and reporting.

### 3.12.5 Project Component 3a

**[30%] reduction in untreated point source pollution discharges against baseline within 5 years of project start date.**

Specific activity components for Project Type 3a will result from methodology development through consultations with landowners and land managers. This will include:

- Baseline survey and site mapping. This will include recording pre-project extent of point source pollution discharges into the Tagabe stream system.
- Determining legality of existing discharges and regulatory requirements incumbent upon discharge licence holders (where relevant).
- Determining capacity of discharge licence holder to upgrade treatment of discharge system to reduce or prevent contaminants entering stream system.
- Calculating cost of treatment systems or other solutions and determining extent to which discharge licence holder has capacity to absorb costs of upgraded treatment system.
- Consideration of performance-based financial incentives to enable discharge licence holder to successfully transition to an upgraded system.
- Consideration of legal penalties for failure to continue with upgraded treatment system following project intervention.

A summary of point sources of pollution as determined by the community gathered from the Port Vila PEBACC workshop in June 2017 can be found in Appendix 8.1.



Figure 3.16 Sketch of community estimations of important point sources of pollution entering rivers  
(Port Vila PEBACC workshop June 2017)

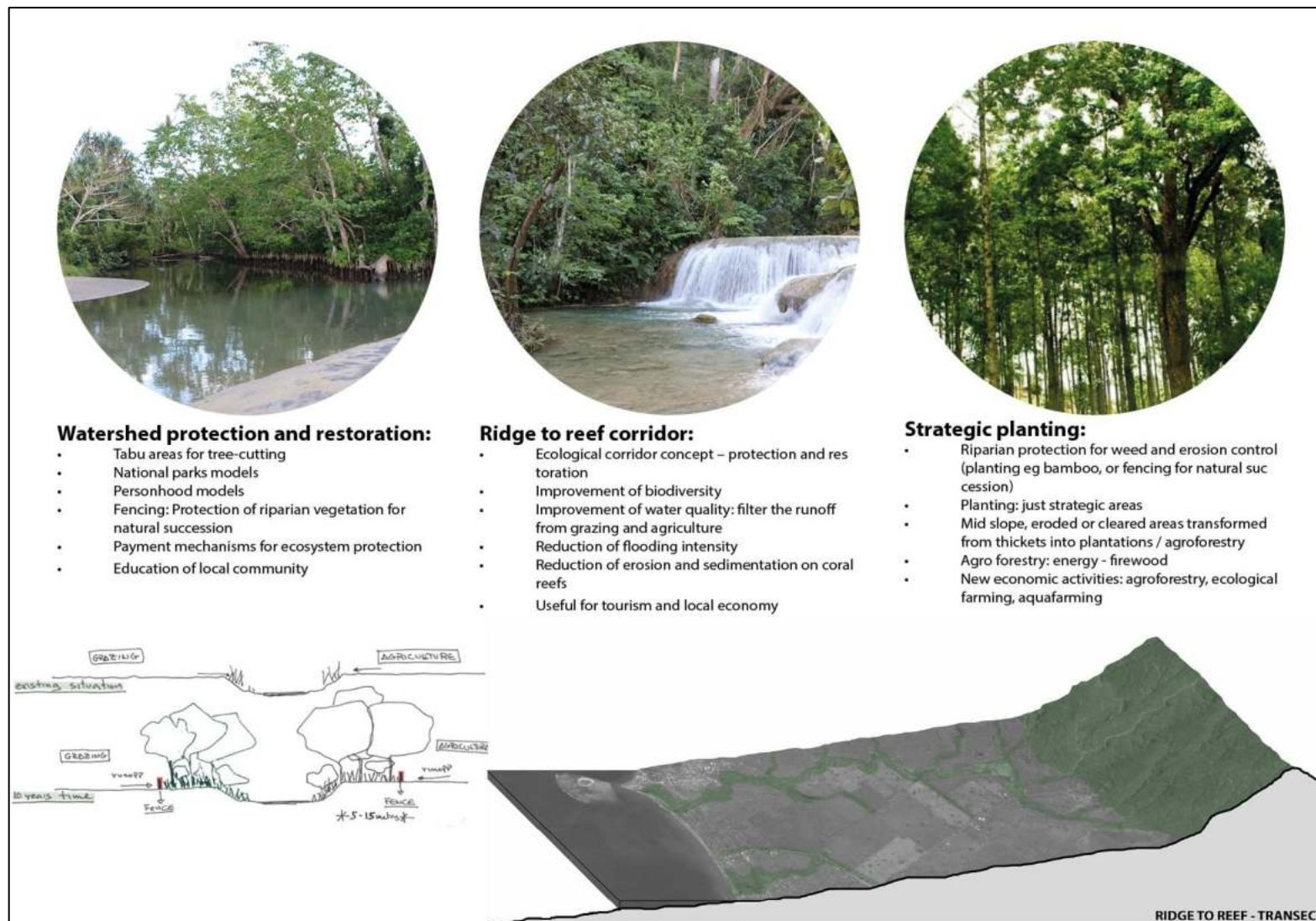


Figure 3.17 Project components of a Tagabe Riparian Corridor Regeneration project

### 3.12 Starter and smaller project components: how to start the project

To have a measurable impact on a riparian system, a riparian management project or programme needs to happen at scale. The realities of progressing to scale, however, typically require a strategic approach that starts where the project is relatively easy to implement and then expand the geographical reach of a project from a solid base. This means that smaller projects e.g. components 1a or 1b (sections 3.12.1 and 3.12.2) can function as pilots or demonstration activities that are designed to test the project model and sensitize the wider community to the targeted activity. Policy support can also be very helpful in the strategic development of a catchment programme. Here a government jurisdiction can signal that regulation will be imposed at some future date (i.e. command and control approach), but also that voluntary participation in an incentive programme may enable landowners to move ahead of regulation and take advantage of incentive financing. For example, allowing livestock to have direct access to rivers could be put onto a medium-term policy agenda whereby such activity will become illegal after 10 years, but where a government-supported voluntary programme can enable landowners to undertake incentivised early action at a much lower cost than if they wait until regulatory constraints are implemented.

### 3.13 Roles and Responsibilities

A programmatic approach using a performance-based financing model will benefit from having an organisational structure with the following entities and roles (or similar):

#### Programme Operator entity role (supply side):

- Programme coordinator across all projects and activity types
- Programme financial management
- Technical support for projects
- Quality control and quality assurance
- Government relations
- Funder relations

#### Project coordinator (supply side):

- Project coordination and management
- Training provider to project participants
- Project co-management with project participants
- Leads technical and operational matters
- Liaison with Programme Operator

#### Project participant (supply side):

- Project owner (e.g. landowner or land manager)
- Long-term responsibility for project outcomes

#### Project verifier (supply side):

- Quality assurance of measurable outcomes

#### Project standard:

- Criteria upon which quality assurance is based. This could be a regulatory requirement in the case of point-source pollution or an independent environmental standard designed for sustainable land management activities

#### Project Development Funder (demand side):

- Provides finance for programme and project development. This brings the programme and each specific project into a position where it is ready to deliver measurable outcomes. This covers the set-up costs of a project.

#### Project outcome Buyer (demand side):

- Provided finance for the purchase of measurable outcomes. These can include payment for ecosystem services, and payments of performance-based incentives to stimulate behaviour change among project participants

### 3.14 Education, research, training and public awareness opportunities

At the programme level, community education and public awareness is a key deliverable in community consultations and funder consultations (see: table 3.4). At the project level, project scoping undertaken during the phase of project development will determine the education, research, training and public awareness requirements specific to each project. In general, projects will operate according to the principles of Free, Prior and Informed Consent (FPIC) and this requires participant education and training sufficient for consent to be informed. Baseline surveys (empirical research) are a core component of each project (see: section 3.8).

### 3.15 Indicative costs and other resourcing requirements

The intervention logic model (ILM) for the Tagabe Riparian Corridor Regeneration Project presented in section 3.7 shows the Activities, Outputs and Outcomes for short term outcomes purchased by the funder of this project. Each activity for each project type requires financial and human resources, and on this basis a detailed budget can be developed. An efficient approach to project financing would assign a high-level indicative budget, and thereafter allocate a detailed budget as a result of project scoping (incorporating methodology development community consultations and community-based project plan development). The Project Plan will contain the detailed project budget unknowable in detail until such plan has been developed.

The order of magnitude of funding to execute a programmatic approach to this initiative is based on the following resourcing assumptions:

- Programme Operator with two staff (one technical and one administrative) working full time for the duration of the 5-year programme.
- Office overheads for two Programme Operator staff.
- External consultants (providing support for FPIC, technical and financing programme elements).
- Core project development funding for each project (allocated to project coordinator entities).
- Quality control and quality assurance (e.g. verification audits).
- Core project support funding for each project (allocated to project participants).

#### **Indicative total cost over 5 years: \$NZ1 million - \$1.2 million.**

Required inputs and resources:

- Personnel:
  - 1 FTE manager and 0.5 FTE technical staff; say \$80 000 - \$110 000 p.a. for 5 years, i.e. \$400 000 – \$550 000.
  - consultants: \$70 000 (Year 1), \$30 000 (Years 2-5), i.e. \$190 000.
  - auditor: \$20 000 every 3 years for 3 separate audits, i.e. \$60 000.
- Overheads:
  - cost unknown at this stage but allocate a minimum of \$20 000 p.a. (i.e. \$100 000).
- Core project development and support funding
  - approx. \$20 000 p.a., i.e. \$100 000.
- Materials:
  - Fencing and water troughs, approx. \$100 000
  - Nursery and plant supply, approx. \$40 000.

### 3.16 Financing, project design implications, opportunities for scaling

The financial model for this project follows performance-based payment for environmental services (PES) model as described in Blaschke et al., (2017) section 3.9. This project is structured as a 'programme of activities' and this designed to scale up through the replication of the first project activity for each activity type (see: sections 3.7, 3.8, and 3.9 above).

### 3.17 Monitoring outcomes

As described in several sections above, performance and outcome monitoring is central to the successful operation of this project. Performance monitoring is linked to the Key Performance Indicators developed for the responsibilities outlined in section 3.9 above. Outcome monitoring is based on the standards set out in section 3.8 above, and is dependent on comparison with the baseline study described in table 3.10.

### 3.18 Addressing barriers to implementation: What could go wrong?

There are a number of potential barriers to successful implementation of this ambitious project. These include:

#### 3.18.1 *Complex conflicting land tenure and land use arrangements:*

These can be addressed by means of a strong governance body lead by landowners but with meaningful roles for stakeholders and government agencies.

#### 3.18.2 *Non-cooperation with riparian protection policies and measures:*

This can only be addressed by strong overall community ownership and recognition of shared aims, backed up by strong traditional and contemporary leadership and management of practical land management issues. The incentive-based management structure outlined in previous sections will also help to create incentives for cooperative behaviour if the roles of the supply entities are set up with clear and achievable goals.

#### 3.18.3 *Damage from storms and adverse climate events:*

These have the potential to be very disruptive in both headwater and downstream areas. They can only be faced with effective disaster response management (at national, regional and local levels) and strong long-term leadership of local institutions.

#### 3.18.4 *Inadequate response to pollution sources and incidents:*

This is mainly an issue for downstream areas. This is partly a resourcing issue and can also be addressed by a good relationship between government and non-governmental interest groups, and by robust policy, including implementation, compliance monitoring and enforcement, for addressing water quality problems.

### 3.19 Relationships to other projects

#### 3.19.1 *Port Vila PEBACC*

This project directly links into other proposed PEBACC projects such as the Coastal Restoration project, the Urban Trees project, and the Urban Agriculture project, all in the lower Tagabe catchment. This means knowledge, skills, staff, and possibly funding opportunities can be shared across these programmes where objectives align. There is a particular alignment of technical skills required for some of the tree planting aspects of the coastal vegetation project and therefore a 50:50 split of a technical manager's time between these two projects may be advantageous for both projects.

#### 3.19.2 *Greater Port Vila Planning Scheme (Draft)*

Most of the lower and mid Tagabe catchment including riparian areas fall within the scope of the Greater Port Vila Planning Scheme. Mid-catchment areas are mainly within the Rural Zone within Shefa Province, while the lower catchment is within a range of peri-urban, residential and urban zones within the Port Vila Municipal boundary, as well as including restricted areas zones such as Riparian Reserve and Foreshore Area. Draft policies in the latter two zones are quite restrictive towards development. For example, the Riparian Reserve zone "is intended to act as a buffer area to

waterways and includes riparian vegetation and should be protected and rehabilitated where required. Development should not occur in this zone” [without adequate setbacks where development is proposed] (p. 21). It is apparent that the draft Planning Scheme proposes controls on development, yet it is not apparent that policy outcomes (or breaches) are being effectively monitored or implemented. Achievement of the aims of the Tagabe Riparian Corridor Regeneration project is at least partly dependent on effective completion and implementation of the Greater Port Vila Planning Scheme.

### 3.19.3 Other projects

Tagabe Water Management Area Management Plan and ELMA land reserve proposal: These are both highly complementary projects and there needs to be good cooperation with both of them. There is an opportunity to share resources between these three projects.

Work on the Matnakara (Tagabe) Water Management Area Management Plan focusses on maintaining the quality of the Port Vila water supply and its source area in the Tagabe catchment area. Current work on the plan involves zoning and controlling land use activities in the vicinity of water extraction bores near the Freswind community. Work is under the management of a representative watershed management committee.

The Efate Land Management Area (ELMA) project is a proposed protected area in the central region of Efate (approximately 20% of the island’s area). The project is the vision of the Vaturisu Council of Chiefs and the communities of Efate, to preserve and protect the natural resources, land and water within a large area of unleased custom ground in the central part of the island of Efate. The ELMA seeks to protect and conserve the terrestrial and aquatic environments within the protected area, whilst ensuring that local people, particularly Man Efate (people originally from Efate) are able to use the area in a sustainable manner to support subsistence lifestyles and local livelihoods and economies. The area is envisioned to become a legislated protected Community Conservation Area under Vanuatu's *Environment Protection and Conservation Act 2002* or the *Water Resources and Management Act*.

## 4.0 Restoration and Protection of Coastal Vegetation Project Implementation Plan

### 4.1 Abstract

This project aims to restore and protect coastal vegetation, particularly mangrove habitats, along key parts of the greater Port Vila coastline. The project has been designed to protect the very significant and generally well-recognised ecosystem service values provided by these habitats. It is centred on a practical restoration component of replanting and regenerating areas where mangroves and other important coastal tree species have been depleted. Restoration work would be undertaken as a co-management approach between local communities, NGOs, government agencies and other stakeholders. Many businesses (especially coastal resorts) and infrastructure providers are dependent on stable coastal habitats and climate change adaptation measures, and must be seen as important stakeholders in this project. There is also a policy component, of strengthening the institutional arrangements at the urban, provincial and national level for protection of mangrove and other coastal forest habitats. An important complementary component would be to reinforce provisions in the Greater Port Vila Plan (Municipal Council of Port Vila, 2017) for encouraging coastal vegetation and protecting mangrove areas. The project builds on and implements earlier work under the Mangrove Ecosystems for Climate Change Adaptation and Livelihoods (MESCAL) programme.

### 4.2 Coastal restoration project aims and purpose

The vision is that “all remaining mangrove habitats and significant coastal forest on the Port Vila shoreline are securely protected for all to enjoy their many benefits, and that successful restoration and enhancement of these habitats is actively supported by all Port Vila residents and stakeholders”. An “action-oriented” working title could be: “*Protect and restore Port Vila’s valuable mangrove habitats and coastal forests*”.

Specific aims and outcomes:

- Follow up and implementation of the relevant findings and recommendations of the Mangrove Ecosystems for Climate Change Adaptation and Livelihoods (MESCAL) programme.
- Addressing of specific threats to mangrove and other coastal habitats in the Port Vila area.
- Design and implementation of robust measures for the full mitigation or offsetting of mangrove and other coastal habitats if unavoidable loss occurs.
- Implementation and monitoring of site-specific replanting and restoration projects in key Port Vila sites.

### 4.3 Background

Mangrove habitats and other coastal forest types are a prominent part of Port Vila’s long shoreline. The most abundant mangrove species include: *Rhizophora stylosa*, *R. apiculata*, *Bruguiera gymnorhiza*, *Sonneratia alba*, and *Avicennia marina* (Port Vila Urban Development Project 2011). Non-mangrove communities include vegetation with prominent *Pandanus*, *Calophyllum inoplyllum* (tamanu), natungura and sea poison tree (*Barringtonia asiatica*), all of which are used by local communities.

Similarly to what has occurred in cities in tropical and sub-tropical zones world-wide, these forest types have declined significantly in extent and condition over the last 40 years as the Port Vila urban population and resulting development pressures have increased, as shown in Tables 4.1 and 4.2.

Most individuals agree on the need for conservation of coastal vegetation especially mangrove habitats because of their many benefits. Even occasional transgressions of consensus values have cumulative effects of loss, so effective mechanisms for enforcing laws and policy need to be found. Restoration and enhancement of mangrove and other significant coastal forest will correspondingly increase the benefits of these habitats.



Figure 4.1 Fatumaru Bay loss of mangroves

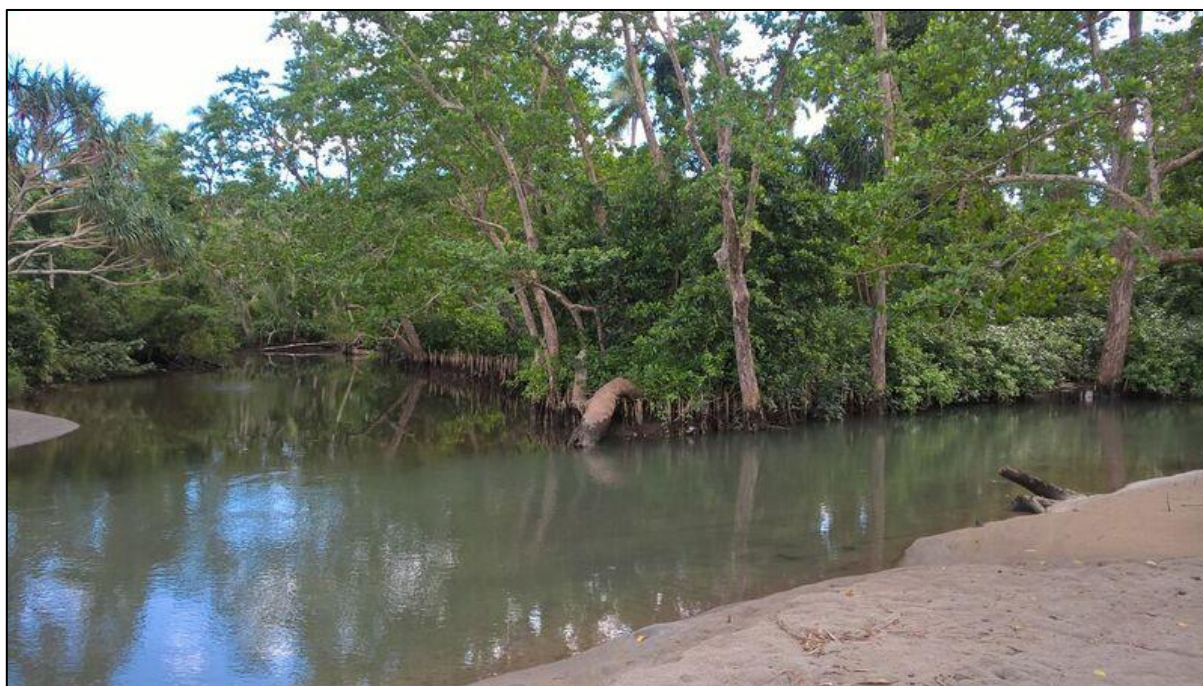


Figure 4.2 River mouth mangroves, Mele Beach west

#### 4.4 How would a coastal restoration project reduce the degradation of local ecosystems?

The main causes of ecosystem degradation that coastal restoration and protection would reduce, or potentially increase resilience to, if the project was implemented and maintained effectively are summarised in table 4.1.

**Table 4.1 Causes of ecosystem degradation that a coastal restoration and protection project could reduce or increase resilience to**

Black text = Local human caused drivers of change. Blue text = Climate change drivers of change.

L = low, M = medium, and H = high in terms of how effectively the project might address these causes of change. First grade is catchment level, second is at localised site.

\* = low level of certainty based on literature reviews, precedents, and common sense. \*\* = medium level of certainty. \*\*\* = high level of certainty. All assessments made on the assumption that project is successfully implemented.

Coastal Regeneration targets these drivers of change:		Justification:
Causes of Degradation of Terrestrial Ecosystems	Removal or over-harvesting of coastal vegetation for agriculture / firewood / building/ development L/H	Increasing coastal vegetation reduces the impacts and losses of these ecosystems and the services they provide**
	Rapid unplanned urbanisation near coast L/H	Strategic spatial prioritisation areas for restoration may help to reduce unplanned encroachment onto important areas. If space is taken up by these restored or protected habitats important trees, people may not use or clear this space for development. Areas that are vegetated are less likely to have rubbish dumped on them. **
	Spread of invasive species L/M	Cleared/degraded areas are likely to be invaded by weeds and may provide habitat for animal pests. Reduction of cleared or degraded areas would generally lead to reduction in spread of invasive plant species and animal pests. *
	Sea level rise and Increased flooding and storm surge risk L/H	Trees can prevent or reduce erosion of riverbanks and coastal areas during storms and flood events. This in turn can reduce inundation. ***
Causes of Degradation of Freshwater Ecosystems	Increased sedimentation in rivers and estuarine areas L/M	Increased vegetation can help to prevent erosion or movement of soil or debris during rain, and therefore can reduce sedimentation in rivers.**
	Input of pollutants into rivers L/M	Vegetation can slow the movement of pollutants into waterways or in some cases can remediate soil or water pollution. Vegetation can also prevent people from dumping solid waste in areas. *
	Unplanned urbanisation encroaching on riparian and estuarine areas M/H	Allocation of land to or protection of trees / vegetation along riversides and estuarine areas is likely to reduce amount of clearance for development ** and may prevent informal building.*
Causes of Degradation of Coastal Marine Ecosystems	Run-off of land based pollutants directly into ocean L/L	Vegetation can physically slow the movement of pollutants into the ocean. *
	Coastal erosion L/M	Increased vegetation can prevent coastal erosion. **
	Increased ocean water turbidity L/-	Increased vegetation on land can prevent some erosion and sedimentation, and therefore turbidity. **
	Loss of reef biodiversity and ecological function from over-harvesting or exploitation M/M	Reef biodiversity and ecological function is affected by mangrove habitat health so can be benefitted from increased amount or health of that mangrove habitat.**
	Climate-driven loss of reef biodiversity and ecological function (increased temperature, acidity, physical storm damage) M/M	Reef biodiversity and ecological function is affected by mangrove habitat health so can benefit from increased amount or health of that mangrove habitat.**

**Table 4.2 Impacts of ecosystem degradation that a coastal vegetation restoration and protection project could reduce or address**

L = low, M = medium, and H = high in terms of how effectively the project might address these impacts.

\* = low level of certainty. \*\* = medium level of certainty. \*\*\* = high level of certainty. Note: All assessments made on the assumption that project is successfully implemented

	Impacts on ecosystems:	Impacts on human wellbeing and resilience:	Justification:
Degraded Terrestrial Ecosystems	<ul style="list-style-type: none"> <li>Reduced ability of land to absorb storm water</li> <li>Increased erosion and soil loss</li> <li>Increased silting / sedimentation</li> <li>Damage to seagrass and coral reefs</li> </ul>	<ul style="list-style-type: none"> <li>Increased flooding of homes, infrastructure, crop and garden land</li> <li>Reduced access to plants that are culturally significant</li> </ul>	<ul style="list-style-type: none"> <li>Urban trees may prevent some of the causes of freshwater degradation (erosion, flow of pollutants into rivers). Some trees can also remediate soil and water pollution. **</li> <li>Increased vegetation can help to prevent erosion or movement of soil or debris during rainfall events along rivers, on the coast or on slopes. ***</li> <li>Increased areas of vegetation in built up areas translates to increased permeable areas. This slows storm water flows. ***</li> </ul>
Degraded Freshwater Ecosystems	<ul style="list-style-type: none"> <li>Degradation of coastal systems (mangrove, seagrass, reef)</li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to, or more expensive food (marine / fresh water)</li> <li>Reduced physical health and increased health care costs</li> <li>Negative impact on tourism</li> <li>Loss of recreational use</li> </ul>	<ul style="list-style-type: none"> <li>Urban trees near waterways may prevent some of the causes of freshwater degradation such as erosion and flow of pollutants into rivers. Some trees can also remediate water pollution. **</li> <li>Increased vegetation, depending on location, can help to preserve riverbanks which in turn can reduce damage from flooding. **</li> </ul>
Degraded Coastal Marine Ecosystems	<ul style="list-style-type: none"> <li>Increased silting in coastal areas</li> <li>Reduction of sediment stabilising</li> <li>Reduced fish nursery / feeding grounds</li> <li>Decline of coastal marine systems</li> <li>Decline of habitat of culturally important species</li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to, or more expensive food (marine)</li> <li>Reduced physical health and increased health care costs</li> <li>Less flood / storm surge / coastal erosion / tsunami protection</li> <li>Increased storm / sea level rise damage and cost</li> <li>Negative impact on tourism</li> <li>Loss of recreational use</li> </ul>	<ul style="list-style-type: none"> <li>Urban trees may prevent some of the causes of coastal ecosystem degradation (due to erosion, flow of pollutants into rivers). **</li> <li>Increased vegetation, depending on location can reduce the effects of flooding, storm surge, and tsunami. **</li> </ul>

#### 4.5 How would a coastal restoration project increase communities' resilience?

The main ways that coastal restoration and protection address or increase resilience to vulnerabilities or issues that ecosystem degradation and climate change cause for people (if the project was to be implemented and maintained effectively) are summarised in table 4.2.

#### 4.6 Key benefits of coastal restoration

A project to protect and restore these valuable habitats would have the following benefits in summary are shown in figure 4.3



Figure 4.3 Major benefits of a coastal restoration project

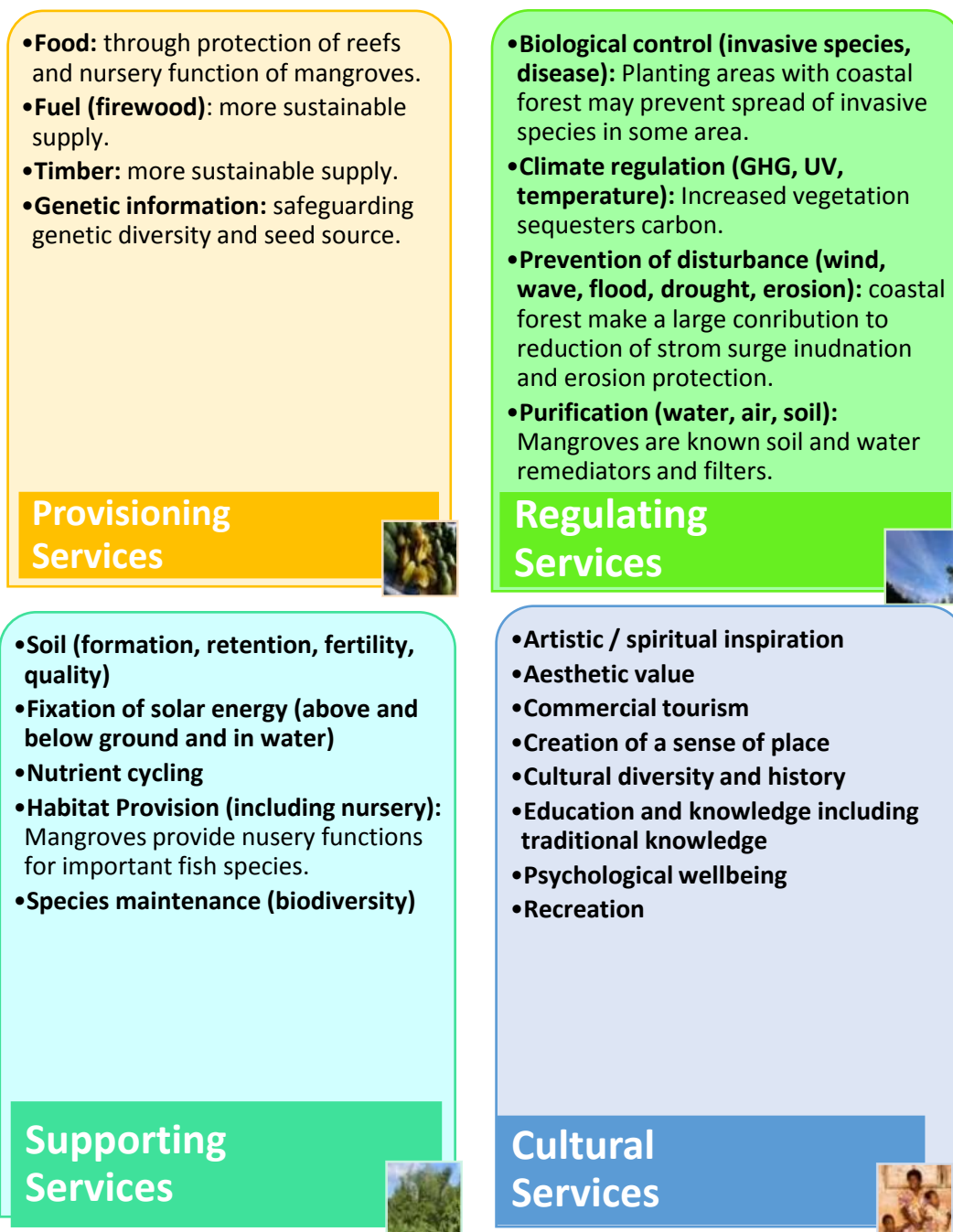


Figure 4.4 Ecosystem services benefits of coastal vegetation restoration and protection project

Coastal forests deliver many ecosystem service benefits to people in the areas where they occur as summarised in figure 4.4. Similarly to what has occurred in cities in tropical and sub-tropical zones world-wide, these forest types have declined significantly in extent and condition over the last 40 years as the Port Vila urban population and resulting development pressures have increased, as shown in tables 4.1 and 4.2. Some coastal vegetation is also destroyed by large storms, as occurred most recently and destructively during after Cyclone Pam in 2015. Almost all individuals seem to agree on the need for conservation of coastal vegetation, especially mangrove habitats, because of their many benefits. But even occasional transgressions of consensus values have cumulative effects of loss, so effective mechanisms for enforcing laws and policy need to be found. Restoration and enhancement of mangrove and other significant coastal forest will correspondingly increase the benefits of these habitats.

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*'The people are dependent on the mangrove ecosystem to ensure a certain [part of their] sustainable livelihood, its resources are abundant and satisfy the most basic needs like food and shelter... The abundance of crabs, shells and fishes supplied by the ecosystem ensure food security for the villagers, especially those without [salaried] jobs.... With market prices fluctuating unreliably, this ecosystem service of supplying free food gives them an advantage.... The ecosystem service serves as a back-up for food, housing materials, gardening tools, etc., and also as a means of earning some income' (Pascal and Bulu, 2013).*

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#### 4.7 Intervention Logic

The summary of intervention logic for this project, as described in Blaschke et al. (2017), is summarised in outcome terms as follows (cf table 3.6):

##### Long-term outcome:

All remaining mangrove habitats and significant coastal forest on the Port Vila shoreline are securely protected for all to enjoy their many benefits, and that successful restoration and enhancement of these habitats is actively supported by all Port Vila residents and stakeholders. Any unavoidable loss of habitats is fully mitigated or offset.

##### Medium-term and short-term outcomes

###### 1. Coastline revegetation

**Medium-term outcome:** Complete restoration or replanting of at least 10ha of forested shoreline habitats has occurred within 10 years of project start date.

**Short term outcomes:**

- a. Replanting of at least four areas of forested shoreline habitats each of at least 1 hectare, has occurred within 5 years of project start date.
- b. Natural regeneration of mangrove or other coastal forest species has been documented in at least four separate coastal areas within 5 years of project start date.
- c. Adequate seed and or/rootlet sources sufficient for supplying at least 4 ha of coastal forest replanting per year are available within 5 years of project start date.

###### 2. No net loss of vegetation

**Medium-term outcome:** There is no documented net loss of mangroves or coastal forest on the Port Vila coastline.

**Short term outcomes:**

- a. Policy gaps for vegetation protection have been identified and addressed within 5 years of project start date.
- b. Secure long-term funding for coastal revegetation is available within 5 years of project start date.
- c. Mitigation and offset provisions for situations of unavoidable loss of habitats are in place and successfully implemented within 5 years of project start date.
- d. Complaints to Port Vila Municipal Council or Shefa Provincial Council, or published news reports, concerning unauthorised sand mining on the Port Vila coastline, are fewer than 3 per year.

#### 4.8 Project location, ridge-to-reef position

The distribution of mangroves on Efate is limited, covering a total of about 40 hectares. In Port Vila the largest remaining areas of mangroves are found along the banks of the Erakor and Nambatu (Emten) lagoons and on the southern coasts around Eratap (in part outside the Greater Port Vila area). Small areas occur at Seaside, Mele, Blacksands (Tagabe River mouth), Fatumaru Bay, and Ifira. The suggested areas for restoration work focus on the Tagabe River mouth, the Fatumaru estuary, and the Erakor and Emten Lagoons (figures 4.5-4.7). These areas include landowner villages, established and informal settlements, and privately-owned lease areas including resort frontages.

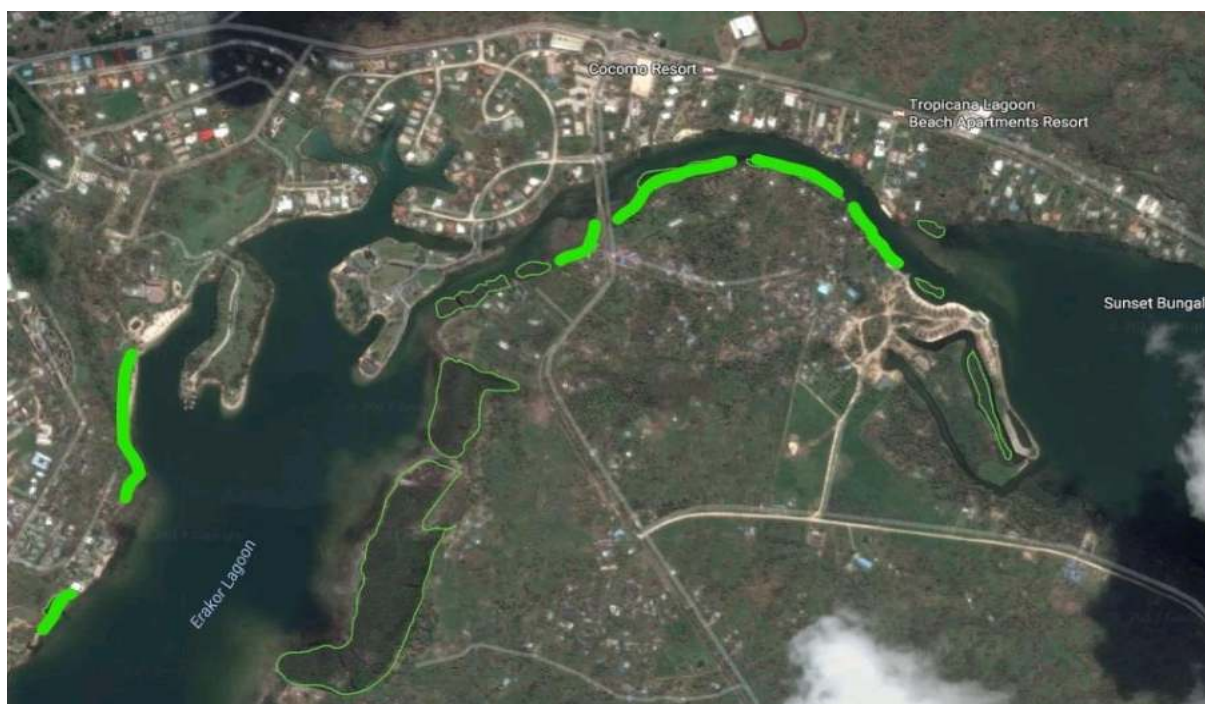


Figure 4.5 Erakor Bridge potential mangrove restoration areas



Figure 4.6 Tagabe-Mele potential mangrove restoration areas



Figure 4.7 Fatumaru Bay potential mangrove restoration areas

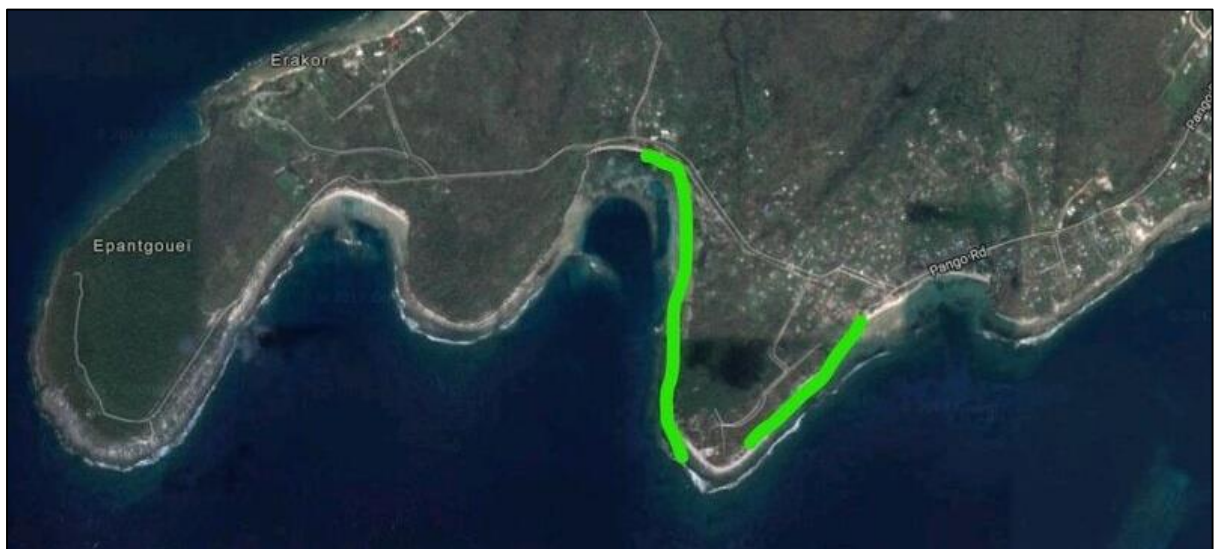


Figure 4.8 Pango potential coastal reforestation areas

#### 4.9 Timeframe and sequencing

Stages 1 and 2 are project-financed. Stage 3 would be independently financed through carbon credits and/or sponsorship.

**Stage 1: 2017-8:**

- Complete project planning and initiation.
- Policy development, including policy to address beach access issues and sand mining from beaches.
- Initiate and plan community restoration efforts, source propagation stock, baseline monitoring.

**Stage 2: 2018-20:**

- policy implementation.
- Implement restoration, up to four small areas (<1ha each site).

**Stage 3: 2020-30:**

- policy monitoring and compliance management.
- Implement restoration, extended areas (>1ha each site).

#### 4.10 Description of project components

##### 4.10.1 Practical restoration components

Identify specific threats in the target areas. Replanting and regenerating areas where mangroves have been depleted, and other coastal vegetation areas. Research by Barbier (2012) cited in Pascal and Bulu (2013) suggests that a width of 100m of 100m out to sea is optimal for the attenuation of storm waves.

##### 4.10.2 Secure seed and rootlet sources

Potential sources include:

- Department of Forestry nursery in Tagabe: expansion of this source would be needed.
- DARD (Department of Agriculture and Rural Development): provided natungura seedlings after Cyclone Pam<sup>1</sup>.

##### 4.10.3 Traditional knowledge integration

A project to protect and promote traditional knowledge to conserve mangrove and other coastal vegetation should be seen as an essential component of the project. This project could include, among other things, the collection and documentation of traditional knowledge, integration of traditional knowledge into the development of strategies and management plans for sustainable harvest when mangrove or other timber products are wanted for high-grade timber, and, perhaps most importantly, the development of contemporary Tabu mechanisms for the protection of vegetation from clearance.

Pascal and Bulu (2013) describe how for the community on Amal Bay in Malekula the work of the well-established conservation committee is difficult in response to challenges of occasional non-compliance and emergency needs. In Erakor, a multi-cultural community with different beliefs, backgrounds and life goals, there is no conservation committee and reaching agreement is seen as difficult. Nevertheless, a multi-stakeholder conservation committee (represents both landowner and settler interests as well as other stakeholders) that has status and responsibility to work through management issues and towards consensus on essential conservation requirements, would seem a way forward.

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<sup>1</sup> See: [http://dailypost.vu/news/natangura-seedlings/article\\_792b51f1-235b-5a44-9b6e-9be78d6130b6.html](http://dailypost.vu/news/natangura-seedlings/article_792b51f1-235b-5a44-9b6e-9be78d6130b6.html)

#### 4.10.4 Policy Components

Policy components at the urban, provincial and national levels are essential. These components include:

- Reinforcing provisions in the Greater Port Vila Plan (to the extent that coastal areas are covered by the plan) for encouraging coastal vegetation and protecting mangroves.
- reviewing legislation and local/provincial/national policy to ensure appropriate emphasis is put on avoidance of coastal forest loss.
- designing robust and enforceable mitigation/offset provisions for unavoidable mangrove / coastal forest loss that ensures no net loss of mangrove and coastal forest.
- develop policies to regulate sand-mining to either prohibit sand-mining or reduce it significantly in at-risk coastal areas, particularly Mele and Blacksands, in order to protect the coastal shoreline and adjoining property and infrastructure, and to ensure longevity of any coastal revegetation projects.
- Generally, several of these components repeat and develop policy measures suggested in the MESCAL programme.
- Research and implement carbon sink financing components and incentives for long-term funding. For example, recently the Green Climate Fund has disbursed money to Vanuatu to increase the country's capacity to access climate finance and to expand the use of Climate Information Services in Vanuatu to integrate climate change and disaster risk reduction more closely<sup>2</sup>. The MESCAL project has provided good evidence of the relatively high ecosystem services values of mangrove ecosystem, and this work provides a basis for seeking climate finance.
- Rubbish clean-up projects in and around mangrove habitats, especially at Erakor Bridge and the narrow opening to Erakor Lagoon: Mangrove habitats are often seen as places to dump rubbish. This is harmful to organisms that visit mangrove habitats e.g. mud crabs (*Scylla serrata*), molluscs, juvenile fish and various bird species. Plastics also disrupt efficient nutrient cycling processes in these habitats, and reduce their cultural and spiritual importance to communities. Rubbish clean-up projects involve the community and offer an opportunity to raise awareness of the important services mangrove, seagrass and coral ecosystems provide.



Figure 4.9 Rubbish near mangrove area at Mele



Figure 4.10 Sand mining at Mele Beach

<sup>2</sup> See: <https://vanuatuindependent.com/2017/06/28/gcf-helps-vanuatu-smooth-climate-finance-path/>

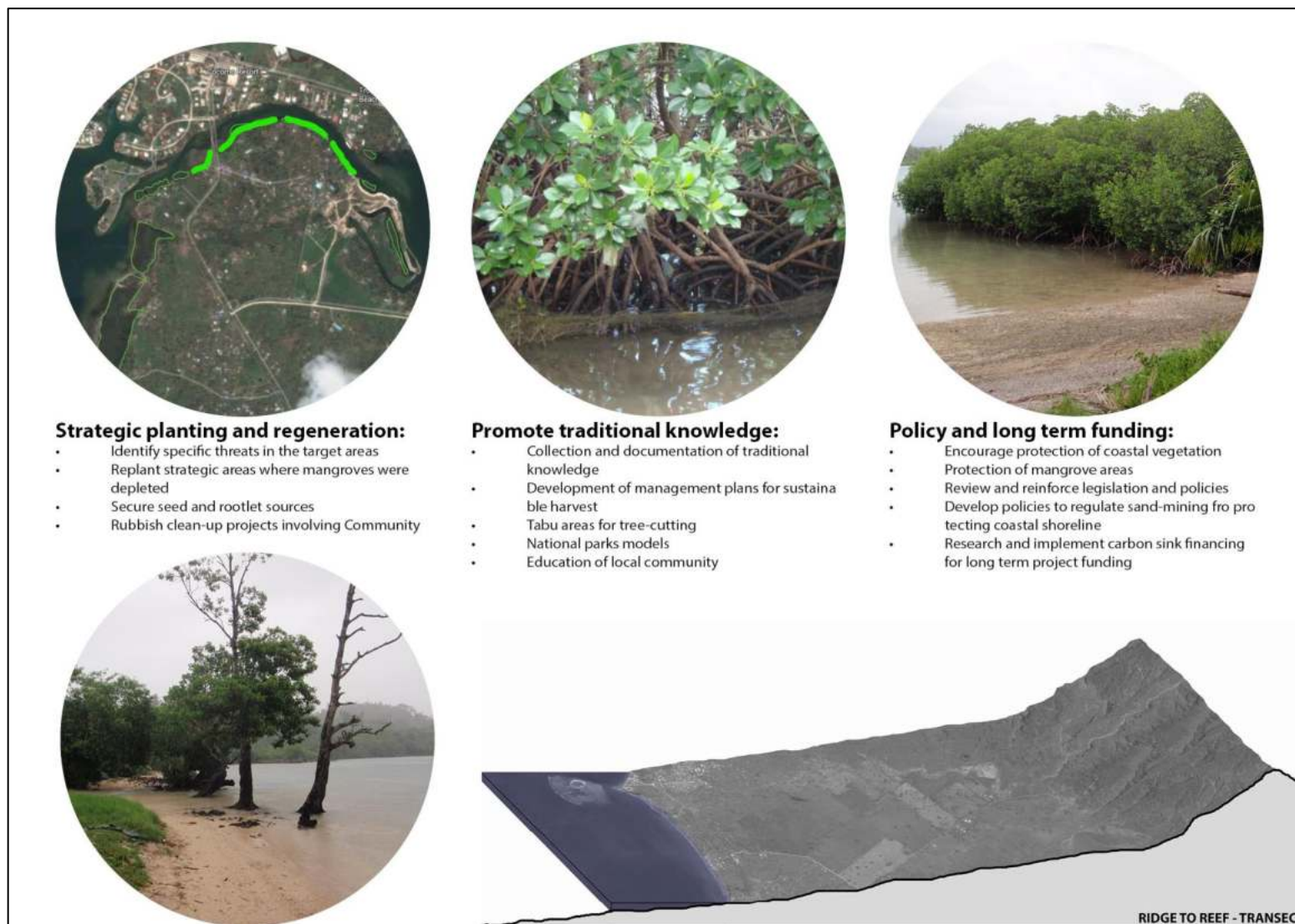


Figure 4.11 Project components of a coastal restoration and protection project

#### 4.11 Starter and smaller project components: how to start the project

If a shorter term project is required as a starting point, a focus on some of the short term restoration/replanting components suggested in section 4.7 above is recommended. Work would aim towards the medium-term outcome of restoration or replanting of at least 10ha of forested shoreline habitats within 10 years of project start date. Short term projects within this programme could then focus on the replanting of at least one area of shoreline habitat (suggested minimum area of 1 hectare). An area would need to be selected for this project, and baseline monitoring of canopy vegetation in this area should be done before planting, to enable later outcome monitoring.

Adequate seed and or/rootlet sources will need to be available for this replanting work. As noted in the urban trees project plan (see: section 3.6), before any planting on a number of our suggested projects can begin, Port Vila needs a comprehensive and inclusive nursery system that can supply seeds and/or seedlings to these projects, along with other non-PEBACC projects. Therefore, establishment or expansion of a reliable nursery capable of providing seed and planting stock for a range of projects would also be a suitable starting project component.

Policy aspects of this project are longer term and probably more ambitious but no less important. Initial policy-oriented work should focus on: work on relevant aspects of the Greater Port Vila plan; identifying specific policy gaps for coastal vegetation protection; and strengthening government systems for effective environmental monitoring.

#### 4.12 Implementers and stakeholders. Who should be involved?

##### 4.12.1 Landowner communities/villages

- Pango Chief/s (Pango).
- Ifira Chief/s (Ifira, Blacksands and Fatumaru Bay).
- Seaside (Chiefs from Tongoa, Paama and Futuna communities, church and women's representatives).
- Erakor Village and Club Hippique Chiefs: Possibility to implement clean-up days for the Nambatu and Erakor Lagoons. In April 2016, the chiefs of the lagoon communities organised a clean-up event to address growing pollution concerns. There could be an opportunity to make this an annual/semi-annual event.

##### 4.12.2 Local NGOs

NGOs involved in Port Vila should be involved. For example:

- Fatumaru Consortium for Fatumaru estuary.
- Pango Green Force (a youth-led clean-up group).
- Vanuatu National Youth Coalition (VNYC).
- Vanuatu Environment Advocacy Network (VEAN).
- Lai Sakita.
- Vanuatu Association of Non-Government Organisations (VANGO)<sup>3</sup>.

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<sup>3</sup> VANGO recently signed a MOU with the Department of Fisheries to implement the REDD+ programme, so has an incentive to be involved in a greenhouse gas mitigation initiative; see: <https://vanuatuindependent.com/2017/03/06/vango-and-forestry-work-together-on-redd-and-climate-change/>.



Figure 4.12 Eratap Lagoon

#### 4.12.3 UNELCO and other infrastructure providers

For example, Pacific Energy is currently involved in planting sandalwood trees around Port Vila, and has been involved in mangrove replanting in Fiji and Tuvalu<sup>4</sup>.



Figure 4.13 Eratap Beach resort loss of habitat

#### 4.12.4 Tourism partners

A number of resorts are located in the priority sites and are ultimately dependent on coastal protection provided by mangroves and coastal vegetation, e.g. Eratap Beach Resort and Aquana Beach Resort in Eratap, Mele Beach resort, and several resorts on the edge of Erakor and Emten Lagoons. Resorts are important beneficiaries from mangrove and coastal forest ecosystem services and are at high risk from climate change effects (Pascal and Bulu 2013). Resort owners need to be educated and incentivised to see themselves as essential stakeholders in the protection rather than the destruction of mangroves.

<sup>4</sup> See: [http://dailypost.vu/vanuatu\\_sports/van-legacy-tree-planting/article\\_ea65920a-5b63-54b3-8c02-455131c3a4a6.html](http://dailypost.vu/vanuatu_sports/van-legacy-tree-planting/article_ea65920a-5b63-54b3-8c02-455131c3a4a6.html)

#### 4.12.5 Government

- Department of Environment Protection and Conservation (DEPC).
- NAB-CCDRR (National Advisory Board on Climate Change & Disaster Risk reduction).
- Ministry of Climate Change.
- Ministry of Lands.
- DARD (Department of Agriculture and Rural Development).
- SHEFA Provincial Government (for Mele-Devil's Point Rd and Erakor areas).
- DGMWR: Department of Geology, Mines and Water Resources.
- Department of Forestry.

Note that staff from DEPC worked in conjunction with the MESCAL project, and Ministry of Lands is involved with the implementation of a mangrove replanting project at Erakor as a follow-up to the MESCAL project. The PEBACC project would be complementary to the MOL project at Erakor.

#### 4.13 Education, research, training and public awareness opportunities

There are many opportunities to increase knowledge and awareness through this project. Education and awareness projects are centred on raising awareness of the importance of mangrove and coastal forest for the range of ecosystem services they provide. These projects need to reach a wide range of stakeholders, from residents of local communities to the managers and investors of tourism facilities and the building sector. The project component dealing with illegal sand mining also needs to address the importance of coastline stability and the effects of sand mining exacerbating climate change effects on coastal areas. The project component dealing with traditional knowledge requires much further work to document traditional knowledge and provide support for mentoring arrangements between elders and youth in aspects including natangura roofing, carving, weaving, canoe building, etc. The Vanuatu Cultural Centre's fieldworker programme and Oral Traditions Collection Project provide models for the required work and approach.

Required research includes further knowledge of local mangrove ecology and other suitable species for coastal restoration. Training will be required to improve forestry management for coastal vegetation, and harvest management of commercially significant trees such as pandanus and natangura. Community/NGO organisations that could be involved include:

- Live&Learn Vanuatu: involved with a range of climate change adaptation and environmental governance programmes. These programmes are aimed at: providing information to local communities and advocating for more responsible policies on climate change; increasing participation of women and youth; and strengthening the capacity of village councils<sup>5</sup>.
- Wan Smol Bag, a local drama group that included activities aimed at raising awareness of environmental and social issues<sup>6</sup>.

#### 4.14 Indicative costs and other resourcing requirements

##### Indicative cost over 4 years: \$NZ0.3-0.6 million.

(N.B. This indicative costing is for Stages 1 and 2 only; it is envisaged that Stage 3, 2020-2030, would be funded by carbon credits or sponsorship).

Required inputs and resources:

- Personnel:
  - 1.5 FTE staff: approx. \$40 000 - \$75 000 p.a. for 4 years, i.e. \$240 000 – \$450 000.
  - consultants: \$30 000 - \$50 000 (for each of Stages 1 and 2), i.e. \$60 000 - \$100 000.

<sup>5</sup> See: <http://www.livelearn.org/locations/vanuatu>

<sup>6</sup> See: <http://www.wansmolbag.org/>

- Office overheads:
  - cost unknown at this stage.
- Materials:
  - approx. \$2000 – \$10 000.

#### 4.15 Financing, project design implications, opportunities for scaling

The overall approach to financing the restoration component of this project is performance-based payments for environmental services (PES) as described in Blaschke et al. (2017), section 3. Such a system by no means precludes volunteer involvement in planting and other conservation activities, as the manager being paid under a PES system would be almost entirely dependent on volunteer effort to achieve those goals.

The policy component of the project would need to be substantially grant-funded. However, the funding model envisages the project to be primarily independent of grant income after the first five years by which time the policy development component would be complete, and restoration activity self-funding through ecosystem services payments or independently generated grant funding.

#### 4.16 Monitoring outcomes and governance aspects

A representative government/community coordinating group under the oversight of a government minister would be a suitable governance option. Monitoring should be outcome based. Under the three proposed stages suitable monitoring outcomes could include:

- **Stage 1:** Detailed project plan is completed and approved; policy needs are clearly identified and critical gaps addressed by draft policy. Restoration plans for four restoration demonstration sites (covering approximately 4 hectares) are complete and propagation stock for these sites available.
- **Stage 2:** Priority policy approved and compliance monitoring is initiated. Restoration of four restoration demonstration sites is complete and establishment documented. Restoration plans for a further approximately 20 hectares are complete and ongoing propagation stock sources in place. First re-monitoring of mangrove/monitoring extent on Greater Port Vila coastline.
- **Stage 3:** Policy monitoring and compliance management is fully in place. Restoration of approximately 20 hectares complete and establishment documented. Regular monitoring of mangrove/monitoring extent on Greater PV coastline. Review of programme, governance and community involvement aspects.

#### 4.17 Addressing barriers to implementation

The major barriers for this project are seen as:

1. Inertia in addressing policy gaps (national and local) in particular to address mitigation and offset processes, and sand mining.
2. Enforcement of legal and compliance requirements.
3. Landowner/settler tensions preventing adequate community responses.

The first two barriers can be overcome by adequate political will that requires action to address what is widely seen as a significant environmental pressure, as well as dynamic project leadership that can identify and make available adequate resources for successful implementation. The third barrier is part of a more pervasive social and resilience issue but, in the context of the widely-supported recognition of the importance of coastal vegetation, may be best met by a multi-stakeholder conservation committee approach as suggested above.

## 4.18 Relationships to other projects

### 4.18.1 Port Vila PEBACC

This project has an overlap with the urban trees project especially in the areas around Fatumaru Bay and on the lower Tagabe River. It also relates in part to the riparian corridor regeneration plan where rivers meet coasts. This means that knowledge, skills, staff, and possibly funding opportunities can be shared across these programmes where objectives align. There is a particular alignment of technical skills required for some of the tree planting aspects of the riparian corridor project and therefore a 50:50 split of a technical manager's time between these two projects may be advantageous for both projects.

### 4.18.2 Greater Port Vila Planning Scheme (Draft)

Almost all coastal and foreshore land within this project falls within the scope of Greater Port Vila and the Greater Port Vila Planning Scheme. Much of the land concerned is zoned Foreshore Area. Draft policies in this zone are quite restrictive towards development. For example, the Foreshore Zone *'is intended to provide buffer strips to protect the Foreshore areas from development and to enable public access to those areas. Development in the zone will only be approved if it does not have a negative impact on the environment and physical attributes of the Foreshore area'* (p. 21). It is apparent that the draft Planning Scheme proposes controls on development, yet it is not apparent that policy outcomes (or breaches) are being effectively monitored or implemented. Achievement of the aims of the Coastal Vegetation Restoration and Protection project is at least partly dependent on effective completion and implementation of the Greater Port Vila Planning Scheme.

### 4.18.3 Other programmes:

There may be potential links with other previous, current or planned projects in the region that can be explored when a detailed project development process occurs. These include:

- MESCAL programme: As described above, the PEBACC project is very complementary to the MESCAL project which ran between 2009 and 2013, and the related current MOL mangrove replanting project at Erakor. The proposed PEBACC project would work principally on the restoration component within the Port Vila metro area with a partnership arrangement between government and NGO agencies and host communities.
- Vanuatu Coastal Adaptation Project (VCAP) with support from Department of Agriculture is currently promoting planting vetiver grass to control coastal erosion, including a project at Mele. Vetiver grass is widely used around the world for erosion control but is not a native species and only just being introduced into Vanuatu, so the ecological impacts of this are unknown. It is possible that native tree species over vetiver could be an appropriate agroforestry combination for preventing eroding of sandy coastlines like Mele Beach.
- Vanuatu National Coconut Strategy 2016 – 2025 aims to provide a million nuts to communities around Vanuatu by 2025, as part of TC Pam's recovery. Communities of Mele, Erakor and Seaside could potentially benefit from this (although this programme is mainly targeted to rural communities).
- The Pacific Mini Games Environmental Legacy Plan.<sup>7</sup>
- RESCUE project: Supports the development and implementation of an integrated coastal management (ICM) plan for North Efate that is consistent with programme guidelines and the National Integrated Coastal Management Framework and Implementation Strategy for Vanuatu. The North Efate project is not spatially contiguous with the proposed PEBACC project but has complementary aims and activities<sup>8</sup>.

<sup>7</sup> See: [http://dailypost.vu/vanuatu\\_sports/van-legacy-tree-planting/article\\_ea65920a-5b63-54b3-8c02-455131c3a4a6.html](http://dailypost.vu/vanuatu_sports/van-legacy-tree-planting/article_ea65920a-5b63-54b3-8c02-455131c3a4a6.html)

<sup>8</sup> See: <http://www.spc.int/resccue/country-activities/vanuatu/>

## 5.0 Intensification of Suburban and Peri-urban Village and Settlement Home Gardens Project Implementation Plan

### 5.1 Abstract

Maintaining, or improving, food and cooking fuel security for communities in Greater Port Vila over the period to 2030 and beyond would make a major contribution to improving their resilience and overall well-being. This could be done if the extent and productivity of home gardens ( common throughout Port Vila) were to be increased and, with an eye to the future, if home gardens were made as resilient as possible to the effects of climate change.

There are many changes to common gardening practices that could make home gardens more productive, such as applying permaculture principles, intercropping and composting. Having a reliable water supply is also likely to make a significant difference; as might easier access to seeds, seedlings and cuttings . Different crops, or varieties of crops, as well as different gardening practices have the potential to make home gardens more resilient to the effects of climate change. Similarly, household freshwater fish ponds would help maintain food security and have the potential to reduce harvesting pressure on marine sources of food.



Figure 5.1 Aquaculture and home garden demonstration project (VCC, Port Vila)

A switch in diet away from Pacific staple food crops to imported food is a major factor contributing to a high incidence of non-communicable diseases (such as obesity, heart disease and diabetes) in Port Vila as in other Pacific Island Countries and Territories. Climate change is expected to contribute to reductions in global supplies of grains and this is expected to result in increased prices, and reduce affordability, in Vanuatu of rice and wheat-based foods. Increased production of Pacific staple food crops from home gardens in Port Vila has the potential to make a significant positive contribution to both of these issues.

Increased utilisation of technologies for preserving and storing food would also contribute to improved food security. Increased adoption of better practices for storing and drying firewood and increased utilisation of technologies that use firewood more efficiently would also contribute to improved cooking fuel security. There is potential within the project to improve access to traditional building materials, mat- and basket-making materials, medicinal plants and plants of cultural significance.

The situation of existing and potential home gardens throughout the suburban and peri-urban area is diverse, varying with respect to such things as size, soils, land tenure, access to a reliable supply of

water, and availability of family labour. Because of this, for the project to be successful, the precise nature of the specific support provided under this project needs to be further researched as part of a detailed project design stage and then further developed through engagement with the relevant households and communities. Because engagement with households/communities is the core means by which the project would achieve the desired outcomes, education to reduce the current over-harvesting of natangura and pandanus fits well with it. It is expected that in many cases identifying and spreading traditional knowledge would be an important part of this project.



Figure 5.2 Food preservation demonstration project (VCC, Port Vila)



Figure 5.3 Pandanus

## 5.2 Home gardens project aims and purpose

The vision for this project is that communities in Greater Port Vila become more resilient as a result of increased food and firewood security, more adequate housing, better nutrition and health, and maintaining opportunities for generating cash incomes.

Specific aims and outcomes:

- To provide cost-effective support to households in the urban and peri-urban areas of Port Vila to:
  - intensify food production, firewood supply, medicinal plants, construction materials and mat- and basket-making materials production in home gardens;
  - increase the preservation and storage of produce from home gardens;
  - increase understanding in households in the project area of which diets do, and which diets do not, provide good nutrition;
  - increase adoption of better practices for storing and drying firewood and to increase utilisation of technologies that use firewood more efficiently; and
  - increase understanding in households of which harvesting practices do, and which harvesting practices do not, kill natangura and pandanus.
- To have provisions included in the approved Greater Port Vila Planning Scheme that encourage and protect urban and peri-urban agriculture and freshwater aquaculture.

## 5.3 Background

### 5.3.1 Food

A rapidly growing population in Port Vila will mean an increased demand for food; also, climate change may have an adverse effect on locally-grown food supply, for example, as a result of increases in temperatures, changes in rainfall patterns, changes in seasonality, increased variability (resulting in more frequent crop failures), an increased spread of invasive plant species, a decline in the abundance of important pollinators or the arrival of new pests and diseases (Blaschke et al., 2017; section 2.4). Further, prices of imported grains such as rice and wheat are expected to increase in part due to

climate change-induced reductions in global yields and supply (Taylor et al., 2016). These imported foods are a significant component of household food in Port Vila and increases in price will reduce their affordability.

In their Report *Vulnerability of Pacific Island agriculture and forestry to climate change* Taylor et al. (2016, p464) state:

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*‘Perhaps the greatest impact resulting from the increase in the real price of imported grains will be to encourage rural households to grow more staple foods for their own consumption rather than use their cash income to purchase imported food. Governments should also be encouraged to support this trend by encouraging urban gardening and promoting and supporting the processing of locally produced agricultural products.’*

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Taylor et al. (2016, p226) further argue that:

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*‘[E]nhancing national and regional self-sufficiency through strengthening the production and increasing the consumption of [Pacific staple food] crops will be the most effective approach for meeting the climate and non-climate challenges projected for the future. Climate change is too often considered in isolation; decision-makers need to acknowledge that nutrition-related health challenges and climate change challenges are linked, and that by increasing the sustainable production of staple food crops both types of challenges can be addressed.’*

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Much of the vulnerability of Vanuatu food production to climate change in the period to 2030 is expected to be from cyclone damage (Taylor et al., 2016). Better, and more widespread, preserving and storage of food would improve food security in the periods following cyclone damage.

Evidence that food security and resilience is an important issue is confirmed by the fact that the Vanuatu Christian Council ran a food security training workshop for 90 women from across Vanuatu late in 2016. The objective was to train the women how to conduct their own food security assessments in their villages and how to prepare food supplies so that village families are more resilient in times of disaster.

Four in five households in Port Vila rely on wage-based salaries as their primary source of income (RMIT, 2015, p. 10). Notwithstanding this, over half the households in the Greater Port Vila area are estimated to be engaged in self-supply and consumption of fruit and vegetables and other products such as meat and poultry (McEvoy et al., 2016, pp7, 30). Production comes from both home and bush gardens: primarily fruit (banana, pawpaw, citrus), annual vegetables (such as island cabbage, corn, garlic, onions, spring onions, chilli, beans, carrots, cucumbers, pumpkins, melons, tomatoes, ginger, Fijian cabbage, lettuce) from the former and traditional root staples (yams, manioc, taro, kumala) and sugar cane from the latter (McEvoy et al., 2016, p. 20, 32, 34). Most bush gardens do not have a nearby, accessible water supply, so plants that require regular watering are generally not grown in

bush gardens. Island cabbage is grown by many households but currently few households grow other [green/coloured] vegetables (McEvoy et al., 2016, p. 22).

There is a common perception that people living in the urban area do not have enough space to grow root crops in their home gardens but the validity of this has been questioned by some (e.g. a permaculture expert) (Komugabe-Dixon, pers. com. 2017). People living in the more rural (peri-urban) areas often have more space and some do grow root crops in their home gardens.

While local growers supplying the markets and supermarkets may be able to meet the increased demand, if the consequence of that is rising prices for locally-grown fresh fruit and vegetables, this may lead to reduced affordability of these items, reduced consumption of fresh fruit and vegetables, increased reliance on 'rice, tinned fish and noodles', poorer nutrition and poorer health.



Figure 5.3 Bush garden, Port Vila

Nutrition is a serious problem in Vanuatu. The country is currently ranked 6<sup>th</sup> in the world for diabetes, and there are a number of campaigns on radio to improve diets by 'having more colour on your plate' (i.e. adding greens and vegetables to a meal in addition to just rice). This is quite a radical way of thinking because in many communities visited, a good meal was considered as one that is 'filling'. Rice is more popular to eat and is fast replacing island staples (e.g. taro and kumala) because it is cheaper to buy and also because of its novelty aspect (Komugabe-Dixon, pers. com. 2017).

As noted in Taylor et al., 2017, in 2011 the Pacific Forum Leaders acknowledged that non-communicable diseases (NCDs) (diabetes, cancer, chronic respiratory diseases, heart disease including hypertension and stroke) have reached epidemic proportions in the region and are creating a 'human, social and economic crisis', requiring an urgent and comprehensive response. Many studies have discussed how the change from a diet of predominantly root vegetables, coconuts and fresh fish to one consisting of bread, rice, tinned fish, and more processed foods high in sugar and salt have contributed to the escalation of NCDs. Improving access and availability of local, more nutritious foods would help to minimise the contribution of diet to NCDs (Taylor et al., 2016, p16; World Bank 2012).

Including education about good nutrition in the project may increase people's motivation to grow food that will improve their nutrition in their home gardens.

For some households, some of the production from their home garden is sold as a cash crop. More than 50 per cent of households in the peri-urban area grow cash crops (McEvoy et al., 2016, p. 17). Some households have limited, or no, access to a home garden (McEvoy et al., 2016, p. 20).

A rapidly growing population in Port Vila will also mean increased harvesting pressure on marine food sources and in all likelihood, reduced harvests and increased prices in the market. This is likely to increase the demand for alternative, affordable sources of fish or other types of protein.



Figure 5.4 Port Vila market

The poorer communities in Port Vila rely disproportionately on the continued integrity and functioning of local ecosystems and are often unable to replace critical 'provisioning' services through other means (McEvoy et al., 2016, p. 16).

All this suggests that, if it were possible, increasing the number, size and productivity of home gardens (including through adaptation to climate change, and the uptake of 'novel' activities such as aquaculture or bee keeping) and increasing the amount of preserving and storage of food, would improve food security and resilience for communities in Port Vila. These outcomes would be likely to also improve nutrition and health.

The cash incomes of any households able to produce more than they need for their own consumption and sell it, would be expected to increase, but, assuming that prices at the market reflect changes in supply and demand, if supply increases more rapidly than demand the cash incomes of current suppliers to the market would be expected to be less than they otherwise would have been. However,

if demand increases more rapidly than supply (for example because of increased prices of imported food, or of nutrition-motivated switches to locally grown food) that would not be the case.

### 5.3.2 Firewood

A rapidly growing population in Port Vila will also mean an increased demand for firewood for everyday cooking and for use in ceremonies (McEvoy et al., 2016, p. 34). It is possible, but seems less likely, that climate change may have an adverse effect on firewood supply.

Firewood is collected from bush gardens, forest areas and mangrove areas. Tropical Cyclone Pam created a temporary surplus of firewood (and future cyclones will likely do the same) but this resource is now running out (McEvoy et al., 2016, p. 39). Many households now regularly purchase firewood and charcoal. The firewood is considered to be expensive (McEvoy et al., 2016, p. 39).



Figures 5.5 and 5.6 Port Vila market – firewood and charcoal



Figures 5.7 Firewood harvesting near lagoon

Those supplying firewood to the market may be able to meet some or all of the increased demand but this may result in increased prices and increased affordability issues. Another way of meeting the increase in demand would be increased use of kerosene or bottled LPG for cooking but this may not be an affordable option for many households. Also, increased burning of kerosene or LPG would be undesirable because it would increase emissions of greenhouse gases. Meeting the increased demand by households or those supplying the market

cutting more firewood from bush gardens or forested areas would damage the health of the forest ecosystem (McEvoy et al., 2016, p. 39).

At present firewood is often not stored or dried properly (McEvoy et al., 2016, p. 39). Cooking facilities are typically an open fire and require a lot of fuel; alternative cooking methods such as charcoal or rocket stoves, solar cookers or deeper cone pits could be expected to reduce the pressure on limited firewood reserves (McEvoy et al., 2016, p. 39).

All this suggests that, if it were possible, growing more firewood in home gardens, better practices for storing and drying firewood at home and more firewood-efficient cooking fires or stoves would improve firewood security and resilience for communities in Port Vila.

The cash incomes of any households able to produce and sell a surplus of firewood would be expected to increase, but, assuming that prices at the market reflect changes in supply and demand, if supply outstripped demand the cash incomes of current suppliers to the market would be expected to be less than they otherwise would have been. Similarly, for a given level of demand, if more firewood is purchased in the market instead of buying kerosene or LPG, sales of these latter items would be less than they otherwise would have been.



Figure 5.8 Rocket stove, Port Vila

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*Medicinal plants, forest fruits (mango, naus) and nuts (navel, nangae, natapoa), sugar cane, building materials (bamboo), roofing materials and materials for mats, baskets and handicrafts (natangura, coconut fronds, pandanus), kava, chickens, pigs*

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All of the above are grown in some home gardens. Most require a reasonable amount of space but, where there is the space, having more grown would increase the resilience of communities.

### 5.3.3 Over-harvesting of *natangura* and *pandanus*

Natangura and pandanus are key resources for many households in Port Vila (McEvoy et al., 2016, p. 22). Currently natangura and pandanus are sometimes over-harvested, not only in quantity but also in timing. This can kill the plant. The supply of natangura for traditional roof thatching is not meeting local demand. As a consequence, the price is rising (McEvoy et al., 2016, p. 39).



Figure 5.9 Roof thatching, Port Vila

### 5.4 How would a home gardens project reduce the degradation of local ecosystems?

The main benefits of a home garden project relate most to increasing the resilience of people. Despite this however, several important causes of ecosystem degradation would also be addressed. See table 5.1 for a summary of the causes of degradation that a home gardens project would address if implemented and governed effectively.

### 5.5 How would this project improve communities' resilience?

Now, and in the foreseeable future, a significant number of households in Port Vila have access to land suitable for home gardens and possibly home freshwater aquaculture ponds. In some instances, home gardens could be made larger than they currently are and in many cases home gardens could be made more productive, and more resilient through diversity, and the adoption of different gardening practices – what is grown and how it is grown. In some cases, home garden activities might be able to be extended to honey production and freshwater aquaculture.

Increased food, and possibly firewood, production from home gardens would help increase food, and possibly firewood, security, nutrition and health for households that carry out the intensification, thereby increasing their resilience to the effects of climate change and rapid urban population growth. Increased home food production, especially aquaculture or other forms of protein (such as chickens or insects), might reduce the harvesting pressure on coastal reefs and other marine food sources.



**Figure 5.10 Integration of small livestock into bush gardens, Port Vila**

Better and more extensive preserving and storage of fresh food may also have significant benefits. More frequent crop failures or destruction (for example as a result of greater climate variability) would mean more periods with a shortage of food from the home garden. Taylor et al. (2016) cite evidence that traditional food preservation, once a disaster mitigation strategy, has all but disappeared. But on the other hand, more productive home gardens might lead on some occasions to more produce than the household can consume or profitably sell. Improved and increased preservation and storage of produce from home gardens might provide at least a partial solution to both of these problems.

Education about good nutrition and support to grow more fruit and green/ coloured vegetables in home gardens, may improve nutrition and health and reduce health costs.

Reducing the over-harvesting of natangura and pandanus will, in a reasonably short time, increase the supply of roof thatching materials and materials for mats, baskets and handicrafts and put the supply on a more sustainable footing. Of course, in the very short term this action will reduce the supply.

See tables 5.2 and 5.3 for a summary of how a home gardens project would address some of the vulnerabilities and issues for people caused by ecosystem degradation and climate change.

**Table 5.1 Causes of threats to food, firewood and building materials security that an intensification of urban and peri-urban gardens project could reduce or adapt to**

Black text = Local human caused drivers of change. Blue text = Climate change drivers of change.

L = low, M = medium, and H = high in terms of how effectively the project might address these causes of change. First grade is catchment level, second is at localised site.

\* = low level of certainty based on literature reviews, precedents, and common sense. \*\* = medium level of certainty. \*\*\* = high level of certainty.

Intensification of urban and peri-urban gardens targets these drivers and impacts of change:		Justification (the way in which the project will address the impacts):
Causes of Degradation of Terrestrial Ecosystems	Rapid unplanned urbanisation: - Constrained access to food; poor nutrition and health <b>M/H</b> - Increased pressure on marine sources of food <b>L/M</b> - Constrained access to firewood and construction materials <b>L/M</b> - Constrained access to materials for making mats and baskets <b>L/L</b> - Constrained access to medicinal plants <b>L/M</b> - Constrained access to plants that are culturally significant <b>L/L</b>	Increased food production from home gardens (more, larger, more productive) as well as 'novel' food products, and better preservation and storage techniques. *** Education re good nutrition. ** Increased production of firewood and construction materials from home gardens; better storage and drying of firewood; more firewood efficient cooking methods. ** Increased numbers of natangura and pandanus in home gardens* Increased numbers of medicinal plants in home gardens. ** Increased numbers of plants that are culturally significant in home gardens. *
	Removal of vegetation for fire wood <b>L/M</b>	Increased production of firewood from home gardens; better storage and drying of firewood; more firewood efficient cooking methods. **
	Overharvesting / poor management of resources <b>M/M</b>	Education concerning over-harvesting of natangura and pandanus.**
	Possible changes to rain and weather patterns: - Constrained access to food; poor nutrition and health <b>-/M</b>	Increased food production from home gardens from better adapted crops. ** Better food preservation and storage techniques **
Causes of Degradation of Freshwater Ecosystems	Increased sedimentation in rivers <b>L/L</b>	Better design and management of home gardens in, or close to, riparian areas. ***
	Pollutants (fertilizers) entering waterways and groundwater <b>L/M</b>	Adoption of practices that result in reduced run-off and leaching of fertilizers. **

**Table 5.2 Impacts of ecosystem degradation that an intensification of urban and per-urban gardens project could reduce or address**

L = low, M = medium, and H = high in terms of how effectively the project might address these impacts.

\* = low level of certainty. \*\* = medium level of certainty. \*\*\* = high level of certainty. Note: all assessments made on the assumption that project is successfully implemented

	Impacts on ecosystems:	Impacts on human wellbeing and resilience:	Justification:
Degraded Terrestrial Ecosystems	<ul style="list-style-type: none"> <li>Changes to productivity of food webs <b>H</b></li> <li>Reduced soil fertility <b>H</b></li> <li>Increased erosion and soil loss <b>H</b></li> <li>Reduced abundance of some plant/tree species <b>H</b></li> </ul>	<ul style="list-style-type: none"> <li>Reduced ability to grow food on land <b>H</b></li> <li>Reduced access to, or more expensive food <b>H</b></li> <li>Reduced physical health and increased health care costs <b>H</b></li> <li>Reduced access to, or more expensive construction materials <b>M</b></li> <li>Reduced access to medicinal plants <b>M</b></li> <li>Reduced access to plants that are culturally significant <b>M</b></li> </ul>	<ul style="list-style-type: none"> <li>Increased food production from home gardens from more and larger home gardens, better gardening practices, 'novel' food products, better preservation and storage. ***</li> <li>Increased numbers of natangura and pandanus, bamboo, medicinal plants, and culturally significant in home gardens. *</li> </ul>
Degraded Freshwater Ecosystems	<ul style="list-style-type: none"> <li>Increased silting / sedimentation <b>L</b></li> </ul>		<ul style="list-style-type: none"> <li>Better design and management of home gardens in or close to riparian areas. ***</li> </ul>
Degraded Coastal Ecosystems	<ul style="list-style-type: none"> <li>Degradation of mangroves, seagrass, reef <b>L</b></li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to, or more expensive food (marine) <b>M</b></li> </ul>	<ul style="list-style-type: none"> <li>Increased food production from home gardens from more and larger home gardens, better gardening practices, 'novel' food products, better preservation and storage may supplement some marine food sources. ***</li> </ul>

### 5.6 Key benefits of a home gardens intensification project

The main tangible potential benefits of a home garden intensification project for residents of Port Vila are illustrated in figure 5.11. Figure 5.12 illustrates which main ecosystem services home gardens project would protect, add to, or regenerate in the context of urban Port Vila.



Figure 5.11 Potential benefits to the people of Port Vila of a home gardens project

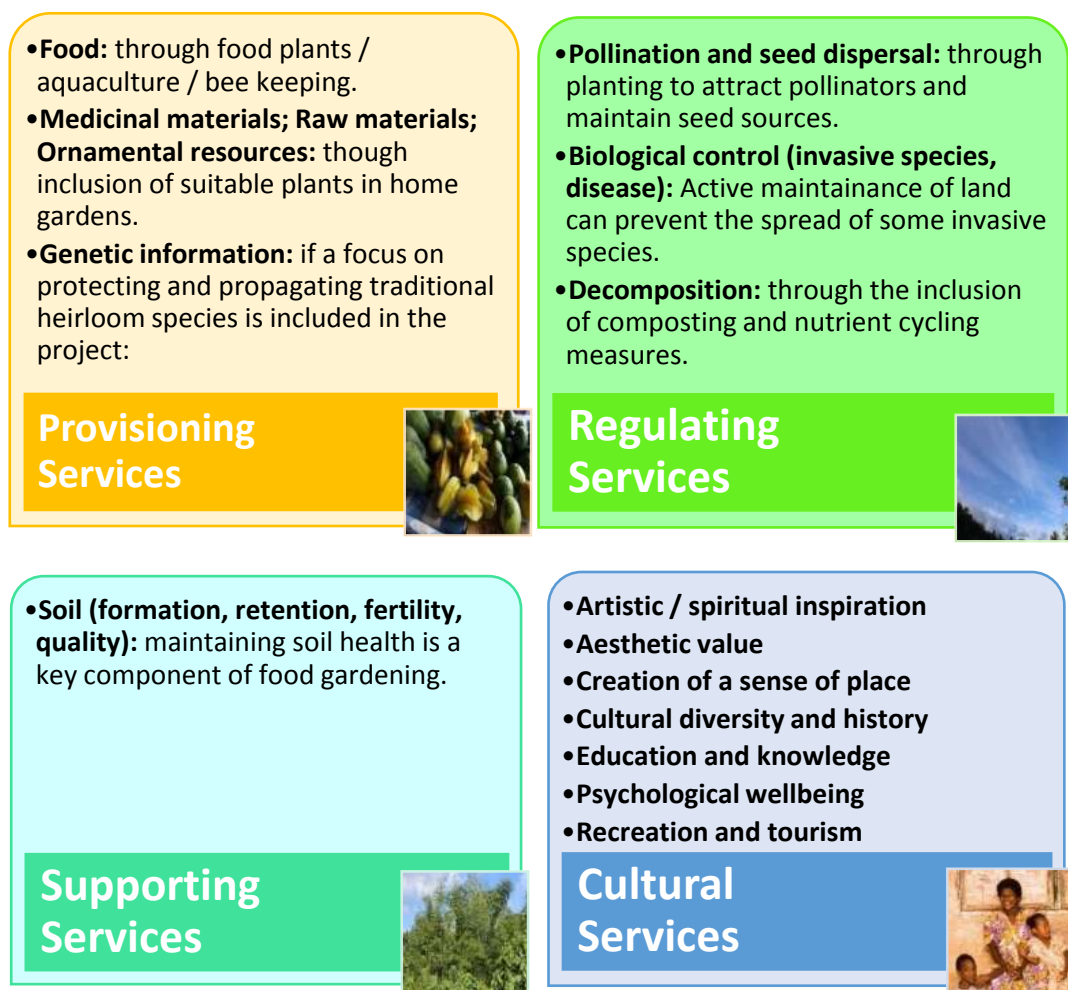


Figure 5.12 Ecosystem services benefits of an intensification of home gardens project

### 5.7 Intervention logic

The desired outcome is improved resilience of Port Vila communities through to 2030 and beyond and the intervention logic is as follows:

- the most likely significant drivers of the changes over that period that improved resilience would help Port Vila communities to cope with are a continued rapid growth in Port Vila's population, continued largely unplanned urban development, and climate change (both local and global);
- increased food (and firewood) security for Port Vila households/ communities will make an important contribution to improving their resilience to the changes resulting from these drivers;
- under certain conditions, increased production of food (and possibly firewood) from home gardens would improve food (and firewood) security for Port Vila households/communities.

To achieve increased production of food (and possibly firewood) from home gardens we propose that the project should:

- work with households/communities to establish what support they would need to change their practices in ways that would lead to increased production and diversity of food (and possibly firewood) from their home gardens;
- identify ways in which home gardens could be made more resilient to the expected effects of climate change;
- work with households/communities to establish what support they would need to change their practices in ways that would lead to improved resilience of home gardens to the expected effects of climate change;
- provide the required support where that is possible;
- extend the number of participating households/communities;
- monitor and evaluate whether the project is making a significant contribution to the intended outcomes; and
- be adaptable as appropriate.



Figure 5.13 People returning from bush garden harvest. Mele Mart

### 5.8 Location, ridge to reef position

Food security and resilience obviously involves more than just home gardens – food is also sourced from bush gardens, freshwater environments, marine environments, markets and supermarkets. However, the particular focus of this project is on feeding people and increasing resilience from land resources that are readily at hand.

Accordingly, the activities involved in this project will take place in residential areas of urban and peri-urban Port Vila. These areas could include town suburbs within the Port Vila Municipality or either established villages on ancestral land or informal settlements within Greater Port Vila. Their direct impacts will occur in those same areas but indirect impacts may reach further afield, for example they

may impact on the growing of similar types of food in areas outside Greater or metropolitan Port Vila and they may reduce the harvesting pressure on marine sources of food. Figure 5.14 indicates likely general project locations.

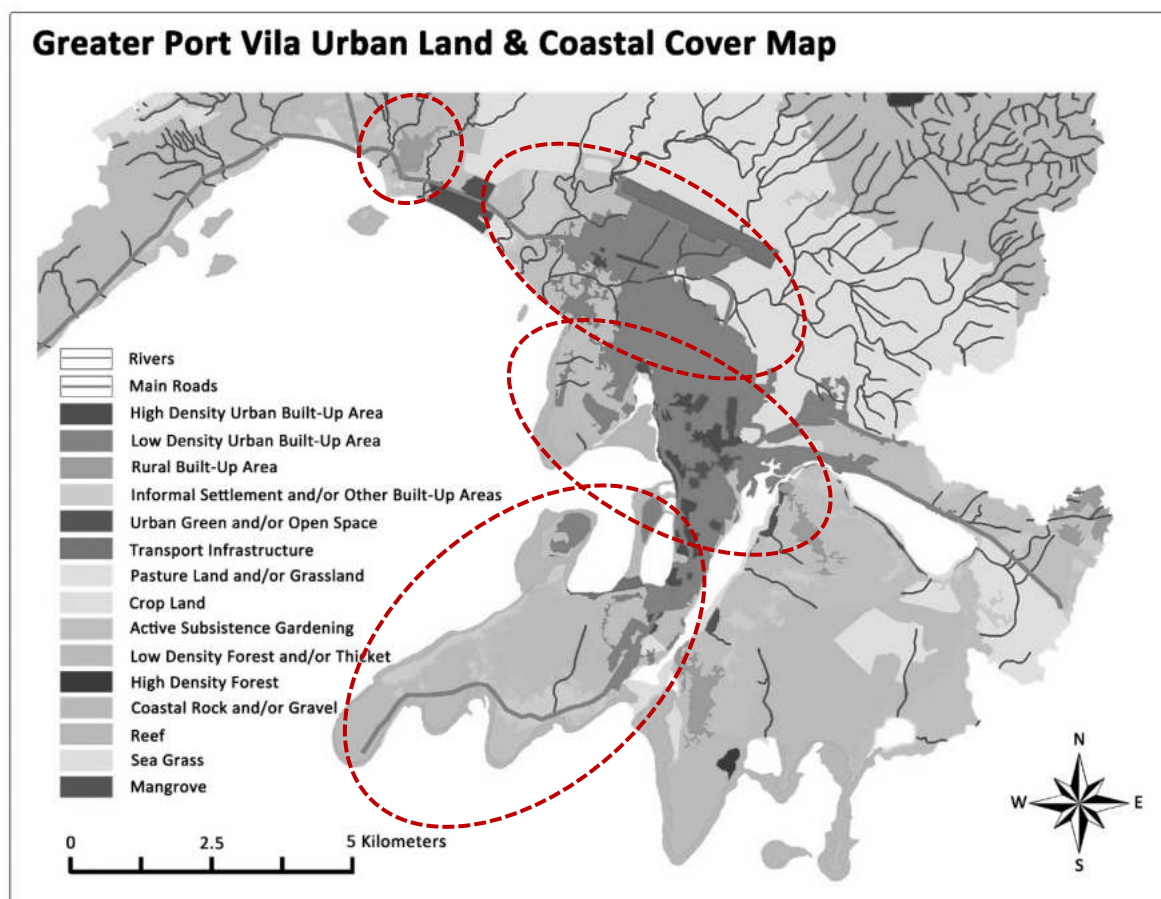


Figure 5.14 Suggested general locations for home garden project

### 5.9 Timeframe and sequencing

We have assigned a 10 year timeframe to the project: long enough to give it time to become established and to then expand its geographical coverage significantly.

It is envisaged that the project would start in a few, say three, communities, villages or settlements but would be designed so that it could readily be scaled up. It may be desirable that the initial communities/villages/settlements are a mix of formal settlements, traditional villages, informal settlements and possibly communities of interest such as church members: this should be addressed in the detailed project design stage.

Over the 10 year period we consider that the project could be expanded to, say, 12 communities. Intensified home gardens are a component of the proposed Demonstration of Alternative Housing Solutions project, so if that project were to go ahead it would become a participant in this project. Potentially, over a longer period, the project could be scaled up to encompass all the residential areas of urban and peri-urban Port Vila.

### 5.10 Description of approach and project components

The project will achieve its objective by providing households/communities with the support that they need to intensify their home gardening (possibly including firewood production), to preserve and store surplus produce, to store and dry firewood, to adopt more firewood-efficient ways of cooking and to harvest natangura and pandanus in a sustainable manner. Depending on the circumstances, intensification could involve one or both of extending the size of home gardens and increasing the productivity of home gardens through the adoption of different gardening practices. The project could also provide support to households/communities to increase activities such as honey production and freshwater aquaculture.

We expect that some households will already have, and be practicing, much of the required knowledge about best practice gardening and management of resources such as natangura and pandanus. Also, we expect that some organisations provide training and support for these activities (such organisations might be appropriate partners, or collaborators, in the project). The project would aim to tap, extend if appropriate, and spread that knowledge. However, it would also aim to experiment with, and where appropriate, spread new innovations.

At this stage we envisage that support could be of the following nature:

- provision of information/advice/education: on nutrition and on best home gardening / rainwater harvesting / preserving and storing food / freshwater aquaculture / bee keeping / avoiding over-harvesting of natangura and pandanus / home firewood growing, storing, drying / cooking practices.
- hands-on demonstration of best home gardening / rainwater harvesting / preserving and storing / freshwater aquaculture / bee-keeping / avoiding over-harvesting of natangura and pandanus / home firewood growing, storing, drying / cooking practices.
- provision of materials (e.g. seeds, plants, fertilisers, pesticides/fungicides, guttering/water tanks, stoves, fencing materials) or tools and equipment at cost/at concessionary prices/free. This might involve the establishment of seed banks or nurseries.
- facilitation of soil testing to ensure that gardens are not established on contaminated sites. Soil testing might be provided at cost or subsidised.
- engagement within communities to increase the number of households that are informed about good nutrition practices and are intensifying their home gardens, preserving and storing produce, engaging in honey production or freshwater aquaculture / avoiding over-harvesting of natangura and pandanus / growing, storing and drying firewood / adopting more firewood efficient cooking practices.
- reinforcement of provisions in the Draft Port Vila Municipal Plan for encouraging and protecting urban and peri-urban agriculture and freshwater aquaculture.

If credible, relevant information is available, one dimension of this support might be advice on which home garden crops, or varieties of these crops, do best in expected or observed changed climatic conditions (e.g. warmer temperatures, longer dry periods, changes in seasonality) and what changes to home gardening practices best increase the productivity of crops in the expected or observed changed climatic conditions.

Different communities in Port Vila face different challenges regarding food and firewood security. The importance of different aspects of resilience differs between communities depending on such things as their location in relation to, and access to, land suitable for home gardens, access to water for home gardens, land suitable for bush gardens, places where firewood can be collected and places where forest fruits and nuts can be collected. (McEvoy et al., 2016). For this reason the specific forms of

support that would be offered through this project must be determined in consultation with the communities and households that agree to participate in it.



Figure 5.15 Port Vila bush garden area

Also, and of paramount importance, the success of this project depends almost entirely on convincing people to do things differently. That is a high hurdle as generally people will resist changing their ways unless the downside risks have been adequately covered off and the benefits to them are clear. To overcome this will require careful, detailed engagement with households/communities at a pace, and in a manner, that they are comfortable with, and hard evidence about the risks and benefits of what they are being asked to do.



Figure 5.16 Project components of a home gardens project

### 5.11 Starter and smaller project components: how to start the project

In the event that the whole project presented here cannot be implemented initially, smaller components could be actualised more quickly or readily, as follows:

1. Working with the Vanuatu Council of Churches on small-scale aquaponics/fish farming (see: sections 5.10 and 5.12);
2. Working with the Department of Home Affairs on policy and planning aspects of the Port Vila Plan to encourage and protect urban and peri-urban agriculture and freshwater aquaculture (see: section 5.10 and 5.12);
3. Working with appropriate partners to increase the production of firewood from home gardens and to improve the drying and storage of firewood;
4. Working with appropriate partners to increase the production of root crops in home gardens;
5. The first 3-year cycle of the proposed 10-year project, could involve only a single community, and involve a reduced number of the project's proposed components which are: vegetable and fruit production (including the implementation of appropriate water supply and storage); food storage and preserving; nutrition awareness education; aquaculture; growing firewood; growing building materials; growing medicinal plants; and introducing relevant provisions into the Greater Port Vila Plan (see: section 5.12).

### 5.12 Project activities and timing

At this stage we envisage the following activities for the project:

#### Year 1

1. Meeting with selected local organisations to establish whether they might be partners, or collaborators, whose involvement would strengthen the project (such organisations might have local expertise in, for example, alternative gardening practices, food security projects, plant nurseries, community engagement or community awareness raising); negotiating partnership, or collaboration, arrangements with such organisations where appropriate.
2. Working with stakeholders to establish an appropriate governance structure.
3. Appointing staff.
4. Choosing the initial three communities.
5. Establishing, or further developing, a relationship with each of these communities.
6. Exploring with each of the communities, the idea of home garden intensification (including growing firewood, honey production and freshwater aquaculture), food preservation and storage, firewood storage and drying, and cooking methods, identifying the barriers that apply in each community and what support would be necessary to overcome those barriers (as well as technical and financial barriers there may be social and opportunity cost barriers).
7. Establishing the best way of providing the required support. One of the matters to be considered at this point would be whether there are already sufficient people available with the required knowledge and community engagement skills to implement the project on the scale envisaged or whether, as part of the project, people should be trained in areas such as these.
8. Recruiting households in each community to be participants in the project.
9. Deciding how best to establish a baseline for the outputs of the project (production of food, and possibly fuel wood) and how best to monitor these over time. Directly monitoring the desired outcomes of the project (improved nutrition and health) would not be part of the project but appropriate health professionals might be able to offer informed opinions about the relative health status of project participant households and other comparable households.
10. Measuring the baseline production of food, and firewood (if production of firewood in home gardens has been confirmed as being practical).

11. Establishing the best way to incorporate education/incentives about good nutrition into the project; obtaining or developing appropriate resources on good nutrition.
12. Establishing the best way to incorporate education/incentives on sustainable harvesting of natangura and pandanus into the project; obtaining or developing appropriate resources on sustainable harvesting of these species.
13. Establishing whether, as the project progresses, relevant health professionals could provide informed opinions on its impact on nutrition and health. If they could, seeking their co-operation in this regard.
14. Starting to provide the required support to households / communities (incorporating the good nutrition and sustainable harvesting elements).
15. Developing and implementing a strategy to reinforce provisions in the Draft Port Vila Municipal Plan for encouraging and protecting urban and peri-urban agriculture and freshwater aquaculture.
16. Getting information about the project out via the media and government / non-government channels.

## Year 2

1. Continuing to provide the required support to households / communities (incorporating the good nutrition and sustainable harvesting elements).
2. Continuing to get information about the project out via the media and organisations.
3. Monitoring the production of food, and possibly firewood; possibly monitoring the extent of food preservation and storage.
4. Engagement within communities to increase the number of households that are intensifying their home gardens, and possibly preserving and storing food. Schools might be one avenue for this work.
5. Assembling information on expected climatic changes and its impacts on food production and assessing whether there is enough confidence in the information for it to form the basis of action within this project.
6. Assembling information on the performance of home garden species under expected climatic changes and assessing whether there is enough confidence in the information for it to be included in advice given to home gardeners.
7. Assembling and assessing information on the performance of different home garden practices under expected climatic conditions and assessing whether there is enough confidence in it for it to be included in advice given to home gardeners.

## Year 3

1. As for Year 2.
2. Choose additional communities to be included in the project.
3. For these new communities, carry out the Year 1 activities (but there should be no need to repeat activities 9 and 13 and the window for activity 15 will have closed by then).

Thereafter this 3-yearly cycle of activities would be repeated but with monitoring and evaluation, and adaptation of the project if needed, added.

### 5.13 Implementers and stakeholders. Who should be involved?

- The funder or their delegated agency.
- Any partner, or collaborating, organisations.
- Local Chiefs.
- Port Vila Municipal Council.

- Ward Councils for the wards in which the chosen communities are located.
- Shefa Provincial Government.
- Relevant government agencies including the Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity (MALFFB), Ministry of Health (responsible for the National Plan of Action on Food and Nutrition Security), the National Advisory Board on Climate Change & Disaster Risk reduction (NAB) responsible for the Vanuatu National Sustainable Development Plan 2016-2030).
- Local Agricultural Extension Officers.
- Live&Learn Vanuatu (a possible partner/collaborator).<sup>9</sup>
- Other NGOs who have relevant resources or knowledge (e.g. the Vanuatu Christian Council has recently run a 2-year programme with many of the same aims and components as this project and could be a possible partner/collaborator or otherwise help with engagement or communal activities).
- Co-operatives (may be able to offer relevant models or advice).
- Wan Smolbag Theatre (a possible partner/collaborator).<sup>10</sup>
- Medical professionals (to contribute to evaluating outcomes).
- The media (to help spread relevant messages at all stages of the project).

#### 5.14 Education, research, training and public awareness opportunities

Education, training and public awareness are all integral aspects of the project. See: section 5.9 Description of project approach and components.

#### 5.15 Indicative costs and other resourcing requirements

**Estimated cost over 10 years: \$NZ1-2 million.**

Required inputs and resources:

- Personnel
  - 2 skilled people to fill the roles of project manager/community workers/advisers/researchers/negotiators who can access nutrition experts, home gardening experts, permaculture experts, apiary experts, freshwater aquaculture experts, planning experts, etc.: \$40 000 - \$75 000 each p.a. for 10 years, i.e. \$0.8 - \$1.5M
- The time, travel and accommodation of the above-mentioned experts: say \$10 000 - \$30 000 p.a. for 10 years, i.e. \$100 000 – \$300 000
- Work accommodation
  - office space and materials for 2 people
  - workshop/storage space
- Materials for community engagement
  - unknown at this stage
  - budget of \$10 000 – \$30 000
- Materials, tools and equipment for project staff to use in demonstrations
  - unknown at this stage
  - budget of \$5000 – \$10 000
- Materials, tools and equipment for provision to households participating in the project
  - unknown at this stage
  - budget of \$50 000 – \$250 000

<sup>9</sup> [www.livelearn.org](http://www.livelearn.org)

<sup>10</sup> [www.wansmolbag.org](http://www.wansmolbag.org)

### 5.16 Financing, project design implications, opportunities for scaling

The majority of funding for this project would need to come from donors; partnership and collaborating organizations may be able to provide significant in-kind support. However, the project could be delivered by a Project Coordinator entity that was recruited on the basis of a tender process to select an entity that could demonstrate a record of PES or equivalent successful outcome delivery.

This project could be scaled up to cover potentially all of Port Vila and then extend to other urban centres in Vanuatu. We have also identified a more ambitious project that would extend this project by including field research elements that would make the project more directly related to climate change adaptation. The additional components of the more ambitious project are outlined in Appendix 8.3. Taylor et al. (2016) note that the Vanuatu Agriculture Research and Training Centre (VARTC) has adopted an approach of providing farmers with large volumes of crops and varieties for evaluation and selection, basically enhancing the farmers' portfolio and crop genepool, thereby buffering risks from abiotic and biotic stress. A successful pilot project by VARTC aimed to broaden genetic diversity of taro, yams, sweet potato and cassava in village farmers' fields. That project was based on evaluating local diversity, incorporating some exotic diversity and then distributing large volumes of planting material for farmers to select from, conserve and use. (Taylor et al., 2016). A more ambitious version of the intensification of home gardens project that included field research elements into crops, varieties and landraces would need to be coordinated with the work of VARTC and others working in this area.

### 5.17 Monitoring outcomes and governance aspects

For a discussion about monitoring outcomes – see: section 5.10 Description of project approach and components.

The governance body for the project would be drawn from major stakeholders. This governance body could either 'own' the project, and be the final decision making body (the 'Board'), or it could be an advisory body to the owner of the project who would most likely be the funder or its delegated agency (presumably PEBACC for SPREP). Consulting with stakeholders and establishing the role and membership of this body would be one of the very first activities to be undertaken. The owner of the project would appoint the project staff, one of whom would be the Project Manager.

### 5.18 Addressing barriers to implementation: What could go wrong?

There are important gaps in the information that we have been able to obtain to this point and as a result, at this stage, there are weaknesses in the intervention logic, primarily in relation to two aspects:

1. the specific conditions under which increased production of food (and possibly firewood) from home gardens would significantly improve food (and firewood) security for Port Vila households/communities; and
2. the practicality, and the extent of applicability, of some of the envisaged changes in household/community behaviour (e.g. making their home gardens larger, adopting better gardening practices, adopting home aquaculture, growing firewood in their home gardens), and hence the magnitude of the contribution that the project would likely make to increased food (and firewood) production. (We note that the recent 2-year programme run by the Vanuatu Christian Council included a number of these activities but we have very little information about the changes in household/community behaviour that have resulted from the programme.) As noted above, wage-based salaries are the primary source of income for 4 out of 5 Port Vila households and this may have an important bearing on whether households see intensified home gardening as beneficial to them.

We have identified much of the information that is required to strengthen the intervention logic in relation to these two aspects (see the list of questions in Appendix 8.1) and we consider that most of this information could be obtained as part of a detailed design stage for the project.

A decision to proceed to the detailed project design should not imply a commitment to proceed with the project as currently envisaged. It is possible that one outcome of the detailed project design stage may be a decision to re-shape the project or, in the worst case, to not proceed further with it.

## 5.19 Relationships to other projects

### 5.19.1 Port Vila PEBACC

This project complements all four of the other proposed Port Vila PEBACC projects as they all have components that may involve home gardens. Adaptive capacity in relation to the severity of winds and their impacts on both traditional roofing (natangura) and on the natangura trees themselves would be a particular link with the proposed sustainable housing and development project. Similarly, rainwater harvesting and its contribution to adaptive capacity in relation to droughts and higher temperatures would be a link with that project.



Figure 5.17 Rainwater harvesting at Port Vila bush garden

### 5.19.2 Greater Port Vila Planning Scheme (Draft)

Policies in the draft Greater Port Vila Planning Scheme refer to market gardening and home sites 'with associated small scale market gardens' (presumably referring to home gardens as well as small market gardening businesses). Significantly though, draft policies and discussions of the residential zones, even the Low-Density Zone, do not refer to any gardening use. This is inconsistent with our land use maps showing the very large area of home gardens occurring within both the Municipal and Shefa Provincial residential parts of Port Vila, even including some areas mapped as 'active subsistence gardening' (Blaschke et al., 2017, sections 1.2 – 1.3). Achievement of the aims of the Intensification

of Urban Gardening project is at least partly dependent on effective completion and implementation of the Greater Port Vila Planning Scheme, with particular emphasis on policy development enabling effective use of residential land for multi-crop home gardens and associated enterprises such as aquaculture, beekeeping and food preparation and storage facilities.

### 5.19.3 Other Projects

The project would complement the Vanuatu Christian Council's recent 2-year AusAid-funded programme that included activities such as trialling different crops, providing seedlings, establishing freshwater aquaculture and providing training to growers and householders. It would also complement the Council's ongoing activities on its land at Fres Wota where it has community gardens and a fish farm. The Council's intention is that these gardens be used to train and assist neighbouring communities cope with extremes for example the cyclone and prolonged El Nino drought<sup>11</sup>.

In part the proposed project would build on the Department of Agriculture: Increasing Resilience to Climate Change and Natural Disasters (IRCCNR) project (funded by the World Bank) that focuses on identifying climate-resilient varieties of root crops. A demonstration plot has been set up in Epule (North Efate) where the new varieties are being trailed, and their growth and productivity monitored<sup>12</sup>.

Similarly, the proposed project would draw on the EU-GIZ Adapting to Climate Change and Sustainable Energy project and the Coping with Climate Change in the Pacific Island Region - CCCPIR (SPC-GIZ) project. The former has an aquaculture component under which community-based aquaculture models are to be tested in northern Efate (Mangaliliu, Eton and Onesua)<sup>13</sup> and the latter involves bee husbandry projects on Pele Island (north of Efate)<sup>14</sup>.

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<sup>11</sup> See: [http://dailypost.vu/news/vcc-launches-nursery-project-free-giveaway-seedlings-for-everyone/article\\_02647af6-8e28-579e-8888-afd3cf8aa708.html](http://dailypost.vu/news/vcc-launches-nursery-project-free-giveaway-seedlings-for-everyone/article_02647af6-8e28-579e-8888-afd3cf8aa708.html)

<sup>12</sup> See: <http://projects.worldbank.org/P112611/increasing-resilience-climate-change-natural-hazards-vanuatu?lang=en>; <http://www.nab.vu/projects/increasing-resilience-climate-change-and-natural-hazards-vanuatu>

<sup>13</sup> See: <http://www.nab.vu/project/eu-giz-adapting-climate-change-and-sustainable-aquaculture-component>

<sup>14</sup> See: <http://www.nab.vu/projects/coping-climate-change-pacific-island-region-spc-giz>

## 6.0 Urban Trees Project Implementation Plan

### 6.1 Abstract

This project involves the strategic introduction of multi-value trees and vegetation to key urban areas and coastal environments in Port Vila. This project is a fairly low-risk and low-cost project that could be implemented rapidly, would be highly visible to the public, and may thereby act as a catalyst for public interest in, and valuing of, other SPREP PEBACC projects. In terms of increasing human resilience to climate change this project focuses on increased food security and access to raw materials. Secondary potential benefits include increased water security, and increased human health and economic wellbeing. Additional human benefits include the use, sharing, support and preservation of traditional knowledge and possible benefits to tourism within the city. These benefits are achieved primarily through the support and regeneration of coastal land based hybrid urban / natural ecosystems which in turn, depending on spatial location, support coastal fresh and salt-water ecosystems, or mitigate further degradation by minimising sediment, land based pollutants, and solid waste from entering water ways. Key opportunities for this project include development of planting schemes for existing major vehicle and foot transport pathways in the built-up areas of Port Villa, and the new CBD waterfront promenade. By focusing on these transportation routes which tend to cross water ways, an opportunity to spatially connect future protected or revegetated riparian areas may exist.

### 6.2 Urban trees project aims and purpose

This urban trees project is envisaged as a living library or repository of the useful plants of Efate which will educate people about the use of trees species, provide tangible resources (including food), increase vital urban ecosystem services, and also act as a seedbank to safeguard vulnerable species against climate change. This will work towards the creation of a city that:

- Enables increased production of food and raw materials;
- Mitigates some of the effects of climate change by creating cooler urban microclimates and shade during hotter weather;
- Has improved air and water quality;
- Effectively manages storm water;
- Protects waterways and coastal ecologies;
- Preserves and actively uses traditional knowledge;
- Is beautiful and attractive to residents and visitors alike;
- Increases resilience to climate change.

The aim of an urban trees project is to transform key existing urban streets and promenades with the addition of urban trees and other suitable vegetation (including where appropriate mini wetlands, raingardens and swales), in order to address the following climate change resilience and rapid urbanisation issues: increased temperatures; increased intense rain events; increased air pollution; and increased pressure on food and raw materials provision.

Specific aims and outcomes:

- Determination of key sites for intervention in the built-up area of Port Vila through a comprehensive spatial analysis of urban storm water drainage flows, point sources of pollution, and landscape fragmentation.
- Establishment of nurseries and seed sources to support regeneration on Efate.
- Implementation and monitoring site-specific tree and vegetation planting in key urban Port Vila sites.

- Contribution to the policy framework for the urban development of Port Vila, including provisions in the approved Greater Port Vila Planning Scheme that will encourage and protect urban agriculture and freshwater aquaculture, and further 'green' the city.
- Preservation of traditional plant related knowledge.



Figure 6.1 Typical streetscape in Port Vila

### 6.3 Background

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*'Urban environments offer opportunities to reverse ecosystem degradation and biodiversity loss in a meaningful way through human engagement in ecological restoration' (Clarkson et al., 2007).*

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Ecosystem-based adaptation (EbA) projects typically target the support or regeneration of ecosystems outside of urban areas. This proposed project recognises urban environments as key drivers of change of non-urban ecosystems. It seeks to integrate urban ecologies more effectively with naturally occurring ecosystems by working towards a hybrid living and built urban environment. In the context of this project, this would be done through strategic planting (both in terms of species and location) of vegetation within Port Vila.

Most cities are increasingly dependent on the services of distant ecosystems for their resources (Doughty and Hammond, 2004) and have been described as *'intensive nodes of consumption'* (Rees, 1999). Because of the built environment's increasing appropriation of the goods and services of natural ecosystems (Rees, 1999), vital ecological services for human society (and other species) such

as climate regulation, salinity control, soil formation, nutrient cycling, the hydrological cycle, photosynthesis, pollination, and waste assimilation are negatively affected (Shepherd et al., 2002, Vitousek et al., 1997, Vitousek et al., 1986, Baik et al., 2001, Daily et al., 2000, Costanza et al., 1997). By aiming to increase the provision of ecosystem services within urban areas, this has benefit in terms of the creation of more ecosystem services locally, but it also supports the conservation or regeneration of more distant ecosystem by reducing pressure on them. Healthier regional ecosystems in turn, mean more resilient human communities.

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*'By considering ecosystem services, cities have the opportunity to make some very positive changes, saving on municipal costs, boosting local economies, enhancing quality of life and securing livelihoods' (TEEB, 2011).*

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Urban environments present some unique benefits for restoring ecosystems. For example, a high concentration of people equates to a high potential volunteer and resource base, and the absence of grazing animals and other threats to rare plants enables more effective regeneration in some instances (Given and Meurk, 2000).

One of the most strategically relevant aspects of this project, therefore, is the opportunity to use it to leverage public awareness of SPREP's other EbA work in the area. If people can see highly visible changes in the city itself and see and experience clearly demonstrable benefits, there may be more willingness to participate in or support other SPREP and PEBACC initiatives.

Because the quantity of individual trees in an urban trees project would likely be relatively low, the overall impact on ecosystem health at the catchment level might be low compared to some other proposed EbA projects. Because this project is spatially located where most of the people are in the Port Vila catchment however, benefits would likely be experienced by more people, and contribute therefore to increased human resilience. This project is also likely to be lower cost than other EbA projects and comes with lower risk factors. It would be a highly visible project and produce very easy to understand, immediate and tangible benefits. For these strategic reasons, an urban trees EbA is included within the suite of proposed projects.

#### **6.4 How would an urban trees project reduce the degradation of local ecosystems?**

There are many causes of degradation of the ecosystems in the Port Vila area. Some of these are caused by the actions of local people or visitors to Port Vila. These causes of degradation are easier to control by Ni-Vanuatu. Others are caused by climate change and cannot be controlled by Ni-Vanuatu, but may be able to be adapted to or planned for. Table 6.1 outlines which causes of degradation of local ecosystems an urban trees project would reduce if the project was implemented and maintained effectively.

**Table 6.1 Causes of ecosystem degradation and climate change vulnerabilities that an urban trees project could reduce**

Black text = Local human caused drivers of change. Blue text = Climate change drivers of change.

L = low, M = medium, and H = high in terms of how effectively the project might address these causes of change. First grade is catchment level, second is at localised site.

\* = low level of certainty based on literature reviews, precedents, and common sense. \*\* = medium level of certainty. \*\*\* = high level of certainty. Note: All assessments made on the assumption that project is successfully implemented.

Urban tree planting targets these drivers of change:		Justification:
Causes of Degradation of Terrestrial Ecosystems	Overharvesting leading to removal of vegetation for agriculture/ settlement/ bush garden/ fire wood etc. <b>L/M</b>	If multiple use trees are planted, and if these are accessible to people for food or raw materials foraging, pressure to remove vegetation in other areas may be reduced.**
	Rapid unplanned urbanisation <b>M/H</b>	Strategic spatial allocation of urban areas for tree planting may help to reduce unplanned encroachment onto important areas. If space is taken up by important trees, people may not use this space for building or infrastructure. Areas that are vegetated are less likely to have rubbish dumped on them.**
	Spread of invasive species <b>L/H</b>	If areas where invasive plant species exist are targeted, meaning that some of the weeds are removed or die out due to natural succession, spread of invasive weeds may be reduced.*
	Increased changes to weather (intensity of rainfall and hotter days) <b>L/M</b>	Urban trees help to absorb water and reduce storm water runoff. This is dependent on location and quantity of both rain and trees. Trees significantly affect temperatures of urban environments through additional shading and humidification. **
	Increased flooding <b>L/H</b>	Urban trees can prevent or reduce erosion of riverbanks and coastal areas during flood events. This in turn can reduce inundation or breaching of banks.**
	Unpredictable effect on biodiversity <b>M/-</b>	Urban tree planting can be used to create strategic seed sources of important tree species in the event that these are reduced in native settings.*
Causes of Degradation of Freshwater Ecosystems	Increased sedimentation in rivers <b>L/H</b>	Increased vegetation can help to prevent erosion or movement of soil or debris during rain, and therefore can prevent increased sediment in rivers.**
	Input of pollutants into rivers / ground water (urban storm water, chemicals, solid waste) <b>L/M</b>	Vegetation can physically slow the movement of pollutants into waterways or in some cases can remediate soil or water pollution. Vegetation can also prevent people from dumping solid waste in areas.**
	Unplanned urbanisation encroaching on riparian areas <b>H/H</b>	Allocation of land to trees or vegetation along riversides may prevent informal building.*
Causes of Degradation of Coastal Ecosystems	Run-off of land based pollutants directly into ocean (urban storm water) <b>L/M</b>	Vegetation can physically slow the movement of pollutants into the ocean.**
	Coastal erosion <b>L/H</b>	Increased vegetation can prevent coastal erosion.**
	Increased ocean water turbidity (caused by river pollution, sedimentation) <b>L/-</b>	Increased vegetation on land can help to prevent erosion, increased sediment in rivers, and therefore water turbidity.**
	Unplanned urbanisation near lagoons / coast	Allocation of land to trees or vegetation along coastal areas may prevent informal building.

### 6.5 What issues or vulnerabilities does an urban trees project address?

The key issues and vulnerabilities urban tree planting in a Port Vila context would include food security, access to raw materials for craft, building, and access to fuel (firewood). Depending on where trees are planted and which kinds, reduction of urban run-off pollutants entering rivers and ocean may be achieved, erosion and sedimentation reduced, and protection against storm surge, inundation, and flooding increased.

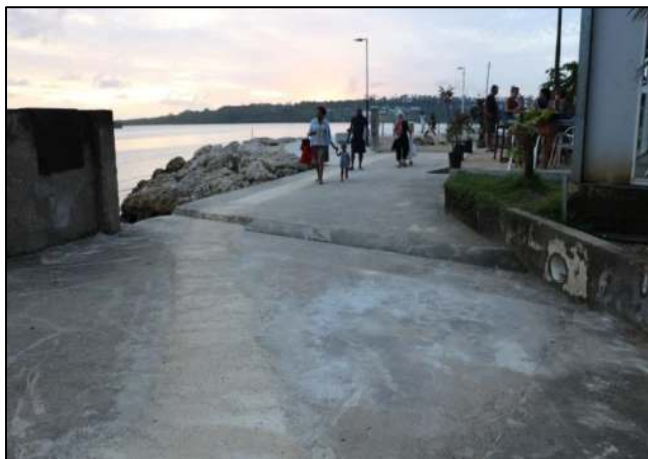


Figure 6.2 Urban stormwater outlet draining directly to ocean.



Figure 6.3 Urban drainage issues.

Increased resilience of the city to other climate change induced vulnerabilities, particularly increased dry periods, and increased intense rain events may also occur. Port Vila residents have noted that some fruiting trees no longer are as abundant as in the past (particularly relative to a decade ago), which they attribute to climate change (McEvoy et al., 2016). There is also rapid population growth in the city (McEvoy et al., 2016; Connell and Lea, 2002), and complicated land tenure arrangements, which puts pressure on traditional home garden and bush garden areas to provide enough food. Increased trees therefore are needed to supply the same amount of fruit as previously. Key impacts and vulnerabilities targeted by an urban trees project are illustrated in table 6.2.

**Table 6.2 Impacts of ecosystem degradation and climate change that an urban trees project could reduce or address**

L = low, M = medium, and H = high in terms of how effectively the project might address these causes of change. First grade is catchment level, second is at localised site. \* = low level of certainty based on literature reviews, precedents, and common sense. \*\* = medium level of certainty. \*\*\* = high level of certainty. Note: All assessments made on the assumption that project is successfully implemented.

	Impacts on ecosystems:	Impacts on human wellbeing and resilience:	Justification:
Degraded Terrestrial Ecosystems	<ul style="list-style-type: none"> <li>Reduced freshwater quality related to erosion and pollution. <b>L/M</b></li> <li>Increased soil loss due to erosion. <b>L/ M</b></li> <li>Reduced soil fertility / arable land related to devegetation and soil loss. <b>L/L</b></li> <li>Increased silting / damage to coastal environment due to erosion. <b>L/M</b></li> <li>Damage to seagrass and coral reefs due to erosion caused silting and ocean turbidity. <b>L/L</b></li> <li>Reduced ability of land to absorb storm water and increased risk of flash flooding related to increased intense rainfall events. <b>L/M</b></li> </ul>	<ul style="list-style-type: none"> <li>Reduced physical health and increased health care costs. <b>L/M</b></li> <li>Reduced ability to grow food. <b>L/M</b></li> <li>Reduced access to, or more expensive food. <b>L/M</b></li> <li>Reduced or more expensive access to raw materials (firewood etc.). <b>L/M</b></li> <li>Increased flooding of homes, infrastructure, crop and garden land. <b>L/L</b></li> </ul>	<ul style="list-style-type: none"> <li>Urban trees may prevent some of the causes of freshwater degradation (erosion, flow of pollutants into rivers). Some trees can also remediate soil and water pollution. <b>**</b></li> <li>Increased vegetation can help to prevent erosion or movement of soil or debris during rainfall events along rivers, on the coast or on slopes. Some forms of vegetation can increase or preserve soil fertility (e.g. bamboo). <b>***</b></li> <li>Increased areas of vegetation in built up areas translates to increased permeable areas. This slows storm water flows. <b>***</b></li> </ul>
Degraded Freshwater Ecosystems	<ul style="list-style-type: none"> <li>Increased silting / sedimentation <b>L/M</b></li> <li>Degradation of coastal systems (mangrove, seagrass, reef) <b>L/L</b></li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to drinking water <b>L/L</b></li> <li>Reduced access to, or more expensive food (fresh water / marine) Reduced access to drinking water <b>L/M</b></li> <li>Reduced physical health and increased health care costs <b>L/L</b></li> </ul>	<ul style="list-style-type: none"> <li>Urban trees near waterways may prevent some of the causes of freshwater degradation such as erosion and flow of pollutants into rivers. Some trees can also remediate water pollution. <b>**</b></li> <li>Increased vegetation, depending on location, can help to preserve riverbanks which in turn can reduce damage from flooding. <b>**</b></li> </ul>
Degraded Coastal Ecosystems	<ul style="list-style-type: none"> <li>Reduction of sediment stabilising <b>L/L</b></li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to, or more expensive food (marine) <b>L/L</b></li> <li>Less flood / storm surge / coastal erosion / tsunami protection <b>L/L</b></li> </ul>	<ul style="list-style-type: none"> <li>Urban trees may prevent some of the causes of coastal ecosystem degradation (due to erosion, flow of pollutants into rivers). <b>**</b></li> <li>Increased vegetation, depending on location can reduce the effects of flooding, storm surge, and tsunami. <b>**</b></li> </ul>

### 6.6 Key benefits of an urban trees project

The introduction of more vegetation into urban environments is widely recognised as having multiple benefits (Dwyer et al., 1991, Samson et al., 2017, Donovan, 2017, McDonald et al., 2016) including: energy savings, improved air quality, storm-water management, reduced temperatures in urban areas, increased wildlife habitat, improved physical health, and other social benefits (see also Appendix 1.2.4). Urban trees strongly support additional urban ecosystem services provision, along with stronger resilience of naturally occurring ecosystems themselves, particularly coastal ones, to climate change and/or storm events (Livesley et al., 2016). This project is particularly relevant to adaptation to potentially hotter and/or drier periods because trees decrease urban temperatures through shade, transpiration, and changing humidity levels (McDonald et al., 2016). Although Port Vila already includes many areas of vegetation, and is quite a 'green' city, some more strategic planning about what vegetation to protect, remove, and plant over short (1-5 years) to medium terms (6-15 years) particularly in the most intensely developed central areas of the city, may lead to increased benefits to people of Port Vila.

Increasing trees in urban environments can also act to mitigate the causes of climate change through increased carbon sequestration (Boukili et al., 2017). The contribution of Port Vila or Vanuatu as a nation to greenhouse gas emissions is obviously very small, but actions to reduce climate change may be part of international treaties Vanuatu is party to (National Advisory Board on Climate Change and Disaster Risk Reduction, 2017).



Figure 6.4 Urban tree planting

The main tangible potential benefits for residents of Port Vila are illustrated in figure 6.5. Figure 6.6 illustrates which ecosystem services an urban trees project would protect, add to, or regenerate in the context of urban Port Vila. Because trees and vegetation are one of the primary drivers of ecosystem services, an urban trees project has many ecosystem services benefits, though some may not be large in magnitude at a catchment scale.



Figure 6.5 Potential benefits to the people of Port Vila of an urban trees project

- **Food** (land, freshwater, marine): through planting of food trees and protection of the quality of freshwater and coastal ecosystems.
- **Biochemicals**: through strategic planting of medicinal or other plants with biochmeical value.
- **Raw materials / ornamental resources**: through planting of vegetation with craft, art, or building material, value.
- **Fuel / Energy**: through planting of trees with firewood value.
- **Freshwater**: through introduction of vegetation to reduce degradation of riparian areas / groundwater.

### Provisioning Services



- **Seed dispersal**: through planting of vegetation and encourgaing seed dispersal and pollination species.
- **Biological control**: through eradication of land plant invasive species and replanting with non-invasive species.
- **Cimate regulation**: through a small amount of additional carbon sequestration. Increased vegetation also modifies the temperature and humidity of urban areas.
- **Prevention of disturbance**: Vegetation can reduce erosion, modify wind and wave forces, and reduce impacts of flooding and drought.
- **Decomposition**: if composting for nurseries is part of the project.
- **Purification**: Vegetation purifies air, and depending on location and species water and soil.

### Regulating Services



- **Soil** (formation, retention, fertility): through planting to avoid erosion. Some vegetation increases soil fertility.
- **Fixation of solar energy**: trees contribute to above and below ground primary production.
- **Nutrient cycling**: vegetation cycles many land-based nutrients.
- **Habitat Provision**: vegetation provides habitat for wildlife.
- **Species maintenance**: through planting of vegetation with stategic biodiversity value.

### Supporting Services



- **Artistic / spritual inspiration; asthetic value; and recreation and tourism; and creation of a sense of place**: urban vegetation is often perceived as being beautiful and is attractive. This could be a point of difference for Port Vila.
- **Cultural diversity and history; and education and knowledge**: through planting of groups of trees which preserve cultural knowledge and traditions (such as medicine / food) and tell a narrative of how to care for and use resources from certain trees.
- **Psychological wellbeing**: research detailing the psychological beefit of direct connection to nature through views of trees is well proven and accepted.

### Cultural Services



Figure 6.6 Ecosystem services benefits of an urban trees project

### 6.7 Intervention Logic

The summary of intervention logic for this project, as described in Blaschke et al. (2017), is summarised in Figure 6.7.



Figure 6.7 Intervention Logic of an urban trees project

### 6.7 Location, ridge-to-reef position

The project will primarily be located along the streets and promenades of the urban built up areas with particular focus on existing areas of ecological degradation, sites of pollution (chemical and solid waste), where flooding issues occur, and where urban areas are near rivers and/or the foreshore. Key transport routes, especially north from the CBD towards the airport and Mele are also areas to be targeted. Figure 6.8 indicates the general project locations.

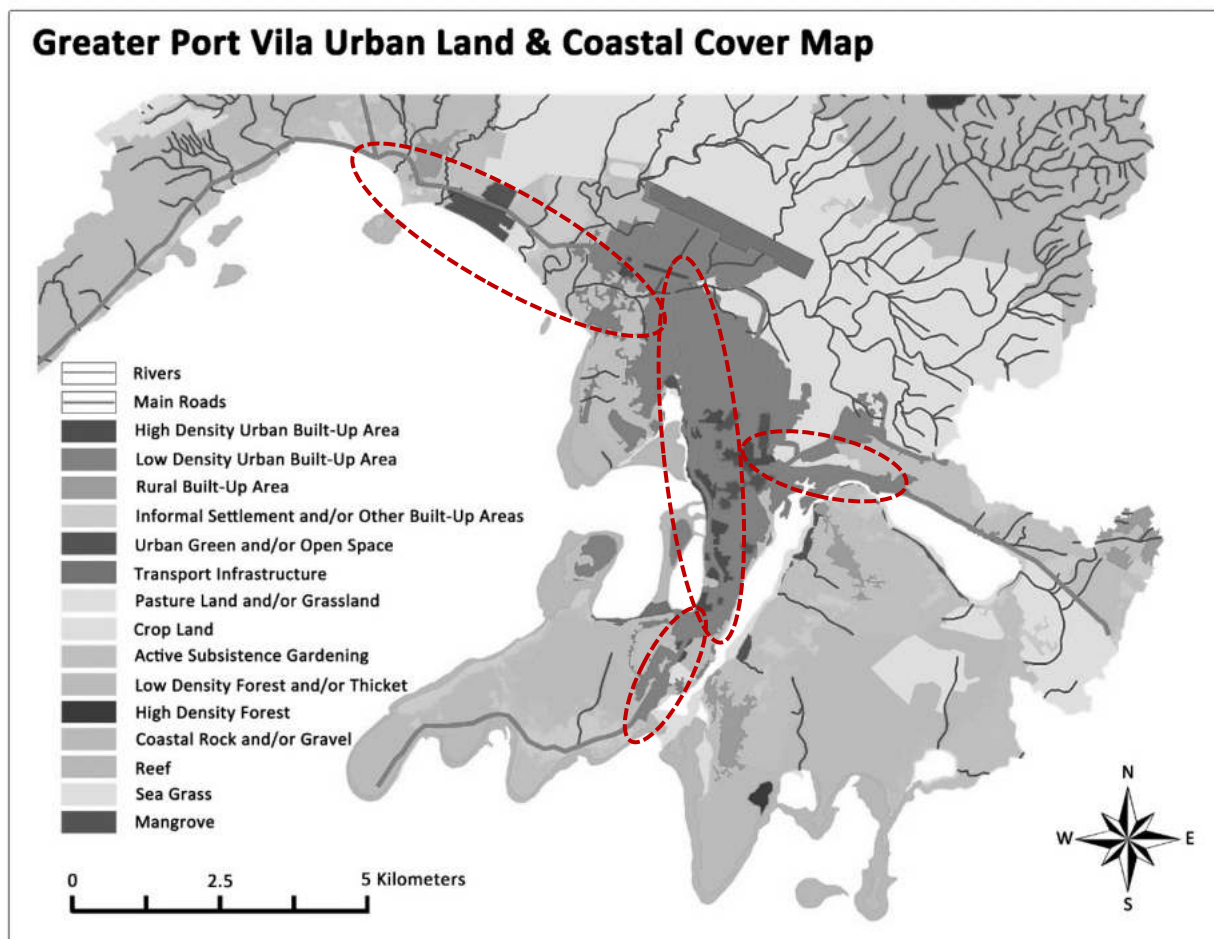


Figure 6.8 General locations of an urban trees project

Figures 6.9 and 6.10 indicate the proposed primary target locations for the project. These include the Kumul highway, George Kalsakau Drive, Rue de Paris and connecting streets and laneways between these three key routes.



Figure 6.9 Images along Kumul Highway

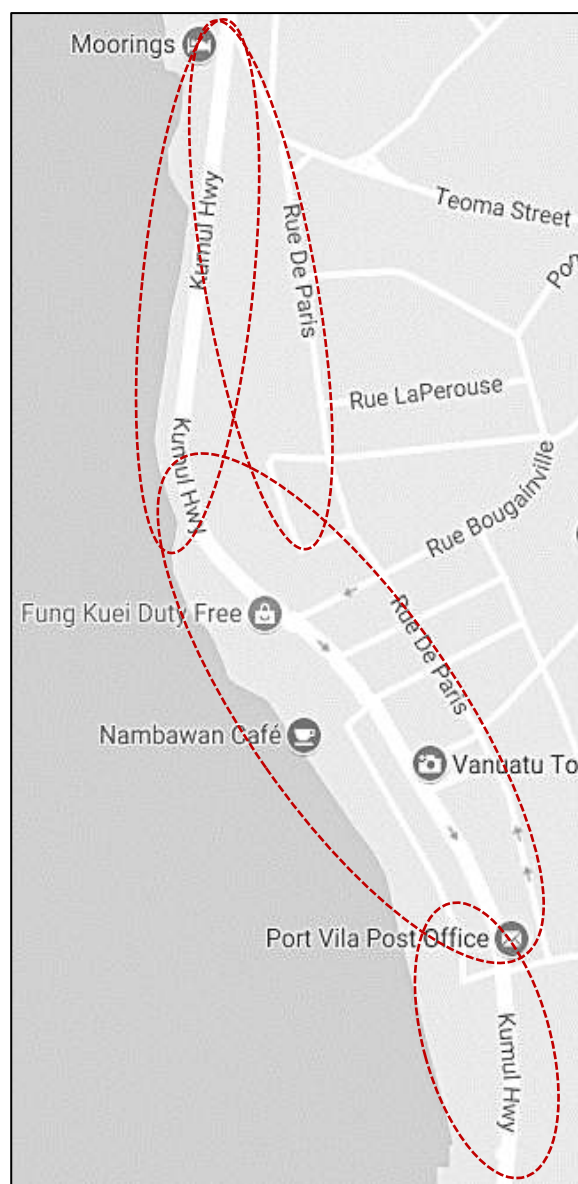


Figure 6.10 Primary target locations within central Port Vila

### 6.8 Timeframe

An urban trees project could be staged over several years, but initial implementation could be short term (up to five years) and continue over a ten to fifteen-year period over a larger area. An initial planning and preparation period of at least a year depending on seasons and growth of nursery stock would need to occur.

### 6.9 Description of project components

The following is a proposed process for implementing an urban trees project in Port Vila, and elaborates on the specific components of the project. After completion of a developed project plan, it is likely that this process would be refined. Figure 6.11 illustrates this process.



Figure 6.11 Urban trees project implementation process / components

6.9.1 Developed project planning:

This should take into account complex land ownership and tenure models in Port Vila and engage key stakeholders, particularly the Port Vila Municipal Council and local and migrant Chiefs. Another key component of this stage is to consider project funding sustainability.

### 6.9.2 Community participatory design and workshopping:

Work with communities of Port Vila has already been done (see: McEvoy et al., 2016). This does not need to be repeated, but instead can be built upon. Community 'buy-in' and agreement of the rules of how the trees will be monitored and managed needs to occur to ensure successful project implementation.



Figure 6.12 Community workshopping (Port Vila PEBACC 2017)

### 6.9.3 Spatial analysis studies:

In order to know where the most strategic locations for groups of urban trees are, a landscape fragmentation study and mapping of existing areas of invasive land plant species (particularly those near rivers) should be carried out to enable effective habitat provision and biodiversity benefits to arise from the project. In addition, determining flood prone areas of the urban area and completing a detailed study to see how urban storm water (and/or grey and black water) enters urban rivers and areas of coast would be useful to enable effective reduction of some pollutants entering waterways and reduction of flooding and erosion issues (see: LUCI results in section 2.3 of Blaschke et al. (2017) and Poustie et al. (2016)). This will also enable effective design of potential swales, rainwater gardens, or small artificial wetlands to act as water filters or remediators before urban run-off enters into water ways. Spatial planning must also take into account the physical and specific realities of roads and other infrastructure.

### 6.9.4 Species selection:

Vegetation species should be selected that can provide food, medicine and raw materials. Other culturally important species or those of biodiversity value or phytoremediation potential could also be candidates. See Appendix 8.4 for a list of potential species.

#### 6.9.5 Nursery and seed source set up:

There may be opportunities to work with schools or churches or other vegetation planting projects (e.g. other SPREP EbA projects, Forestry Department, or other NGO planting projects) to develop or expand nursery space.



Figure 6.13 Existing nursery space (VCC)

#### 6.9.6 Training of planters:

Teams of people who are paid or volunteer to plant the trees need effective training. This could be tied in environmental education initiatives (for example, through schools or churches).

#### 6.9.7 Preparation of ground:

Removal of invasive species or impermeable surfaces may need to occur.

#### 6.9.8 Staged planting of trees:

Seasons should be considered to minimise cyclone risk, and in terms of optimal rainfall and temperature for planting. If planting occurs at stages over several years this may minimise some risks of planting losses. Infrastructure concerns must also be address in this stage.

#### 6.9.9 Monitoring and management of trees:

This stage of the project will be crucial to its success. This should be carefully planned in the developed project stage. 'Adopt a tree' approaches to engaging the public, particularly through schools or local businesses may be a way to increase community care for the trees. The careful and equitable distribution of resources from trees (where appropriate) would be part of this stage.



Figure 6.14 Fruit harvest

#### 6.9.10 Documentation and communication:

This is part of sound project reporting practice, but can also be used to leverage education and preservation of cultural knowledge opportunities (for example, signage that explains the uses of each tree to people). Such communication aspects of the project would also be crucial to leveraging tourism benefits from the project and potentially to increasing interest in or support for more ambitious SPREP EbA projects.

#### 6.9.11 Evaluation:

Evaluation and reporting is a standard part of any project of this nature. Potential indicators for monitoring and evaluation of success include before and after evaluation of:

- Urban air quality (PM<sub>10</sub>, NO<sub>2</sub>, O<sub>3</sub>)
- Urban temperatures, areas of shade, and creation of microclimates
- Urban water quality (rivers and near coast ocean)
- Flooding or drainage issues
- Revenue created
- Local resident survey (knowledge of project, benefits perceived)
- Tourist survey (perceptions of Port Vila and effect on behaviour)



Figure 6.15 Project components of an urban trees project

### **6.10 Starter and smaller project components: how to start the project**

Several key research and infrastructure activities need to be completed before an urban trees project could proceed.

Firstly, as discussed, a small, low cost urban spatial analysis study will enable strategic locations of urban tree planting sites to be determined along with suitable species.

Secondly, before any planting can begin, Port Vila needs a comprehensive and inclusive nursery system that can supply seeds and/or seedlings to an urban trees project, along with other suggested EbA projects and other non-PEBACC projects. This is a tangible and contained project that PEBACC could begin with. Such an initiative will also enable PEBACC (and SPREP) to continue to build upon relationships with other non-governmental groups and government departments active in planting initiatives in the wider Vanuatu context. Linked with the development of the nursery could be training for local teams of planters that can work across projects and eventually manage and monitor the nursery. Development of an integrated Port Vila nursery can happen independently and/or concurrently with an urban trees spatial analysis study.

Thirdly, a wider urban trees project could easily begin as a pilot along one single prominent and suitable street in the inner city, or on the grounds of an appropriate government or council site in the inner city. The urban trees sites then could become in situ nurseries for larger trees if needed or could be testing sites for suitable species trials.

### **6.11 Implementers and stakeholders: Who should be involved?**

Key project partners could include the Port Vila Municipal Council, the Malvatu Mauri (National Council of Chiefs), traditional land owners, and leaders of migrant communities. Planting programmes could be tied in with environmental education programmes in schools or churches, or possibly with other community service initiatives. This kind of project could be geared towards attracting international volunteers, which may be a further way to fund the ongoing maintenance of the project as well as leverage the project to feed into tourism opportunities or revenue.

### **6.12 Education, research, training and public awareness opportunities**

An urban trees project holds several key education, training and public awareness opportunities, because it is a highly visible project with tangible benefits, located where the majority of people in the region live.

Education opportunities exist in the implementation stages in terms of participatory community species and location selection, and in training and education about tree planting and care. A unique education opportunity associated with this project, if trees are strategically chosen, is envisioning the project as a living botanical museum of important Vanuatu trees. This is a way to communicate about, preserve, and celebrate traditional knowledge in the city in terms of food, craft, and medicine. Signage would be useful in this regard, and opportunities for local or tourist walking tours, or school group field trips also arise.

Research opportunities include before and after monitoring of sites where trees are planted depending on which indicators are chosen for evaluation (see: section 1.1.9). There may also be research opportunities in terms of the biophilic cities movement, where the benefits of cities that plan for enhanced connections to nature are studied (Beatley, 2011).

### 6.13 Indicative costs and other resourcing requirements

#### Indicative cost over 5 years: \$NZ0.2 – 0.5 million.

(N.B. This indicative costing is for an initial 5-year period; the scale of project could be increased by carrying on the activities for 10 – 15 years.)

Required inputs and resources:

- Personnel:
  - 1 FTE staff: approx. \$40 000 - \$75 000 p.a. for 5 years, i.e. \$200 000 – 375 000.
  - studies (e.g. spatial analysis): \$7000 – 15 000.
  - planting and maintenance workers: \$0 – 5000.
- Office overheads:
  - cost unknown at this stage.
- Materials:
  - nursery and plants, approx. \$10 000 – 50 000.
  - signage and publicity, approx. \$2000 – 5000.

### 6.14 Financing, project design implications, opportunities for scaling

The overarching approach to financing activities in this programme is elaborated in Blaschke et al. (2017), section 3.6. This project is somewhat more straightforward in some respects given the reduced number of key stakeholders for an activity on mainly public (government-owned) land. This project does, however, have a particular advantage for private sector contributions to financing, and a public-private partnership approach. This is especially relevant to the tourism industry in relation to benefits derived from enhancing the visitor experience by increasing the amenity of ecosystem services in the commons of the CBD and also, critically, in the road corridor between the airport and the city, currently not a particularly attractive feature of Port Vila.

An urban-centred project like this one can be designed to have significant amenity and wellbeing benefits for residents and visitors alike as well as the regulating ecosystem services benefits it provides. These benefits contribute to enhancing Port Vila as a tourism destination in itself rather than merely a town next to the main airport. Enhancing the beauty of common spaces can lead to visitors extending the number of nights in Port Vila they stay, or the likelihood of a repeat visit, with consequent benefits for the hotel and tourism sector.

One possibility for attracting private sector finance is for the government and donor contributors to form a keystone investment, with invitations for private sector participants to help the project reach an enhanced target. This could be structured by indicating a minimum number of local tourism operators as a co-financing community (e.g. a minimum of 10 businesses) before any pledges for financial support are redeemed. This will have the effect of lowering risk to businesses considering a meaningful financial contribution, and create opportunities for an industry leadership group to emerge in a public-private partnership. Part of the strategy could include promotion opportunities for participating businesses that add a near-term benefit to their investment in the public good.

### 6.15 Monitoring outcomes and governance aspects

The project methodology and project plan will need to include project measurement and reporting components suitable to an urban landscape scale project like this. The monitoring outcomes are likely to be based around the number and condition of trees established. This will need to be associated with a robust preventive maintenance regime that ensure planted trees are suitably cared for. Being relatively accessible and publicly visible, monitoring should be relatively straightforward. Monitoring could also be associated with a public awareness effort that shares the vision with the wider local community.

## 6.16 Addressing barriers to implementation: What could go wrong?

Key potential barriers to the successful implementation of this project include: community buy in and land tenure; agreement on ownership and distribution of tree products; safety and infrastructure management issues; and cyclone damage.

### 6.16.1 Community participation and land tenure:

A key issue with this project is establishing who has the rights to certain areas of Port Vila land and making sure these people or groups support and give permission for the project to proceed.

### 6.16.2 Ownership and distribution of tree products:

How resources that result from trees are used or shared along needs to be agreed on and understood at a community level. For example: if a stand of trees that bear fruit is planted in the city, who is allowed to take the fruit, and how can the health of the tree be managed against overharvest? Or, if a stand of cash crop trees (such as sandalwood) is planted, who is entitled to harvest them at maturity? Who would the proceeds go to? These issues would need to be worked through at a community level as part of a detailed project planning process. Some ideas for addressing these issues include:

- Signage (written or traditional) on or near trees to explain the rules.
- Profits from tree products returning to a fund to continue the urban trees project over the medium to long term.
- Food, firewood and other raw materials could be harvested from trees by a dedicated city council team and distributed free to needy groups, or to schools or churches, or sold at local markets with profits used to fund the programme.
- Trees could be foraged by the community in an informal peer-monitored and governed system. This is how most urban trees that provide food or other harvestable products are managed in other cities. This means that citizens take what they think is appropriate when harvest is possible. This may be the easiest and most culturally normative option for the Port Vila context.
- It is possible that if citizens do not collectively value the trees and overharvest them causing them to die that the project could fail. This emphasises the importance of initial community buy-in to the project and documentation of it. Perhaps an 'adopt a tree' programme for school children or local businesses could address this.

### 6.16.3 Safety and infrastructure:

Some tree species have large nuts, fruit or foliage that may injure people or damage property when they fall, or may cause mess or attract pests. This is a planning factor to take into account. Consideration should also be given in the spatial planning process to avoiding potential root damage to underground pipes, footpaths or other infrastructure and to minimise tree interference with powerlines.

### 6.16.4 Cyclone damage:

Vanuatu experiences frequent cyclones. The frequency and intensity of these may change due to climate change. It is important to ensure that increased numbers of trees in built up areas of Port Vila will not become safety hazards during storm events. This risk can be reduced if taken into account in the detailed spatial planning stage of the project. A potential risk for this project and all projects involving tree planting or revegetation of any sort is the risk that a cyclone could wipe out efforts. One way to minimise this risk is to stagger plantings of trees over several years so that if one lot of trees are lost, a new crop can replace these once mature enough for planting out.

## 6.17 Opportunities

There are several opportunities for connecting this project with other initiatives. For example, the new seaside promenade is currently being constructed. Some planting is included in this project, but further discussions about species being used may result in additional benefits from the promenade project.

Other opportunities include the current lack of planting on many roundabout and traffic island areas and along many main streets in general. The need to add vegetation to key urban streets will become more urgent as traffic continues to rise and possibly as more high temperature days due to climate change occur.

An opportunity to influence policy exists in terms of how urban streets and green spaces are managed. Aims of an urban trees project could be proposed for greater inclusion in the recently drafted *Greater Port Vila Planning Scheme 2017-2027* (Port Vila Municipal Council, 2016). For example, if all new developments in a certain zone were required or even strongly encouraged to facilitate the strategic addition of urban vegetation, rather than the removal of it, benefits for the city could accrue.



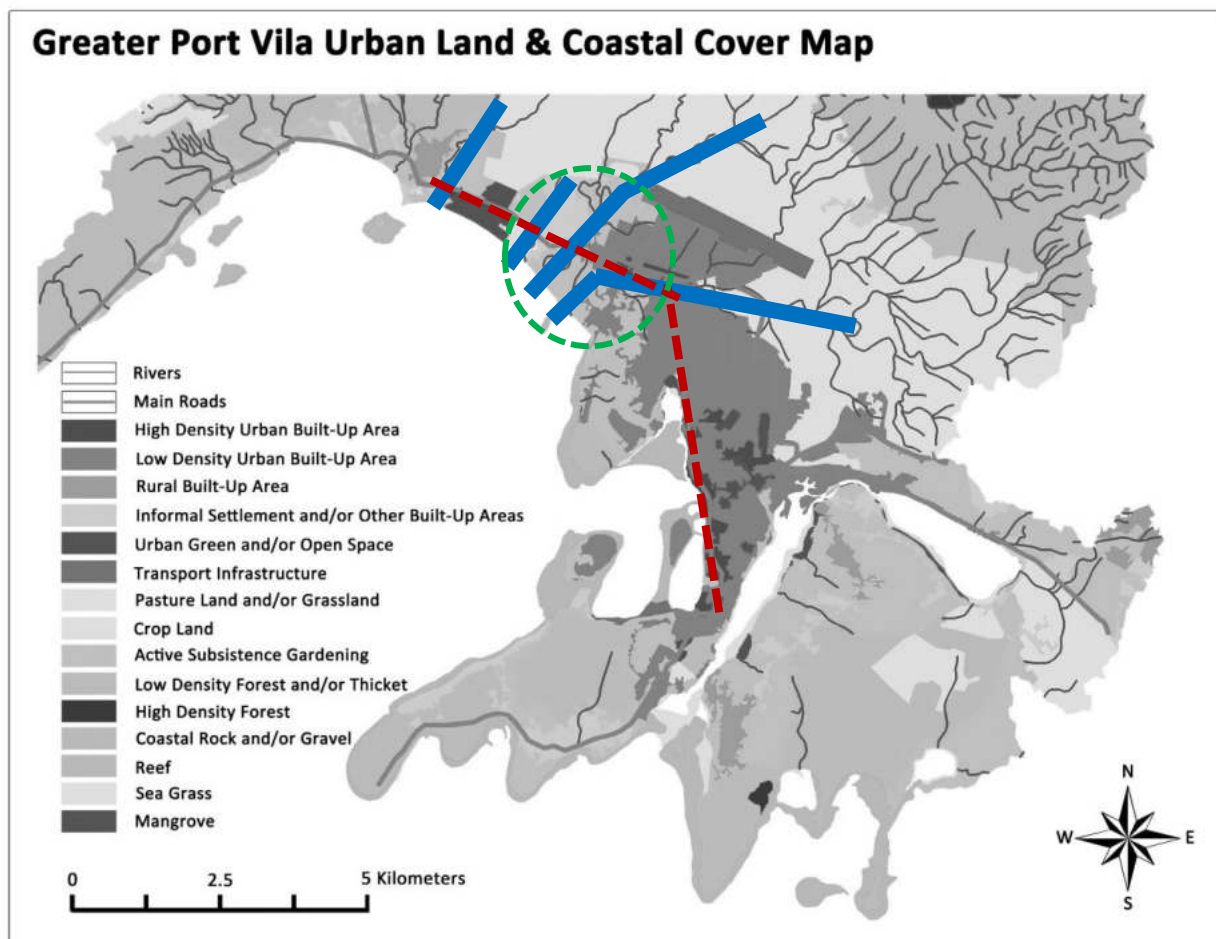
Figure 6.16 New seashore promenade

## 6.18 Relationships to other projects

### 6.18.1 Port Vila PEBACC:

This project directly links into other proposed PEBACC projects such as the Coastal Restoration project, the Riparian Corridors project, and the Urban Agriculture project. This means knowledge, skills, staff, and possibly funding opportunities can be shared across these programmes where objectives align. This is particularly relevant to seed saving and nursery facilities, training of staff, and species selection for maximum benefit across projects. Also of note, is that this project targets the main built-up urban road areas. These tend to run at right angles to most of the main rivers and streams that run through

the urban area. This means when an urban trees project is considered alongside a riparian corridors regeneration project, opportunities to ensure connection between riparian corridors arises, particularly around Mele. This is illustrated in figures 6.17 and 6.18.



**Figure 6.17 Opportunities for connecting areas of vegetation**

(red = potential urban trees project sites along main roads, blue = potential riparian corridors sites, green indicates key area where riparian revegetation corridors could be connected through street plantings)



**Figure 6.18 Road and river junction**

### 6.18.2 Greater Port Vila Planning Scheme (Draft):

Although it is not clear where the boundaries for the different zones fall, as laid out by the draft Greater Port Vila Planning Scheme (2016), it is assumed that the majority of an urban trees project would occur in the 'town centre' or 'town centre frame' areas of the business and commercial zone (see page 19 of the draft). It is intended that the town frame will accommodate 'outdoor entertainment and uses such as areas for commercial tour organisation, botanical gardens, etc...'. This is clearly in line with an urban trees project. Restricted Area Zones including the Foreshore Zone and the Riparian Reserve Zones are also stipulated in the scheme, and are intended to be buffer zones to prevent development but maintain public access (see page 21). The directive to 'protect and rehabilitate vegetation where required' for these zones in the scheme is again entirely in line with the objectives of an urban trees project.

### 6.18.3 Other programmes:

There may be potential links with other previous, current or planned projects in the region that can be explored when a detailed project development process occurs. These include:

- The Pacific Mini Games Environmental Legacy Plan (Sandalwood tree planting).<sup>15</sup>
- Sandalwood City Project (Port Vila Municipal Council, Department of Forestry).<sup>16</sup>
- The Vanuatu NGO Climate Change Adaptation Program (Oxfam, CARE International in Vanuatu, Save the Children, Vanuatu Red Cross, Vanuatu Rural Development Training Centres Association and the German Society for International Cooperation (GIZ)).
- The Vanuatu Christian Council (VCC) urban agriculture demonstration site and nursery.
- Forestry Department and NGO nursery networking efforts.
- The Vanuaflora project by CTRAV (Vanuatu Agriculture research and Technical Centre), AusAID, and the Forestry Department.

<sup>15</sup> For details see: <https://vanuatuindependent.com/2017/06/06/van2017-launches-environmental-plan-legacy-tree-planting/>

<sup>16</sup> For details see: [http://dailypost.vu/news/port-vila-to-become-sandalwood-city/article\\_0a927283-24b5-58e8-ae03-0f1b9d830ae0.html](http://dailypost.vu/news/port-vila-to-become-sandalwood-city/article_0a927283-24b5-58e8-ae03-0f1b9d830ae0.html)

## 7.0 Sustainable Housing Development Project Implementation Plan

### 7.1 Abstract

This project involves the design and implementation of a demonstration housing project in Port Vila. The goal is to introduce concepts related to social, economic and environmental sustainability into new housing developments. It could also be applicable to the refurbishment of existing informal settlements.

### 7.2 Sustainable housing project aims and purpose

The main goal of this project is to help build more sustainable or regenerative communities in Port Vila, starting with a demonstration project, with social and cultural components placed at the core of every design decision.

Specific aims and outcomes are the integration of the following features into this and new urban developments:

- Community participatory design (design development)
- food production (urban agriculture)
- energy production (agroforestry; and if possible, renewable energies)
- integrated water systems (storm water, grey water and black water management)
- waste management (food, and garden trimmings)
- site sensitive landscape architecture (sociability, drainage, comfort, biodiversity, etc.)
- bioclimatic architecture (passive solar design, shading, ventilation, insulation, appropriate materials, rain water harvesting, etc.)
- new housing typologies (cultural components, density, adaptability, etc.)
- economic viability and effective future focused city planning (leveraging local resources, traditional technologies, etc.)

### 7.3 Background

Much like the urban trees project, this proposed project recognises that already urbanised environments are key drivers of change of all ecosystems within the Port Vila metropolitan area, including currently non-urbanised areas. It is the activities related to living in the city that cause much of the degradation of Port Vila's ecosystems including overharvesting of resources and pollution. Most people live in the already urbanised parts of Port Vila (including informal settlements), and population is increasing rapidly. Increasing the resilience of communities to climate change and other drivers of vulnerabilities (such as rapid unplanned urbanisation) should therefore include a focus on where most of the people are, what people do, and how they live. This project recognises that if current patterns and speeds of urbanisation continue in Port Vila, that the degradation of local ecosystems will continue and accelerate. This in turn will decrease health and quality of life for residents and reduce resilience to further climate change impacts, both direct and indirect.

Detailed project planning may reveal different approaches to design that can be employed. One approach likely to be effective, particularly in an EbA context is to use regenerative design strategies. Simplistically, regenerative design can be a quantitative, and qualitative way to increase specific ecosystem services in built developments, or to integrate more effectively with ecosystems that provide them (Pedersen Zari, 2012, 2015).

This implementation plan is conceived and developed at the scale of an urban block. Taking as a reference the size of different existing blocks in Port Vila, one could consider a block of 100 meters wide per 200 meters long as a reference. This project could be implemented in larger areas of Port

Vila, including different blocks, translating its principles to new sustainable neighbourhoods. It could also be adapted to existing areas of Greater Port Vila for retrofitting either established suburbs or informal settlements (see: figure 7.3). Finally, the principles of the project could be included in the Greater Port Vila planning scheme and future developments.



Figure 7.1 Example of existing Port Vila housing

#### 7.4 How would a sustainable housing and development project reduce the degradation of local ecosystems?

The project would contribute to addressing issues generated in the urban environment through unplanned urbanisation; water pollution; energy consumption; waste production etc. At the same time, this project could contribute to reduce the impact of some issues generated in agricultural and forested peri-urban areas such as erosion, sedimentation, flooding, water turbidity, etc. See: table 7.1 for a summary of the causes of degradation that a sustainable housing project would address if implemented and governed effectively.

#### 7.5 What issues or vulnerabilities would a sustainable housing and development project address?

This project would contribute to reduce multiple impacts that would go beyond the boundaries of the urban environment. The main ones would be the ones related to food production, water management and energy production. See: table 7.2.

#### 7.6 Key benefits of a sustainable housing and development project.

The benefits of a sustainable housing and development project primarily address the health and wellbeing of people who would dwell in it. Additional benefits range from increase of biodiversity, reduction and recycling of solid waste and wastewater, integration of food and energy production, water management, community driven habitat provision, climate regulation, etc. See: figure 7.2.

**Table 7.1 Causes of ecosystem degradation and climate change vulnerabilities that a sustainable urban housing and development project could reduce or adapt to**

Black text = Local human caused drivers of change. Blue text = Climate change drivers of change.

L = low, M = medium, and H = high in terms of how effectively the project might address these causes of change. First grade is catchment level, second is at localised site.

\* = low level of certainty based on literature reviews, precedents, and common sense. \*\* = medium level of certainty. \*\*\* = high level of certainty. . Note: All assessments made on the assumption that project is successfully implemented.

Sustainable housing and development targets these drivers of change:		Justification:
Causes of Degradation of Terrestrial Ecosystems	Overharvesting / poor management of resources <b>L/L</b>	The integration of urban agriculture and agroforestry into housing developments would reduce the pressure on peri-urban land and would improve the efficiency of management resources. ***
	Rapid unplanned urbanisation <b>H/H</b>	Planned new housing developments and refurbishment of informal settlements following sustainable principles would help to redress this overall issue. **
	Removal of vegetation for infrastructure / settlement / fire wood / building <b>M/H</b>	The integration of agroforestry into housing developments would reduce the pressure on peri-urban land. ***
	Increased flooding <b>L/H</b>	To integrate agroforestry and reduce forest depletion (especially coastal forest) as part of sustainable urban development, would reduce localised erosion, and sedimentation and thus reduce flooding effects. **
Causes of Degradation of Freshwater	Increased sedimentation in rivers <b>M/H</b>	To reduce depletion of forests for firewood or agriculture would reduce erosion. **
	Input of pollutants into rivers / ground water (sewage, urban storm water, chemicals, solid waste) <b>M/M</b>	To have integrated water systems in urban developments would help to reduce substantially the pollution of surface water and ground water. ***
	Unplanned urbanisation encroaching on riparian areas <b>H/H</b>	To increase the density in new urban developments would contribute to reduce unplanned urbanisation. **
Causes of Degradation of Coastal Ecosystems	Run-off of land based pollutants directly into ocean (sewage, urban storm water) <b>M/M</b>	Water management, urban agriculture, agroforestry and urban forestry introduced into new developments would contribute substantially to an overall reduction of water contamination. ***
	Increased ocean water turbidity (caused by river pollution, sedimentation) <b>L/-</b>	The associated reduction of erosion due to the introduction of agriculture and agroforestry into new developments would reduce water turbidity. ***
	Unplanned urbanisation near lagoons / coast <b>H/H</b>	Increase of density in urban environment. **
	Sea level rise <b>L/H</b>	To introduce sustainability into housing developments contributes to mitigate GHG emissions and if included in the design can take into account predicted inundation zones. **

**Table 7.2 Impacts of ecosystem degradation that a sustainable urban housing and development project could reduce or address**

L = low, M = medium, and H = high in terms of how effectively the project might address these impacts.

\* = low level of certainty. \*\* = medium level of certainty. \*\*\* = high level of certainty. Note: All assessments made on the assumption that project is successfully implemented.

	Impacts of ecosystem degradation:	Impacts on human wellbeing and resilience:	Justification. How different parts of a sustainable housing and development project contribute:
Terrestrial Ecosystems	<ul style="list-style-type: none"> <li>Reduced ability of land to absorb storm water</li> <li>Increased erosion and soil loss</li> </ul>	<ul style="list-style-type: none"> <li>Reduced ability to grow food</li> <li>Reduced access to, or more expensive food (land based)</li> <li>Reduced physical health and increased health care costs</li> <li>Increased flooding of homes, infrastructure, crop, garden</li> <li>Reduced or more expensive access to raw materials (firewood etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Urban agriculture: self-production of food reduces food costs and improves physical health. ***</li> <li>Agroforestry: the capacity to generate an energy source, generates less forest depletion. ***</li> <li>Urban forestry: reduces water runoff and improves water quality. ***</li> <li>Water management: to control the leaching of grey and black water improves water quality and reduces health care costs. **</li> </ul>
Freshwater Ecosystems	<ul style="list-style-type: none"> <li>Reduced fresh water quality</li> <li>Increased silting / damage to coastal environment</li> <li>Degradation of coastal systems (mangrove, seagrass, reef)</li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to drinking water for people</li> <li>Reduced access to, or more expensive food (freshwater)</li> </ul>	<ul style="list-style-type: none"> <li>Integrated water systems: increase the access to freshwater with no cost. ***</li> <li>Integrated water systems: improve substantially the quality of groundwater. ***</li> </ul>
Coastal Ecosystems	<ul style="list-style-type: none"> <li>Increased coastal erosion</li> </ul>	<ul style="list-style-type: none"> <li>Reduced access to, or more expensive food (marine)</li> <li>Less flood / storm surge / coastal erosion / tsunami protection</li> <li>More sea level rise damage to settlements</li> <li>Increased costs of storm recovery</li> </ul>	<ul style="list-style-type: none"> <li>Urban agriculture, agroforestry and urban forests: reduce coastal erosion, sedimentation and flooding extent. ***</li> </ul>

- **Food** (land, freshwater, marine): through integration of food growing into urban development.
- **Fuel / Energy:** by focus on renewable power generation (e.g. solar panels and solar hot water heating) on urban housing, and reduction of the need to use firewood (which may also be provided).
- **Freshwater:** through introduction of rainwater harvesting systems and a focus on effective management of grey and blackwater to reduce pollution of rivers and/or groundwater.

### Provisioning Services



- **Climate regulation:** related to: the generation of renewable energy to reduce the use generators or firewood and therefore GHG emissions; and the ability of structures and trees to provide shading and more temperate micro-climates in hot weather.
- **Prevention of disturbance:** depending on placement and design, buildings can reduce erosion, modify wind and wave forces, and increase resilience to the impacts of flooding
- **Decomposition:** if composting is integrated into the project

### Regulating Services



- **Nutrient cycling:** buildings can be designed for deconstruction to enable materials reuse. Planning also contributes to effect solid waste management
- **Habitat Provision:** the strategic integration of vegetation into housing developments can provide habitat for wildlife.

### Supporting Services



- **Artistic / spritual inspiration; asthetic value; and creation of a sense of place:** through devising new housing typologies drawing upon traditional architecture and technologies and customs.
- **Cultural diversity and history; and education and knowledge:** through integration of traditional knowledge and practice related to architecture to devise culturally appropriate soultions.
- **Community wellbeing:** through the use of community centred design and development processes.

### Cultural Services



Figure 7.2 Ecosystem services benefits of a sustainable urban housing and development project

#### 7.7 Location, ridge-to-reef position

The project would be located in an area where the city is already rapidly expanding, or where informal settlements exist, such as Blacksands on the west side of the city, or Ekasup on the south-east side. In this case, the goal would be to refurbish or retrofit existing informal

settlements for increased health, resilience and mitigation of ecological degradation. Due to complex land tenure and land ownership situations in Port Vila and because of tensions relating to rapid migration of Ni-Vanuatu from other islands to Port Vila, specifying an exact location for an initial catalyst sustainable housing and development project would have to happen during the detailed project design stage. Figure 7.2 indicates suggested general project locations to address known housing pressures.

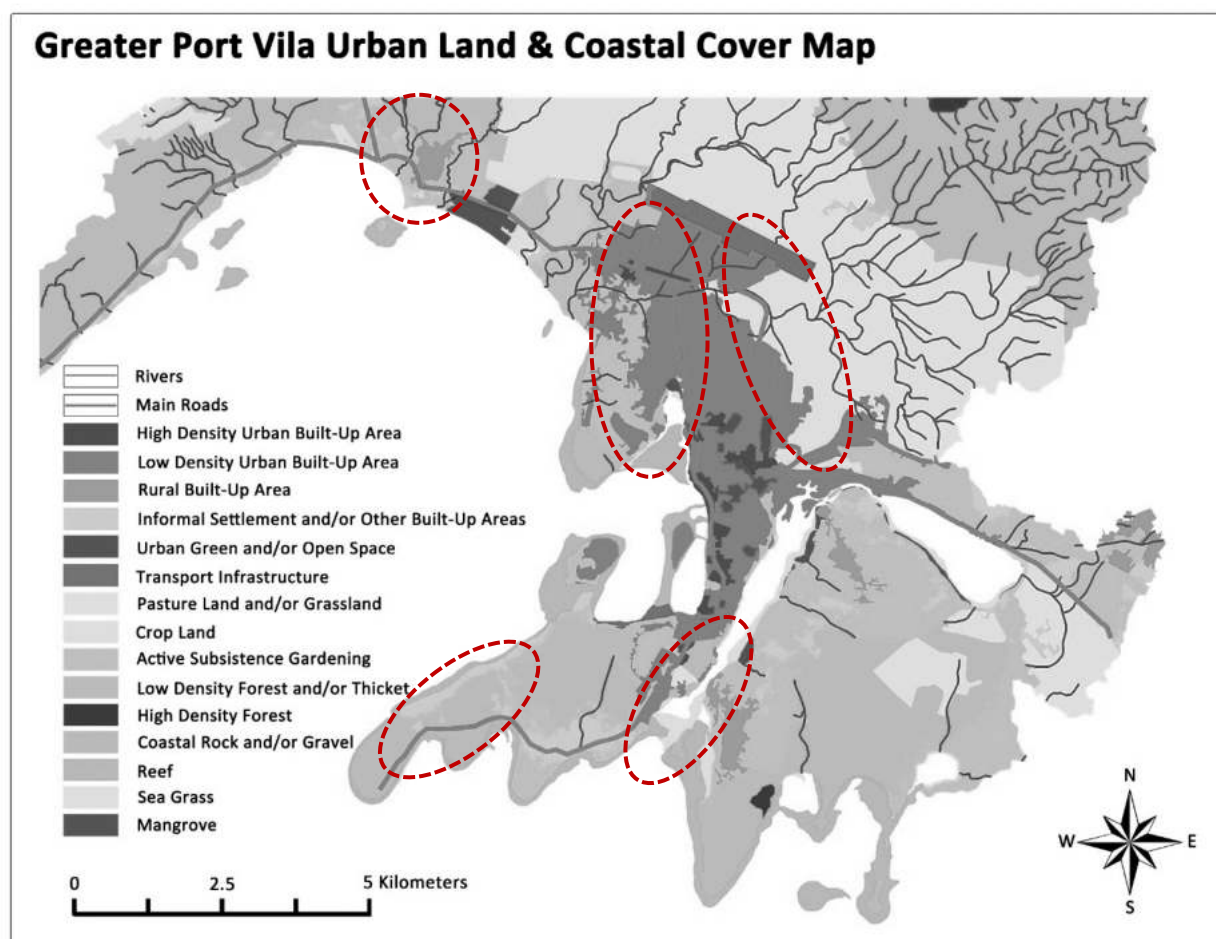


Figure 7.3 Generalised potential location options for sustainable housing project

### 7.8 Timeframe

As with any housing development, this project might be influenced by many factors that could accelerate or slow down the project over time. An initial detail project scoping and development phase would need to be conducted. Beyond that, development projects are divided into different stages. Typically these include: design process (preliminary design, concept design, developed design, and detailed design); construction; and evaluation.

A generic timeframe, would be 6-18 months for the design process and 12-24 months for construction. The complete process could range from 18 to 48 months and will be very much dependant on community 'buy-in'.

### 7.9 Description of project components

The following is a proposed list of the different elements that would be considered throughout the design and construction processes. These components are summarised in figure 7.11.

### *7.9.1 Project location and detailed project planning:*

This should take into account complex land ownership and tenure models in Port Vila and engage key stakeholders, particularly the Shefa Provincial Council, the Port Vila Municipal Council and local and migrant Chiefs. This would imply selecting a proper site as well as clarifying land ownership and the future resident community. At the same time, it would require doing a clear plan of the project as well as the consideration of potential funding.

### *7.9.2 Community participatory design and workshoping:*

Once the location, the brief and the targeted community group is clarified, designers would work together with land owners and future residents using proven participatory design strategies until the final stages of the design process. The goal would be to negotiate all main design decisions throughout the design process. The main drivers of the design would be to attain social, economic and environmental sustainability.



**Figure 7.4 Community participation workshops (SPREP, Port Vila 2017)**

### *7.9.3 Design development and construction process:*

To design always involves long and complex processes, where a lot of stakeholders intervene and many technical, economic and legal constraints need to be negotiated. For reducing complexity, phasing decisions, and sorting issues, the design process is typically divided into different stages. These are the most common stages:

1. Preliminary design: site analysis and initial design strategies are agreed. Topographical surveys are developed to enable the collection of accurate site information.
2. Concept design: all main design decisions are shaped during this phase. These would involve location, disposition and main properties of appropriate gardens, agroforestry, landscaping, buildings and infrastructure for the project. All legal consents tend to be tendered and negotiated at this design stage. During this stage, estimated costings can be done.
3. Developed and detailed designs: development down to the details of all aspects of the project. Accurate costings estimates are done and the construction process is planned. At the conclusion of this stage, documents for tender can be send to contractors.
4. Construction process: implementation of all the different parts of the project, including buildings, infrastructure, grading, planting, etc. Construction can be split in different phases if funding is limited.

### *7.9.4 Site-sensitive landscape architecture (sociability, drainage, comfort, biodiversity):*

The sustainable community vision must include green and blue areas within communal and semiprivate spaces. To facilitate community interaction would be a key aspect of the sustainable housing development. This would be achieved while providing the substrate for developing more effective water and waste management along with food and energy production (see: figure 7.11).

The design of all the exterior spaces of the development would consider placing the shared spaces at the centre of the block, leaving private space just inside of each house. Houses would be placed on the perimeter of the block, but set back from the streets. The immediate exterior spaces of the houses would be transitional, semiprivate spaces facing towards communal space (inner block) or public space (outer boundaries of the block). The boundaries of the block would be planted for guaranteeing privacy from the street, while improving street runoff infiltration, biodiversity and microclimate conditions.

The design of the exterior spaces would consider strategic grading and drainage for establishing the planting and managing of storm water and grey water. This would be done while providing the best possible substrate for food and energy production. The planting of the rest of the vegetation would consider the different gradients of soil moisture and would be focused towards the creation of the maximum comfort for the exterior spaces and the houses.

The creation of shade, moisture and privacy through the designed vegetation would be interacting with the bioclimatic driven architecture. The sustainable landscaping would be achieved using native species and if necessary, well integrated exotic species.

#### *7.9.5 Food production (urban agriculture):*

To be able to grow food is a social, economic and cultural need for most resident groups in Port Vila. At the same time, a food system will only be sustainable as long as it can maintain its ability to feed people without depleting natural resources. Combining local and global inputs, food production will be the core of the proposed sustainable housing development, and strongly links this PEBACC project with the intensification of urban home gardens project (see: section 5).

Urban agriculture would be integrated into the central area of the block, acting as a community space where every group of residents would be able to grow their own food. The overall grading, soil qualities and drainage of the block would be related to this central part of the development for guaranteeing its productivity. It could also be related to small scale agroforestry (tree production).

#### *7.9.6 Energy production (agroforestry):*

Many residents of Port Vila rely on firewood as an energy source. This situation generates associated ecological impacts as have been already discussed in Chapter 5 and in Blaschke et al. (2017). To grow vegetation within the same housing development that can be used as an energy source would be the first step for reaching energy self-sufficiency. If economic possibilities would allow it, agroforestry could be combined with renewable energy sources, using solar panels for heating water or producing electricity. Using small scale wind turbines for producing electricity or pumping water could also produce sustainable outcomes.

The plantation would be managed collectively and the resulting timber shared by the whole community. The plantation would be placed next to the urban agriculture, on the core of the block. The location would be strategic for receiving the surface runoff of the whole block, where also some retention ponds would be placed. For increasing its productivity, some management practices (trimming, chopping) would be required.

The selection of species would be related to their fast-growing capacity, using species that would reach its maturity from 10-15 years. For reaching maximum efficiency, the whole planted lot should be subdivided in 10 or 15 parts, planting one part every year. This planting would allow the sustainable harvest of firewood every year after 10-15 years.



Figure 7.6 Integrated agriculture and agroforestry, Port Vila (left), Kenya (right)

### 7.9.7 Integrated water systems (storm water, grey water and black water management):

Other work reported in Blaschke et al. (2017, section 2) has documented how the quantity and quality of both surface water and groundwater are generating environmental issues. These issues will be increased in the future under the existing water management practices and predicted population growth. These trends can be redressed if more sustainable approaches are implemented into new and existing housing developments.

Within an urban environment where fresh water and sewage infrastructures don't exist everywhere and may not even be implemented over time, it is essential to have new developments with integrated water systems (figure 7.7).

The first key action would be to harvest storm water from the roofs of the buildings to be used as drinking water (if water quality is controlled), washing or irrigation. At the same time, storm water would be harvested through sustainable landscaping, collecting water in ponds or tanks to be used for washing or irrigation.

The second step would be to reuse water utilised for washing. This water would be reused after a cheap and easy greywater treatment (using plants and/or chemicals). The resultant water could be used for washing, toilet flushing, irrigation and other non-potable uses.

The black water resultant from toilet flushing would be kept in sealed septic tanks until the wastewater infrastructure could be implemented and/or the treatment plant would be built. As a sustainable alternative, black water could also be treated on site using chemicals, UV and plants to be used for irrigation and/or infiltrated into the ground for recharging the water table.

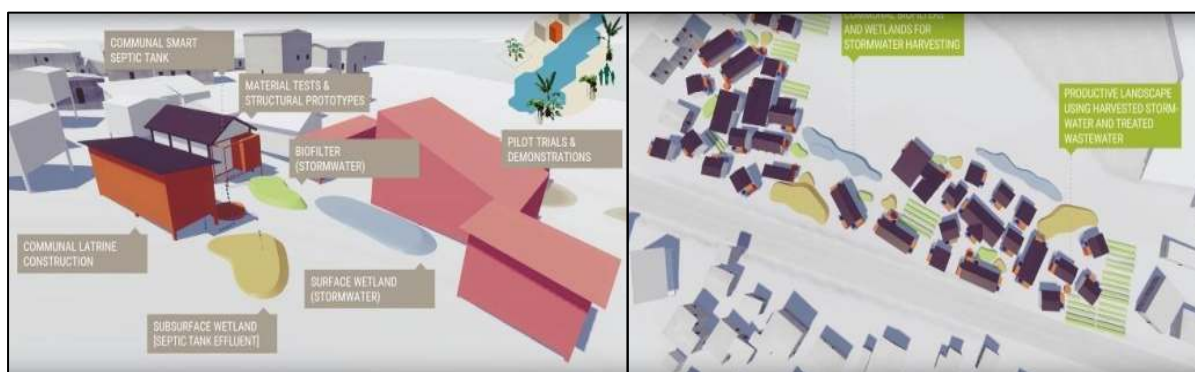


Figure 7.7 Water sensitive revitalisation of informal urban settlements.  
Monash University project (refer to Appendix 8.3)

### 7.9.8 Waste management (food and green waste)

The economy of Vanuatu is based in the primary sector, which facilitates the management of solid waste. Environmental impacts can be more easily mitigated because there is a low proportion of industrialised goods. Through tourism development, the economy is likely to progressively shift into being more services-based (Mackey et al., 2017), especially around Port Vila. But the short-term and mid-term socio-economic situation will maintain one of subsistence farming as a central economic activity. Within this context, it is essential to incorporate sustainable practices of solid waste into new housing developments. These practices return materials to the economic mainstream for reuse, recycling and/or composting. Residual materials can also be used as resources to create clean renewable energy. The proposed sustainable housing development would include facilities for self-managing all solid organic waste. It would be necessary to educate residents about sustainable waste management practices. All solid waste related to food, and garden trimmings would be recycled for generating compost. The resulting compost would be used for enriching the soil of the gardens and argo-forestry.

### 7.9.9 Bioclimatic architecture (ventilation, sun/shade, insulation, materials):

A sustainable design approach attempts to connect people with nature while maintaining comfort based on local climate. This approach to design seeks cohesion between design and natural elements, which then leads to the optimisation of environmental resources, thus reducing energy consumption. Part of this approach is consideration of and learning from traditional architecture, which over centuries has developed these principles.

In a tropical/semi-tropical climate such as Port Vila's, the key aspects of bioclimatic architecture will be shading, passive ventilation and protection from strong rainfalls. This would be achieved firstly by space layout and orientation, merging architecture with vegetation and drainage for controlling sunlight; then, by controlling the volumetric disposition, taking into account prevailing winds, passive ventilation and shading, relating the architecture with the wider context; and finally, using local materials as much as possible in reinterpreted traditional construction systems.

### 7.9.10 New housing typologies (considering cultural components, density, adaptability):

The overall goal of the new housing development would be to increase the density compared to that of current informal settlements to enable a more efficient use of the land. At the same time, to deliver a design that would allow higher densities over time, guaranteeing the adaptability and expansion of the housing units.

To increase density, an efficient framework of exterior spaces should be considered that would allow food and energy production along with water and waste management. The design would seek the investigation of new housing typologies, revisiting traditional architecture and following bioclimatic principles, while merging architecture with landscaping.



Figure 7.8 UN-Habitat, Housing developments. Papua New Guinea (left) and Myanmar (right)



Figure 7.9 Sustainable housing development project implementation process / components

*7.9.11 Economic viability and city planning (local resources, traditional technology):*

Creating sustainable communities must be supported by the community and impacted stakeholders. To secure support for investments in specific sustainable strategies, planners and policy-makers need to articulate the reasons for spending money on initiatives that result in food, energy, water and waste improvements. These improvements increase at the same time that resilience in response to climate change and storm effects does.

The environmental improvements associated with these types of housing developments would bring a financial return over time. This aspect should be considered in order to facilitate and promote these types of developments and translate them into city planning.

On the other hand, the costs of the housing units would be low and would not rely on highly technological and expensive solutions. Cost-effectiveness would be enhanced through the use of local materials and technologies.



Figure 7.10 Vernacular architectural influences, Port Vila restaurant

Table 7.3 Project: approximate dimensions / surfaces / quantities

SUSTAINABLE HOUSING DEVELOPMENT – GENERIC SITE			
COMPONENT	DIMENSIONS / SURFACE	SURFACE (%)	OWNERSHIP
Block	100 m (wide) x 200 m (long)		
Block	20000 m <sup>2</sup>	100%	
Agriculture	9000 m <sup>2</sup>	45%	Communal
Housing (80 m <sup>2</sup> /unit)	6000 m <sup>2</sup> (just 1 floor, expandable)	30%	Private
Housing (ext. Spaces)	1000 m <sup>2</sup>	5%	Semi-private
Agroforestry	2000 m <sup>2</sup>	10%	Communal
Urban forestry	2000 m <sup>2</sup>	10%	Semi-public

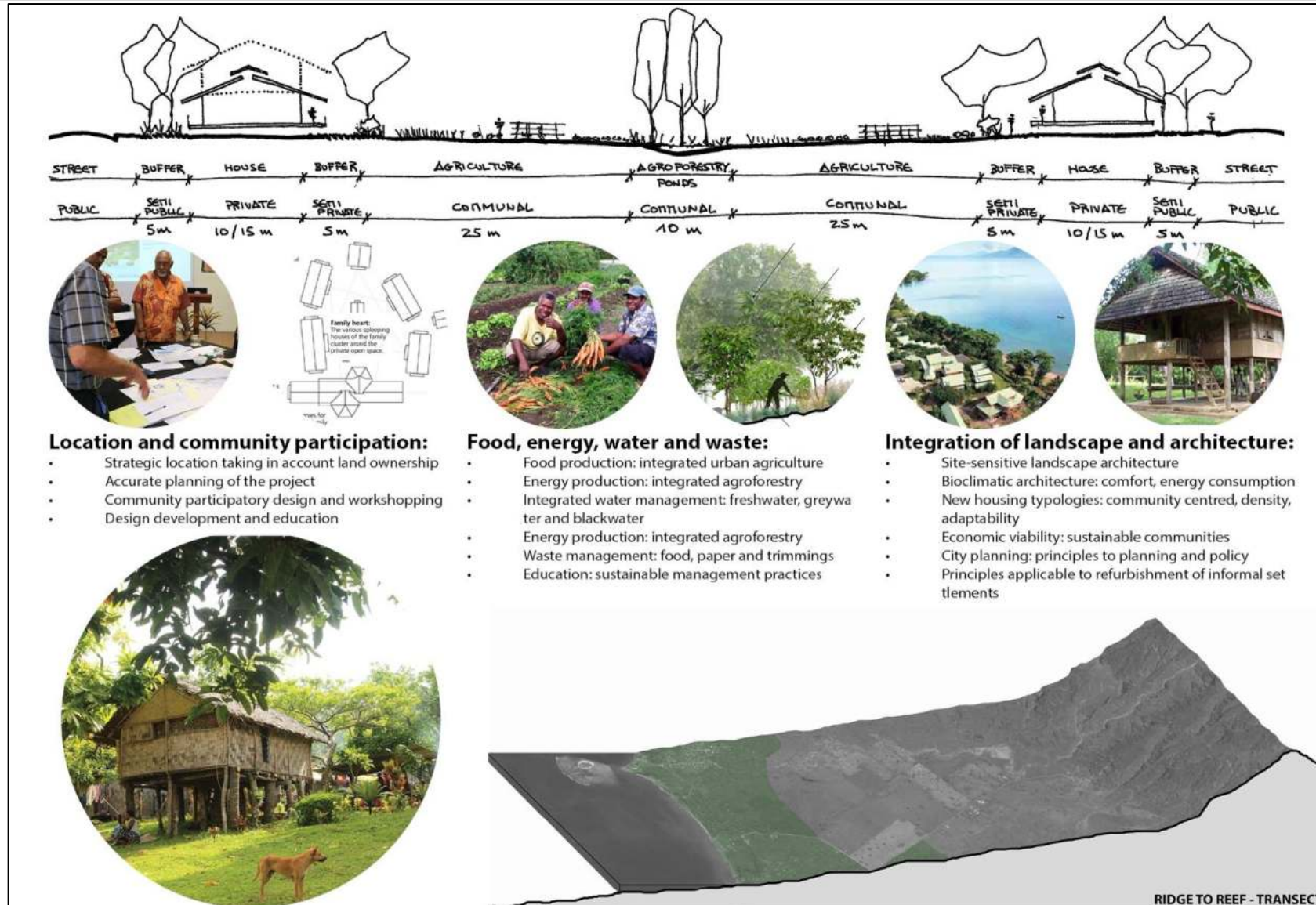


Figure 7.11 Sustainable housing development project: components

### 7.10 Starter and smaller project components: how to start the project

The sustainable housing project has been thought of as a model that could be adapted to many different situations. The flexibility of the proposed model could allow the project to be implemented at different scales, sizes, locations and situations. The relevant aspect for locating a potential site is that the proportion of surface assigned to urban agriculture should be bigger or at least the same as that used for housing (30 to 50%). Also, there is a need to have part of the site allocated to agroforestry and storm water management (10 to 20%).

Depending on the available resources, the type of sites where the project could be initially implemented could be:

- Standard new urban block: around 200 meters long per 100 meters wide.
- Small new urban block: minimum width of 60 meters if double row of houses.
- Part of an existing urban block: plot minimum depth of 35 meters if relating to a single row of houses.
- Part or whole block of an informal settlement. This could be any size that has enough space for allocating the required proportions of space between housing, agriculture and agroforestry / water management.
- Insertion into the Greater Port Vila planning scheme: The main aspects of the project could be easily transformed into regulatory parameters for new developments. These regulatory parameters could be included into the planning scheme that is now under revision. The relevant aspects that should be taken into consideration are:
  - Type of land use within each urban site (or 'block') and location of each use.
  - Proportion of site allocated to each use in the block.
  - Housing: depth, height, bioclimatic parameters and potential expansion over time.
  - Storm water management and rain water harvesting. Consider: water tanks; grading/drainage towards agroforestry and ponds; retention of water in ponds; and overall overflow towards storm water infrastructure or streams.
  - Renewable energy production: solar panels, management practices of agroforestry.
  - Waste: sewage management and solid waste management.

### 7.11 Implementers and stakeholders: Who should be involved?

Key project partners could include the Shefa Provincial Council, Port Vila Municipal Council, the Malvatu Mauri (National Council of Chiefs), traditional land owners, and leaders of migrant communities. Sustainable housing programmes could be tied in with environmental education programmes in schools or churches, or possibly with other community service initiatives. This kind of project could be geared towards attracting international organizations that would be interested on investing funds in highly valuable EbA projects.

### 7.12 Education, research, training and public awareness opportunities

A sustainable housing project offers several key education, training and public awareness opportunities, because it is a highly visible project with tangible benefits. Education opportunities exist in terms of participatory community design, and in training and education about water management and waste management.

In an agriculture-based society as Vanuatu's, where subsistence farming is a reality, food production practices would not need significant training, except in special aspects related to more intensive home garden production (see: section 5.9). Probably, agroforestry would imply some education about management practices for ensuring faster and more resilient growth.

The public awareness opportunities would be related to envisioning that sustainability is basically about adapting traditional practices to a contemporary context, and that these practices are directly related to how people live and interact within their communities.

### 7.13 Indicative costs and other resourcing requirements

**Indicative cost to completion (2-4 years): \$NZ0.5 - 2 million.**

N.B. This indicative costing does not factor in any revenue from sale or renting of the houses when completed.

Required inputs and resources:

- Personnel:
  - 1 FTE manager; approx. \$40 000 - \$75 000 p.a., i.e. \$80 000 – 300 000.
  - Consultants (for design stage): \$100 000 – 600 000.
- Office overheads:
  - cost unknown at this stage
- Construction (7-8 units):
  - approx. \$20 000 – 85 000 each, i.e. \$150 000 – 700 000.
- Infrastructure, landscaping, planting:
  - approx. \$20 000 – 300 000.

### 7.14 Financing, project design implications, opportunities for scaling

The overarching approach to financing in the project is elaborated in Blaschke et al. (2017), section 3.6. This project has particular value as a demonstration activity that models a vision of resilient urban dwellings in the resilient urban/suburban setting. For this to have value as a demonstration activity, close attention will need to be given to demonstrating a financial model for scaling up this activity.

The initial investment is likely to be primarily donor-funded. For a scaled-up sustainable outcome, however, a largely private investment is likely to be necessary (not overlooking that rental or sale income will significantly lower longer-term costs). From a private investment perspective, a housing initiative like this may have the initial appearance of an ‘over-capitalised’ development that may not be justified under business-as-usual housing sector conditions. The financing component of the project could focus on the difference in cost between BAU and a more resilient housing outcome, with external financing covering the over-capitalisation’ element. This can, thereby, model how sustainable housing innovations can be scaled and in the process increase the attractiveness of this project to be funded. This is because scalability is where aggregated gains can be made that a significant measurable impact on urban and suburban housing development in term of providing access to resilient housing to the greatest number as the Port Vila population transitions to a more sustainable and climate-resilient format.

### 7.15 Monitoring outcomes and governance aspects

Of particular importance to this project is the way that it delivers a larger set of benefits to the householder compared to BAU (business-as-usual). This large set of benefits will ideally be quantified through the measurement of key performance indicators (KPIs) of all aspects of performance, including food, energy and water security delivery as well as the physical housing components. The project methodology, therefore, will need to include a baseline and project measurement, reporting and verification system capable of measuring relevant KPIs.

### 7.16 Addressing barriers to implementation: What could go wrong?

Key potential barriers to the successful implementation of this project include: community participation and land tenure; agreement on ownership and distribution of property; management of the project; funding.

#### *7.16.1 Community participation and land tenure:*

A key issue with this project for selecting a site is to establish who has the rights to certain areas of Port Vila land. It would be essential that communities support and give permission for the project to proceed. The nature of the communities affected would vary according to whether the project was situated within the Port Vila Municipal Area or on customary land within Greater Port Vila.

#### *7.16.2 Ownership and property distribution:*

Given the community driven structure of Vanuatu's society, would be a key aspect to clarify the lease/ownership structures for the resulting property of the houses and the exterior communal spaces.

#### *7.16.3 Management of the project:*

Related to ownership and property distribution, a sensitive aspect of the project would be to clarify which community group and community leader/s would take part in the participatory design process. This would be key for making the design process effective and community driven.

#### *7.16.4 Funding:*

The funding of the project should not interfere with ownership, property distribution and design development. Potential clashes between community and funding should be clarified in advanced for not driving the project to failure.

### **7.17 Opportunities**

There are several opportunities for connecting this project with other initiatives. For example, the new seaside promenade currently being constructed. Some planting is included in this project, but further discussions about species being used may result in additional benefits from the project.

### **7.18 Relationships to other projects**

#### *7.18.1 Port Vila PEBACC:*

This project directly links into all other proposed PEBACC projects, depending on where the demonstration project is located. This means knowledge, skills, staff, and possibly funding opportunities can be shared across these programmes where objectives align.

#### *7.18.2 Greater Port Vila Planning Scheme (Draft):*

Although it is not clear where the boundaries for the different zones fall, as laid out by the draft Greater Port Vila Planning Scheme (2016), it is assumed that the potential sites for implementing a sustainable housing development would be suitable for residential low density zones and residential medium density zones (see pages 18 and 19 of the draft). Both zones allow the increase of density that this project fosters. The clarification of land ownership and if necessary, subdivision could be a potential issue that should be faced when planning the project.

#### *7.18.3 Other programmes:*

There may be potential links with other previous, current or planned projects in that can be explored when a detailed project development process occurs. These include:

- The Vanuatu World Bank housing project.
- UN-Habitat program.
- Vanuatu Housing Corporation – housing programmes.
- NevHouse Vanuatu project.
- International Green Structures for relief housing in Vanuatu.
- EWB Challenge – Live&Learn Vanuatu project.

## 8.0 Appendices

### 8.1 Appendix: Home Gardens Intensification Implementation Plan

#### 8.1.1 Information required for the detailed project design stage, and to strengthen the intervention logic

- Past experience
  - Why have similar projects in the past failed?
  - Why have similar projects in the past succeeded?
- Dynamics of food markets
  - What is the ability of growers who supply the market and supermarkets to meet the expected increase in demand for fresh fruit and vegetables? Is increased production by these growers likely to affect prices - an increase, a decrease, or no effect?
- Barriers to larger, more intensive home gardens
  - Why do people not have larger, more intensive home gardens now?
  - Is it a common situation that land that could be used for home gardening at little or no opportunity cost is not used in this way?
  - Could the staple root crops commonly grown in bush gardens be grown in home gardens?
  - Who does the gardening: women, men, children?
  - To what extent is the risk of theft from gardens/bee hives/fish ponds likely to be a constraint?
  - To what extent is the lack of household labour likely to be a constraint?
  - To what extent is lack of security over the land likely to be a constraint?
  - To what extent would increasing the extent and productivity of home gardens result in less time spent in bush gardens? Would reduced time spent working in a bush garden leave some personal or social needs unmet?
- Home aquaculture
  - Do a few, some, most households have access to land that could be used for freshwater aquaculture?
  - Why do more households not engage in freshwater aquaculture?
  - What support would be likely to be needed to increase involvement in freshwater aquaculture?
- Honey production
  - Do a few, some, or most households have access to land that could be used for honey production?
  - Why do more households not engage in honey production?
  - What support would be likely to be needed to increase involvement in honey production?
- Fuel wood in home gardens
  - What issues, if any, are anticipated to arise if current practices re obtaining fuel wood remain unchanged? Which of these issues would growing more fuel wood in home gardens address in a significant way?
  - What is the ability of 'commercial' suppliers to meet the expected increase in demand for firewood? Is increased production by 'commercial' suppliers likely to result in increased prices?
  - Is growing desirable fuel wood a practical proposition in a few, many or most home gardens?
- Cooking practices
  - What issues, if any, are anticipated to arise if current cooking practices (using firewood) remain unchanged? Are there changes that could be incorporated into this Project that would address some of these issues in a significant way?

- Other possible plants/trees in home gardens
  - Is growing kastom building materials for mats, baskets and construction (natangura, bamboo, pandanus, coconut palm), growing pandanus for handicrafts, growing medicinal plants/trees, or growing forest fruit trees such as mango and naus, a practical proposition in a few, many or most home gardens? Should any of these be included in the project?
- Preservation and storage of food
  - How relevant is preserving and storing food to the produce that comes from home gardens?
  - Is there strong evidence that people like, and would therefore be happy to eat, preserved and stored food from home gardens? How does this vary with different preserving and storing techniques?
  - Is there strong evidence that better preserving and storage of food from home gardens would significantly improve a household's food security?
- Possible barriers to any of the above
  - To what extent would the lack of tools and equipment be likely to be a constraint?
  - To what extent would an inability to access seeds/plants etc. be likely to be a constraint?
  - To what extent would lack of a reliable, affordable water supply be likely to be a constraint?
  - What additional support would be likely to be needed to achieve an intensification of home gardens?
- Impact of increased home garden production on marine ecosystems
  - To what extent would increased home garden production reduce pressures on marine food sources?
  - To what extent would freshwater fish be accepted as a substitute for marine fish, shell fish and other marine food items? To what extent would terrestrial plant foods be accepted as a substitute for marine fish, shell fish and other marine food items?
  - To what extent would not harvesting marine sources of food leave some personal or social needs unmet?
- Over-harvesting of natangura and pandanus
  - Are the trees that are being over-harvested an 'open resource'? If so, to what extent is this the reason why they are over-harvested?
  - If they are not an open resource, are those who own the resource not able or willing to control the harvesting?
- Communal/co-operative efforts
  - To what extent is there likely to be sufficient trust in each of the different physical communities to make communal effort viable? If there is insufficient trust in some physical communities, are there communities of interest (e.g. churches) within which there is sufficient trust?
  - Might local co-operatives offer a useful model or lessons for this project?
- Financial self-sufficiency
  - Are there ways in which this project could be structured so that in time it would become financially self-sufficient?

### *8.1.2 A more ambitious project*

We have identified a more ambitious project that would extend this project by including field research elements that would make the project more directly related to climate change adaptation.

#### **Core + climate change adaptation field research**

A more ambitious project more directly related to climate change adaptation would be the core project (as set out in this implementation plan) with the added components of carrying out field research into the performance of home garden crops and home gardening practices under changed climate conditions including current variability.

We envisage that the components of the more ambitious project would be:

1. Providing support to households/communities to enable/assist them to intensify their home gardens.
2. Testing the performance of different species, and varieties of species, of existing and potential home garden crops under different climate regimes that may result from climate change and under the current degree of climate variability.
3. Testing the efficacy of different home gardening practices under different climate regimes that may result from climate change and under the current degree of climate variability.
4. Monitoring the effect on home garden crops of changes to the climate.
5. Incorporating the results of this monitoring and testing into the support being provided to households/communities.

This would be a more complex, costly and long-term project – it would require a minimum 10-year timeframe to investigate a range of climatic conditions and a minimum 20 year timeframe in order to obtain greater clarity about the relevant climatic changes and to give time for the testing and monitoring to show results – and it would have greater implementation and output risks.

As noted in section 5.15, a more ambitious version of the intensification of home gardens project that included field research elements into crops, varieties and landraces should be coordinated with the work of VARTC and others working in this area.

### *8.1.3 Precedents*

Some of the agricultural extension activities in Vanuatu and elsewhere are relevant precedents that confirm the general intervention logic of this project and that can be drawn on in the project's detailed design phase to maximize effectiveness and to minimise and manage risks.

## 8.2 Appendix: Urban Trees Project Implementation plan

### 8.2.1 Key information sources for an urban trees project

These two works are specific to Vanuatu and detail species of plants that are used in Vanuatu (food or medicine) that may be appropriate for the project:

- WALTER, A., & V. LEBOT. 2007. *Gardens of Oceania [trs by P. Ferrar from 'Jardins d'Océanie']*. ACIAR Monograph No. 122. Canberra: Australian Centre for International Agriculture Research.
- WALTER, A., & C. SAM. 2002. *Fruits of Oceania [trs by P. Ferrar from 'Fruits d'Océanie']*. ACIAR Monograph No. 85. Canberra: Australian Centre for International Agriculture Research.

The Ecosystem and socio-economic resilience analysis and mapping (ESRAM) report conducted in 2016 for Port Vila contains important information about what plants people use, how they are used, and where they may be located:

- MCEVOY, D., DE VILLE, N., KOMUGABE-DIXSON, A. & TRUNDLE, A. 2016. *Greater Port Vila: Ecosystem and socio-economic resilience analysis and mapping (ESRAM)*, Technical Summary. Melbourne: RMIT University.

Specific spatial and drainage information about George Kalsakau Drive can be found here:

- MINISTRY OF INFRASTRUCTURE AND PUBLIC UTILITIES (MIPU) & GOVERNMENT OF VANUATU BANK 2015. *VAN: Port Vila Urban Development Project. George Kalsakau Drive*, Environmental Management Plan. Report 15. Port Vila, Vanuatu, Government of Vanuatu.

Discussion about water in general, including urban drainage issues in Port Vila can be found here:

- POUSTIE, M. S., FRANTZESKAKI, N. & BROWN, R. R. 2016. A transition scenario for leapfrogging to a sustainable urban water future in Port Vila, Vanuatu. *Technological Forecasting and Social Change*, 105, 129-139.

### 8.2.3 Urban tree project precedents

The following precedents may form the basis of useful case studies to understand successes and failures of other urban trees projects:

- 2 Million Trees project, Wellington City Council, New Zealand.  
<http://wellington.govt.nz/your-council/projects/two-million-trees>
- The Kaulunani Urban and Community Forestry Program and Hamakua Marsh/Kaelepulu stream rainwater garden project, Hawai'i, Smart Trees Pacific.  
<http://www.smarttreespacific.org/projects/kaulunani/>  
<http://www.smarttreespacific.org/projects/water-quality/>
- GAIA project, Bologna, Italy  
<http://climate-adapt.eea.europa.eu/metadata/case-studies/gaia-green-area-inner-city-agreement-to-finance-tree-planting-in-bologna>
- Urban Forest Rehabilitation, Singapore  
[www.iufro.org/download/file/7383/5120/Singapore\\_pdf/](http://www.iufro.org/download/file/7383/5120/Singapore_pdf/)
- Case studies of urban forestry in the United States of America  
[https://issuu.com/americanforests/docs/af\\_urbanforestscasestudies\\_final\\_web\\_test](https://issuu.com/americanforests/docs/af_urbanforestscasestudies_final_web_test)
- Multiple case studies are included from around the world in this document: MCDONALD, R., KROEGER, T., BOUCHER, T., WANG, L. & SALEM, R. 2016. Planting healthy air. USA: The Nature Conservancy. <https://global.nature.org/content/healthyair>

### 8.2.4 Potentially suitable species

**Table 8.1 Potentially suitable species for an urban trees project**

Tree Name (common)	Uses
<b>Avocado</b>	Used in aelan kakae (traditional cuisine)
<b>Bamboo</b>	Erosion prevention, soil remediation, increased soil fertility, water filtration (when used as charcoal), energy source (when used as charcoal), building material
<b>Banana / plantain</b>	Used in aelan kakae
<b>Breadfruit</b>	Used in aelan kakae
<b>Cacao</b>	Used in aelan kakae
<b>Coastal plants</b>	Erosion prevention, urban run-off slowing
<b>Coconut</b>	Used in aelan kakae, firewood, oil
<b>Pineapple</b>	Used in aelan kakae
<b>Mango</b>	Used in aelan kakae
<b>Grapefruit</b>	Used in aelan kakae
<b>Guava</b>	Used in aelan kakae
<b>Kasis</b>	Fire wood
<b>Korosol</b>	Used in aelan kakae
<b>Lemon</b>	Used in aelan kakae
<b>Lap leaf</b>	Food packaging
<b>Litchi</b>	Used in aelan kakae
<b>Mandarin</b>	Used in aelan kakae
<b>Mangrove</b>	Erosion prevention, flooding control, nursery species (fish), soil regulator, improves water quality and reef health.
<b>Medicinal plants</b>	Medicinal
<b>Nakatambol</b>	Used in aelan kakae
<b>Nakavika</b>	Used in aelan kakae
<b>Namambe</b>	Used in aelan kakae
<b>Nandau</b>	Used in aelan kakae
<b>Nandoa</b>	Used in aelan kakae
<b>Nangae</b>	Used in aelan kakae
<b>Natangura</b>	Used in aelan kakae
<b>Natapoa</b>	Used in aelan kakae
<b>Naus</b>	Used in aelan kakae
<b>Navel Nuts</b>	Used in aelan kakae
<b>Noni</b>	Used in aelan kakae
<b>Orange</b>	Used in aelan kakae, firewood
<b>Other Nuts</b>	Used in aelan kakae
<b>Pandanas</b>	Craft, building material, cooking fuel
<b>Papaya</b>	Used in aelan kakae
<b>Pawpaw</b>	Used in aelan kakae
<b>Pineapple</b>	Used in aelan kakae
<b>Pomelo</b>	Used in aelan kakae
<b>Sandalwood</b>	Oil, timber
<b>Vanilla</b>	Used in aelan kakae, export

Note: Root crops are unlikely to be as suitable for use as urban trees.

## 8.3 Appendix: Sustainable Housing and Development Implementation Plan

### 8.3.1 Information sources

The following sources are of particular relevance to the sustainable housing and development project:

- Ahren, J., Brown, P & Novotny, V. 2010. *Water centric sustainable communities*. Hoboken: John Wiley & sons.
- Chatterton, P. 2015. *Low impact living*. New York: Earthscan.
- Coyle, S. 2011. *Sustainable and resilient communities*. New Jersey: John Wiley & sons.
- Hyde, R. 2006. *Bioclimatic housing: innovative designs for warm climates*. Sterling: Earthscan.
- Runming, Y (ed). 2013. *Design and management of sustainable built environment*. London: Springer.
- Tompson, J. & Sorving, K. 2012 (2<sup>nd</sup> ed). *Sustainable landscape construction*. Washington D.C.: Island Press
- UN-Habitat. 2012. *Going green, a handbook of sustainable housing practices in developing countries*. Nairobi: UN-Habitat.

### 8.3.2 Precedents

The following precedents may form the basis of useful case studies to understand successes and failures of similar projects:

- An evolution of traditional housing. UN-Habitat. Papua New Guinea.
- Cyclone resistant housing. UN-Habitat. Myanmar.
- Ecovillage: Mutual home ownership scheme. Low impact Living Affordable Community. UK
- Water sensitive revitalisation of informal urban settlements. 24 settlements in Asia-Pacific. Monash University & Welcome Trust.
- Passive Solar Housing in the Indian Himalayas. UN-Habitat. India.
- People's Process: Aceh Nias settlements support programme. UN-Habitat. Indonesia.
- Urban density in Springfield terrace. UN-Habitat. South Africa.

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- CHATTERTON, P. 2015. *Low impact living*. New York: Earthscan.
- CLARKSON, B., WEHI, P. & BRABYN, L. 2007. *Bringing back nature into cities: Urban land environments, indigenous cover and urban restoration*, Report No. 52 Centre for Biodiversity and Ecology Research, University of Waikato, Hamilton.
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