PORT VILA

Social mapping and Analysis of Ecosystem Use

LONG GOD YUMI STANAP

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The ESRAM Project

Ecosystem and socio-economic resilience analysis and mapping (ESRAM) is the first phase of the Pacific Ecosystem-based Adaptation to Climate Change project (PEBACC), an initiative funded by the German Government and implemented by the Secretariat of the Pacific Regional Environment Programme (SPREP). The intention of the project (2014–2019) is to promote ecosystem-based adaptation (EbA) through the generation of new knowledge on local ecosystem services and its integration into development, climate change adaptation and natural resource management policy and planning processes in three Pacific island countries – Vanuatu, Fiji and the Solomon Islands.

The world's natural resources not only provide us with the food, water, and raw materials to meet our basic needs but they also contribute broader societal benefits, such as regulating local climates, ensuring the continued health of soils, sustaining the cultural values that are placed on natural landscapes. These benefits are known collectively as 'ecosystem services' and provide the basis for community resilience and well-being through a range of provisioning, regulating, cultural and supporting services.

For the purposes of the Greater Port Vila ESRAM study, the following breakdown of ecosystem services, based on the Millennium Ecosystem Assessment framework, was applied.

Provisioning services: ▪ Food ▪ Fuel ▪ Medicine ▪ Water ▪ Raw materials ▪ Ornaments	Regulating services: ▪ Prevention of pests and disease ▪ Air quality regulation ▪ Soil regulation; prevention of erosion ▪ Water purification and regulation of water flows ▪ Climate regulation ▪ Flood protection
Supporting services: ▪ Pollination ▪ Soil fertility ▪ Biodiversity and habitat ▪ Soil and biomass formation ▪ Nutrient cycling	Cultural services: ▪ Recreational experiences ▪ Spiritual, religious, ceremony ▪ Cultural diversity and inspiration for art ▪ Education and knowledge ▪ Aesthetic value

This technical summary document reports on the findings from the first phase of ESRAM activity that was conducted in Greater Port Vila between January and June 2016. Whilst it was understood at the outset that both climate and non-climate drivers would be important influences on ecosystem quality (and the services they provide), local engagement – through household surveys and community workshops – also uncovered substantial detail on the range of contemporary issues facing these communities: urban development, pollution, access to water, overharvesting and poor management of resources, sand mining, and climate impacts (including ongoing recovery from Tropical Cyclone Pam, March 2015). It is clear that the ecosystem and socio-economic resilience challenges for these urban and peri-urban communities are already considerable but will be further amplified by continued urbanisation and future climate change in the years to come.

The results from the ESRAM scoping study – further details are contained in the full technical report – highlight the importance of ecosystem services to the people of Vanuatu (ni-Vanuatu) who continue to rely overwhelmingly on local natural resources for subsistence food and cash income, as well as benefiting from their social and cultural value. The findings, participatory methods used, and lessons learnt from the ESRAM project not only provide a valuable evidence base for the implementation of PEBACC resilience actions in Greater Port Vila but will also be salient for other towns and cities in Small Island Developing States (SIDS) in Melanesia and elsewhere.

Greater Port Vila, Vanuatu

Port Vila is located on the south-west coast of Efate Island and is the focal point of the north-south 'Y-shaped' Vanuatu archipelago; being the primary centre for economic and commercial activity in the country. Notably, many areas beyond the municipal boundary are now also being considered as part of a wider Port Vila area (for instance, Mele, Pango, Erakor Village and Etas). The Greater Port Vila area covers approximately 24.3km^2 and is evenly split between 'urban' (municipal) and 'peri-urban' (provincial) land.

The city consists of a varied topography with land uses ranging from plantations to quarrying. However, rapid urbanisation is causing considerable degradation of the local environment and poses considerable challenges for maintaining the integrity of a number of the ecosystem services upon which the local population and economy depend. With much of the human settlement and activity concentrated along the coast; pressure is considered particularly acute on beaches, lagoons, mangroves and coral reefs. The sustainability and quality of the city's water catchment is also critical. Although this area is zoned to allow only non-intensive agricultural uses, enforcement has lapsed in recent years with housing developments occurring within Zone 1 of the catchment. To the east of the city, there is also similar pressure on the two lagoons (Erakor and Emten) with implications for their fragile brackish mangrove and sea grass ecosystems. In addition to the pressures caused by rapid urbanisation and unplanned development, climate change will act to exacerbate the many resilience challenges into the future.

ESRAM establishes a baseline of the natural resources that are used by vulnerable communities in the Greater Port Vila Metropolitan Area (Figure 1), as well as identifying the range of services that these local ecosystems provide (including their value to local communities) and highlighting the local and global drivers of change that are adversely affecting their health and functions. This information, elicited through engagement with local stakeholders, will be used to help identify locally-derived adaptation options that are to be developed as pilot studies during the second 'action' phase of the PEBACC project.

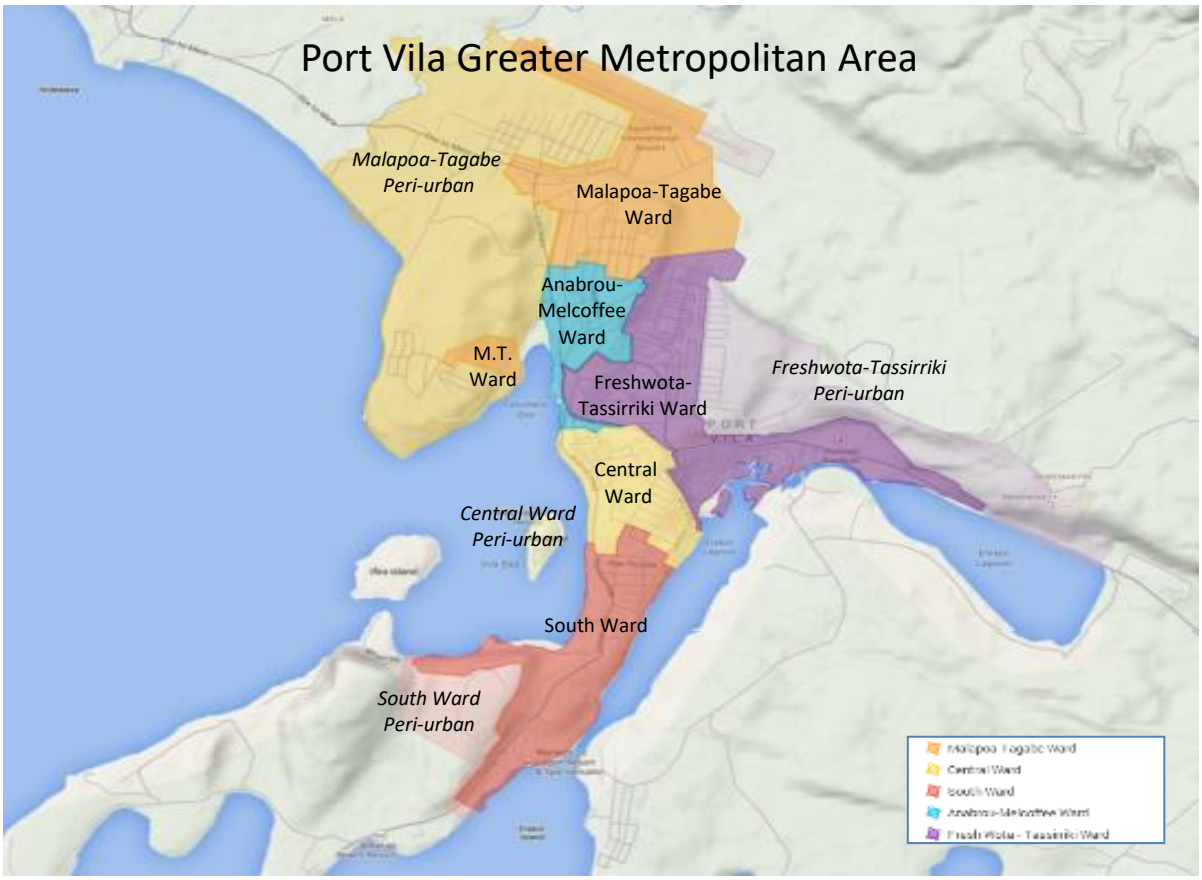

Figure 1: The Port Vila Greater Metropolitan Area

From the outset of the Greater Port Vila ESRAM project, the importance of ecosystem goods to local livelihoods and well-being was clear. In terms of livelihoods, roughly a quarter of Port Vila households are either dependent on, or supplemented by, the direct production of goods. In 2010 this represented a total annual value of over 1.15 billion Vatu, although figures are to be treated with a degree of caution due to the small sample size of the Household Income and Expenditure Survey (see Table 1).[1] A more comprehensive survey of Port Vila household livelihoods and income is recommended to improve livelihood data for the city, but the evidence that is available indicates a reliance of many urban dwellers on ecosystem goods for income.

Table 1: Household production-based income by category

Production-based Income Category	Total Monthly Value Generated (Vatu)	Number of Households	Average Income per Household	% of Households Engaged in Vila
Cash Crops	23,862,800	930	25,700	10%
Fruit and Vegetables	11,862,500	740	16,000	7.6%
Livestock and Poultry	3,237,500	190	17,400	1.9%
Fish and Seafood	1,638,200	170	9,700	1.7%
Manufactured Items	48,422,000	1,260	38,700	13%
Handicrafts	8,772,000	420	20,800	4%
All Categories	**96,634,400**	**2,570***	**37,600**	**26%**

*Note: 'All Categories' includes households that generate multiple products

In addition to market-economy based livelihoods, subsistence is an integral component of many people's livelihoods, costed at 1.26 billion Vatu (2010). Even within the city, over half the households are estimated to be engaged in self-supply and consumption of livelihood products. The bulk of this activity relates to household production and consumption of fruit and vegetables, worth an estimated 59,348,100 Vatu annually. Additional food products generated for self-consumption include meat, poultry, bakery goods, beverages and other farm products.

At the national scale, the 2007 National Adaptation Programme for Action (NAPA) also acknowledged that the economy comprises a large smallholder subsistence agricultural sector, with 65% of the population relying on local ecosystems. The main agricultural products (nationally) were copra, kava (Piper methysticum), cocoa, coffee, taro, yams, fruits and vegetables, beef and fish. Interestingly, this list contrasts with the findings of the ESRAM survey (see later in this report), suggesting differences between crops grown for sale / export and those grown by the local 'urban' communities for subsistence and local livelihoods.

[1] Vanuatu National Statistics Office (VNSO). (2012). *Vanuatu Household Income and Expenditure Survey - 2010*. Vanuatu National Statistics Office, Port Vila.

ESRAM Methodology

The ESRAM project team comprised a consortium of scientists and local NGOs, working in close collaboration with municipal, provincial and national government. This multi-partner make-up ensured that the project was not only founded on the latest international evidence but was also closely aligned with local projects and governance processes. The project was led by RMIT University, Melbourne, and included experts in urban resilience and climate change adaptation, ecology, and marine science; supported by local civil society organisations (CSOs): Vatu Mauri Consortium (VMC) and the Vanuatu Education Policy Advocacy Coalition (VEPAC) network.

In the first instance, desktop analysis was conducted to provide contextual details of the key drivers of change affecting the ecosystem and socio-economic resilience of Greater Port Vila. Analysis considered climate change trends and projections, and demographic and urbanisation pressures. These are summarised below.

The second stage of the ESRAM was deliberately designed to be participatory in nature. Involving local stakeholders in assessing socio-ecological linkages was considered important as the utility of ecosystem services is often highly dependent on the local social and cultural context (which is particularly the case for Vanuatu and other Small Island Developing States in the Pacific). Therefore, assessment activity for Greater Port Vila adopted a stakeholder-led approach, putting local people and communities at the centre of the analysis.

A mix of household surveys and community workshops were used to better understand the reliance of vulnerable communities in Greater Port Vila on their surrounding ecosystems and the services that these resources provide. Furthermore, the ESRAM process not only helped to establish the attributes of the relationship between the community and the goods and services they depend on (as well as the human and climate-related pressures that are affecting the integrity of critical terrestrial and marine ecosystems), but was also useful in identifying – in collaboration with the project team – a range of potential adaptation options that are sensitive to local needs and context.

Although the assessment focused on the capital city of Vanuatu, it extended beyond the municipal boundary to consider the peri-urban and hinterland areas of Greater Port Vila, accounting for a range of different socio-economic conditions and 'ridge to reef' landscape contexts that are likely to prove critical to the continued resilience of the city (e.g. marine, coastal, lagoon, freshwater, forest, peri-urban and urban environments). Communities in Greater Port Vila that rely heavily on natural resources – and were identified as vulnerable to climate change impacts (and other drivers) – were central to the Greater Port Vila ESRAM investigation.

Climate change: trends and projections

The Pacific Islands are commonly cited as being the most vulnerable to the effects of future climate change, although it is also important to recognise that they are also already exposed to non-climate natural hazards that cause 'shocks' to communities (earthquakes, tsunamis, etc.) and are also highly sensitive to impacts due to existing development deficits. Scenarios from the Pacific Climate Change Science Program, Pacific-Australia Climate Change Science and Adaptation Planning Program, Bureau of Meteorology (BoM), & Commonwealth Scientific and Industrial Research Association (CSIRO) are summarised for each of the key climatic variables affecting Vanuatu.

Sea level rise: Global sea levels are currently increasing at an average rate of 3.2 mm per year, but waters around Vanuatu are rising almost twice as fast (an average of 6 mm annually over the last two decades).[2] To add complexity, observations based on global positioning systems estimate that Port Vila is currently 'sinking' at a rate of 4.1 mm per year (+/-0.7 mm), exacerbating the impacts of sea

[2] Pacific Climate Change Science Program (PCCSP). (2013). *Current and Future Climate of Vanuatu* (p. 8). Melbourne, Australia. Retrieved from http://www.pacificclimatechangescience.org/wp-content/uploads/2013/06/15_PCCSP_Vanuatu_8pp.pdf

level rise.[3] These scenarios have implications for coastal erosion and potential salinisation of groundwater.

Ocean acidification and warming: Whilst less obvious, these present immediate threats to Vanuatu's marine ecosystems and coral reefs. Under both high (RCP8.5) and medium (RCP 4.5) emissions scenarios, coral reef health will reach marginal conditions between 2020 and 2030. Even under a low emissions scenario (RCP 2.6), it is possible that this threshold will be reached by 2040. [Interestingly, participants in both the surveys and workshops did not identify this as a key issue, with the exception of one workshop (Seaside). One way to try to mitigate the effects will be to reduce other man-made stressors to marine / coastal ecosystems].

Temperature: Records at Port Vila are not available for the first half of the 20th century; however, over the last 60 years there has been a steady increase in land surface temperatures, with mean annual temperatures rising at a rate of 0.1°C per decade (Figure 2).[4] Projections for all emissions scenarios indicate that the annual average air temperature and sea surface temperature will increase in the future, with a likely increase in the frequency and magnitude of very hot days.

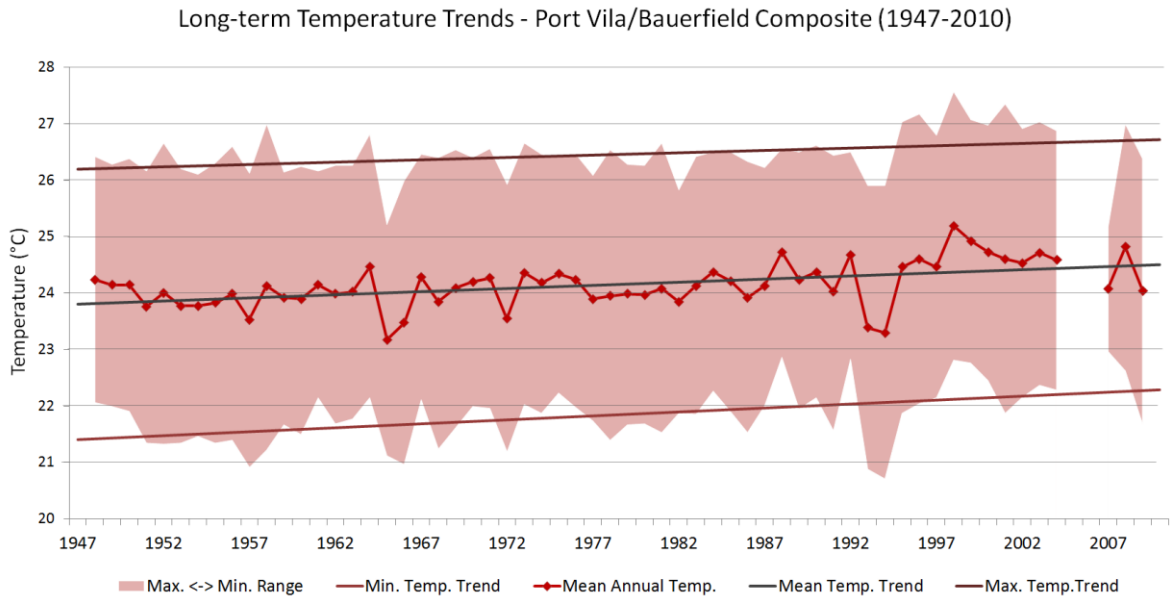

Figure 2: Port Vila long-term temperature records

Rainfall: Vanuatu has long been subject to high levels of inter-annual rainfall variability (Figure 3).[4] This variability, coupled with significant disagreement between climate models in the region, means that there is low confidence in both the direction and extent of future changes to annual rainfall patterns (Table 2; 5–95% uncertainty range in brackets).[5] However, there is high confidence that the frequency and intensity of extreme rainfall events will increase across Vanuatu. In such a case, this will lead to heightened risks of flash flooding in the Greater Port Vila area.

[3] Kouwenhoven, P. (2013) Profile of Risks from Climate Change and Geohazards in Vanuatu: Draft Report. Hamilton, New Zealand. Retrieved from http://www.nab.vu/sites/all/files/documents/03/04/2014 - 12:45/risk_profile_report_draft_1.pdf

[4] Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP) (2014) *Pacific Climate Change Data Portal – Vanuatu Historical Climate Information*. Online Resource, available at: http://www.bom.gov.au/pacific/vanuatu/

[5] Bureau of Meteorology (BoM), & Commonwealth Scientific and Industrial Research Association (CSIRO). (2014). Vanuatu Country Report Update - Climate Futures. In *Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports* (1st ed., pp. 319–340). Melbourne: CSIRO Publishing.

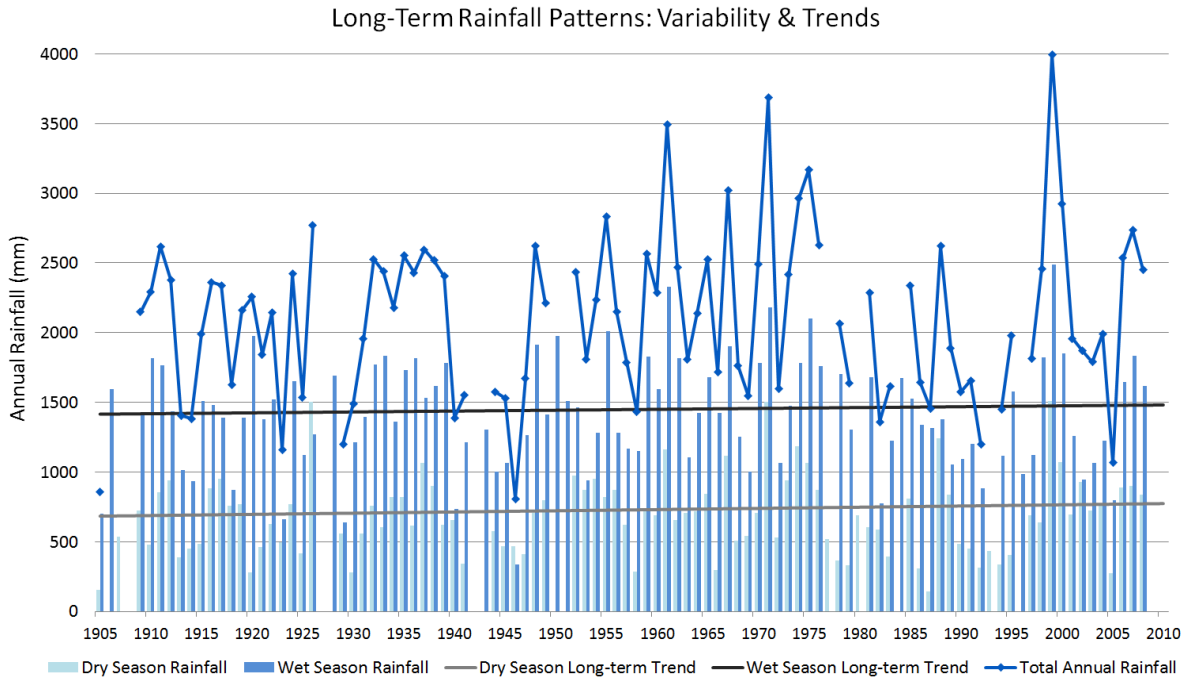

Figure 3: Port Vila rainfall variability and trends

Table 2: National CMIP5 projections: rainfall

Total Annual Rainfall Change	2030	2050	2070	2090
RCP 2.6 (very low emissions)	+1% (-7 to +9%)	+1% (-6 to +9%)	0% (-10 to +9%)	0% (-8 to +7%)
RCP 4.5 (low emissions)	0% (-9 to +13%)	0% (-9 to +6%)	+1% (-9 to +9%)	0 (-14 to +10%)
RCP 6 (medium emissions)	+2% (-4 to +13%)	+2% (-8 to +12%)	+3% (-6 to +16%)	+4% (-11 to +19%)
RCP 8.5 (very high emissions)	0% (-6 to +8%)	0% (-12 to +14%)	+2% (-16 to +15%)	+5% (-15 to +34%)

Drought: There is only low modelling confidence for Vanuatu, as drought is heavily related to ENSO cycles (being exaggerated in El Niño periods), which are yet to be effectively modelled in relation to climate change.

Tropical cyclones: Again, modelling attaches only medium confidence to tropical cyclone scenarios; however, results indicate a decrease in the frequency but an increase in intensity.

Demographic and urbanisation pressures

In recent times, Port Vila has undergone rapid urbanisation, driven primarily by rural-urban migration as people are pulled to the city in search of better work opportunities, education, healthcare facilities, and the range of other services that a major city provides. In the case of the primary Melanesian cities, including Port Vila, this is leading to an increased build-up of informal settlements, as local government struggles to keep up with the rapid rate of population growth.

The quality of data on demographics and urbanisation is generally poor in the Pacific region and in the case of Port Vila a level of ambiguity about city and ward boundaries further complicates matters. However, using point-based household data by the Pacific Community (2015), it is possible to map out the full extent of the modern 'urban catchment' [termed the Metropolitan Port Vila Region (MPVR) to avoid confusion with other terminologies in use – Figure 4).

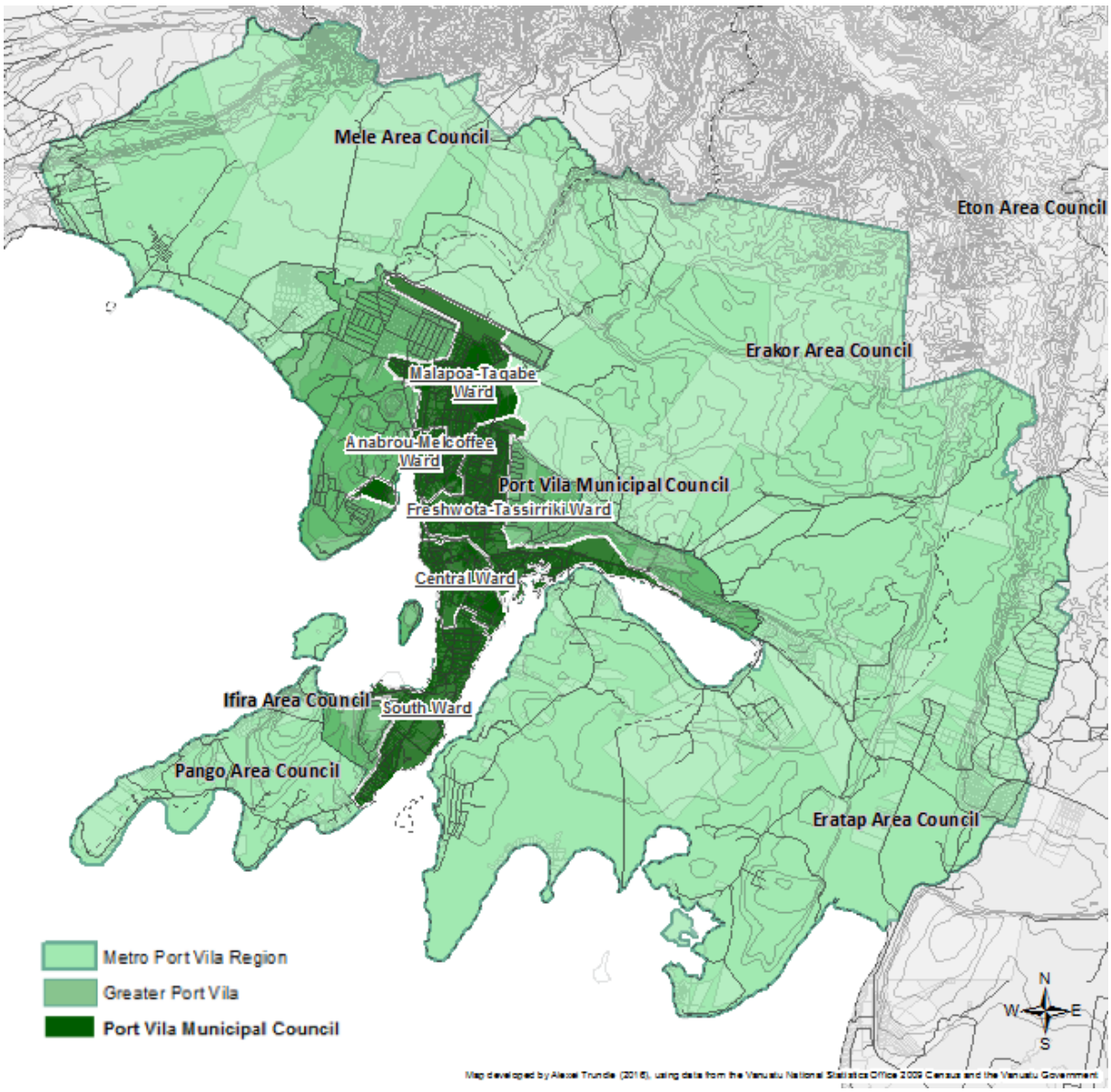

Figure 4: Urban zones of Port Vila used in 1999 and 2009 population estimates

In 2009, the MPVR area had a total population of 62,678. Annual average growth rates from 1999–2009 for each of the 'city' definitions (as well as Shefa Province, Vanuatu, and the area outside of the Metropolitan region) are shown below.

Port Vila Municipality	7.75%
Greater Port Vila	4.80%
Metro Port Vila Region	6.50%
Shefa Province	4.50%
Vanuatu	2.50%
Non MPVR Vanuatu	1.70%

Additional document analysis from the 1967, 1989 and 1999 national censuses (and 1972 urban census) enables these areas to be compared with earlier historical data and beyond the town boundary.[6] These findings, shown in Figure 5, demonstrate an accelerating trend in urbanisation across Vanuatu, particularly in and around the capital Port Vila. Although it is difficult to project population growth with any accuracy, the 2009 census projected Shefa's population to be between 134,000 and 218,000 by 2050; with the upper range figure representing a continuation of rural-urban migration trends.[7] It can be reasonably argued that the rapid urbanisation processes currently being experienced by Port Vila are likely to continue for the foreseeable future (if not accelerate as environmental 'push' factors in regional / rural / island areas are worsened by climate change). This will mean escalating stress on the integrity of ecosystems relied on by the communities of Port Vila.

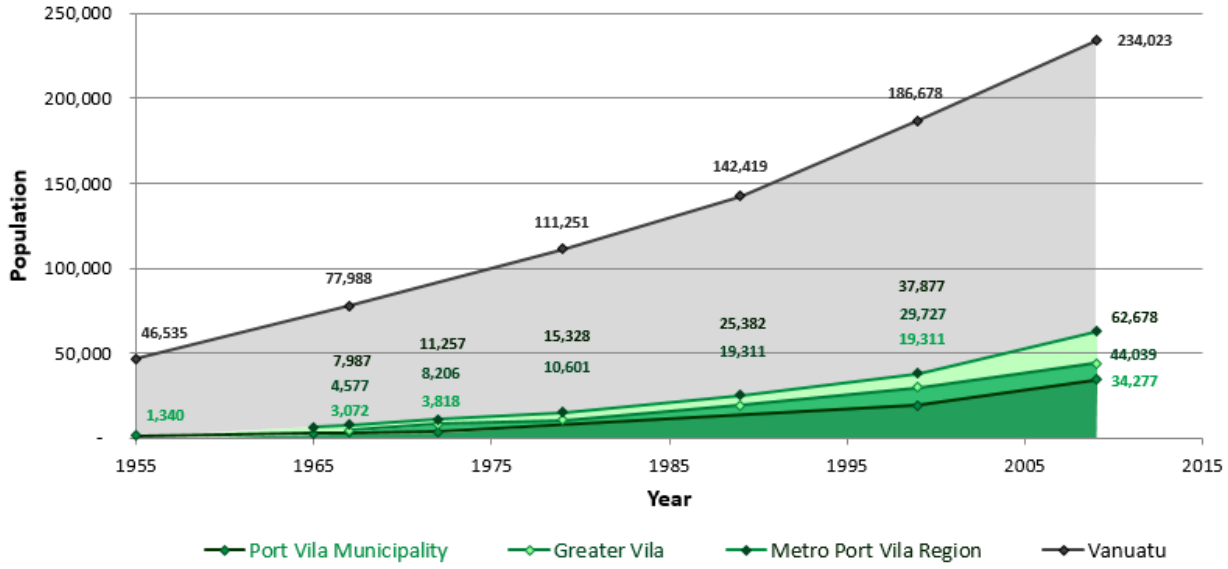

Figure 5: Historical population growth in Vanuatu and Port Vila

It is also worthy of note that the city's most highly urbanised districts closely align with the rapidly growing northern peri-urban fringe, as well as informal and semi-formal settlements throughout the established municipal area (Figure 6).[8] Tongoa / Futuna, the most intensely populated section of the city, has a current density of 410 persons per hectare (Figure 7), equivalent to fitting the entire population of municipal Port Vila within the boundaries of Anabrou - Melcoffee Ward.

[6] Trundle A. (2016) Informal climate resilience: urban transitions in Melanesia's small island developing cities, PhD confirmation report, University of Melbourne.

[7] http://www.vnso.gov.vu/index.php/component/advlisting/?view=download&fileId=1995

[8] Trundle A. and D. McEvoy (2015) *Greater Port Vila Climate Vulnerability Assessment – Full Report*, UN-Habitat, Regional Office of Asia Pacific, Fukuoka, Japan.

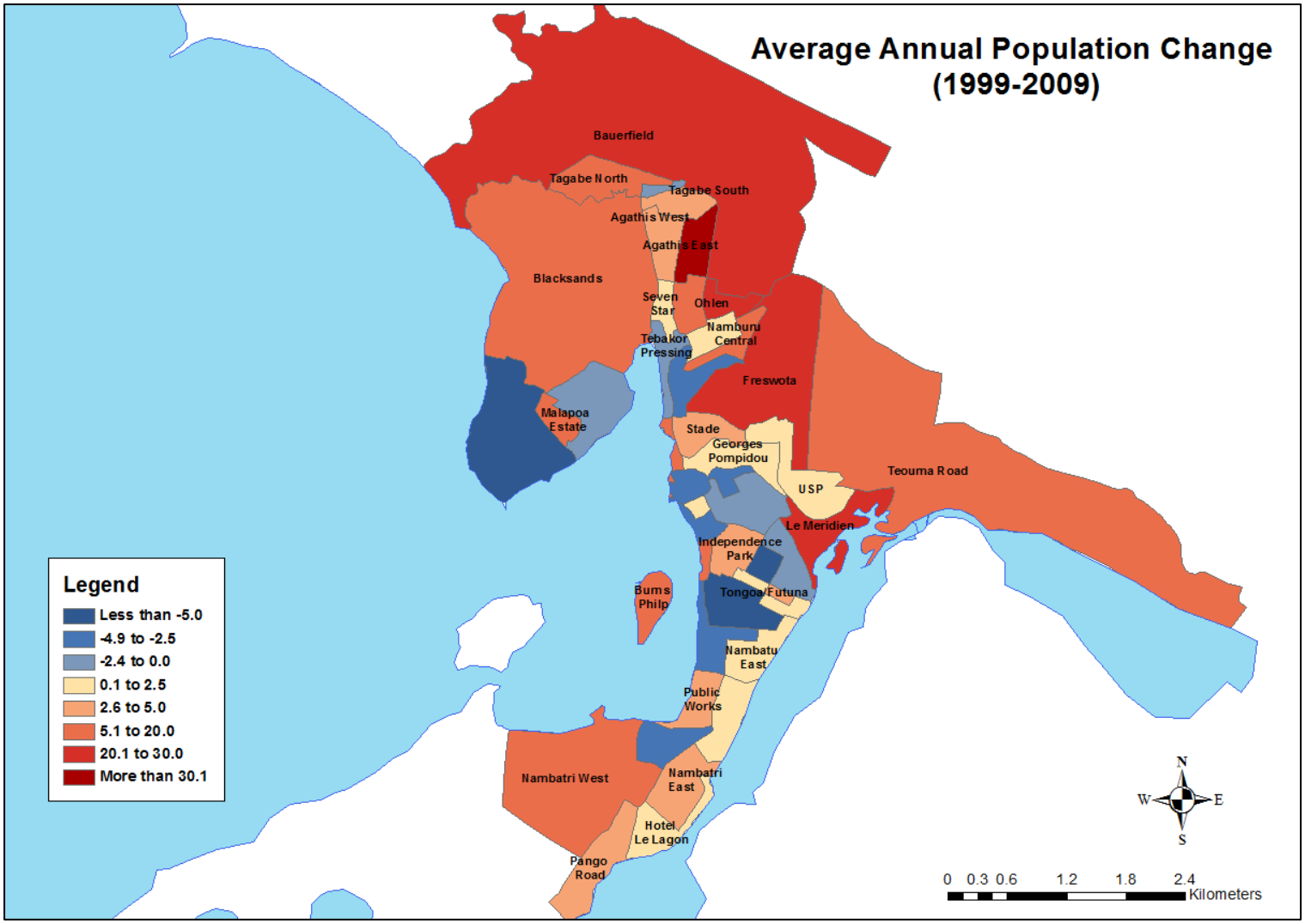

Figure 6: Population growth across Greater Port Vila, 1999–2009

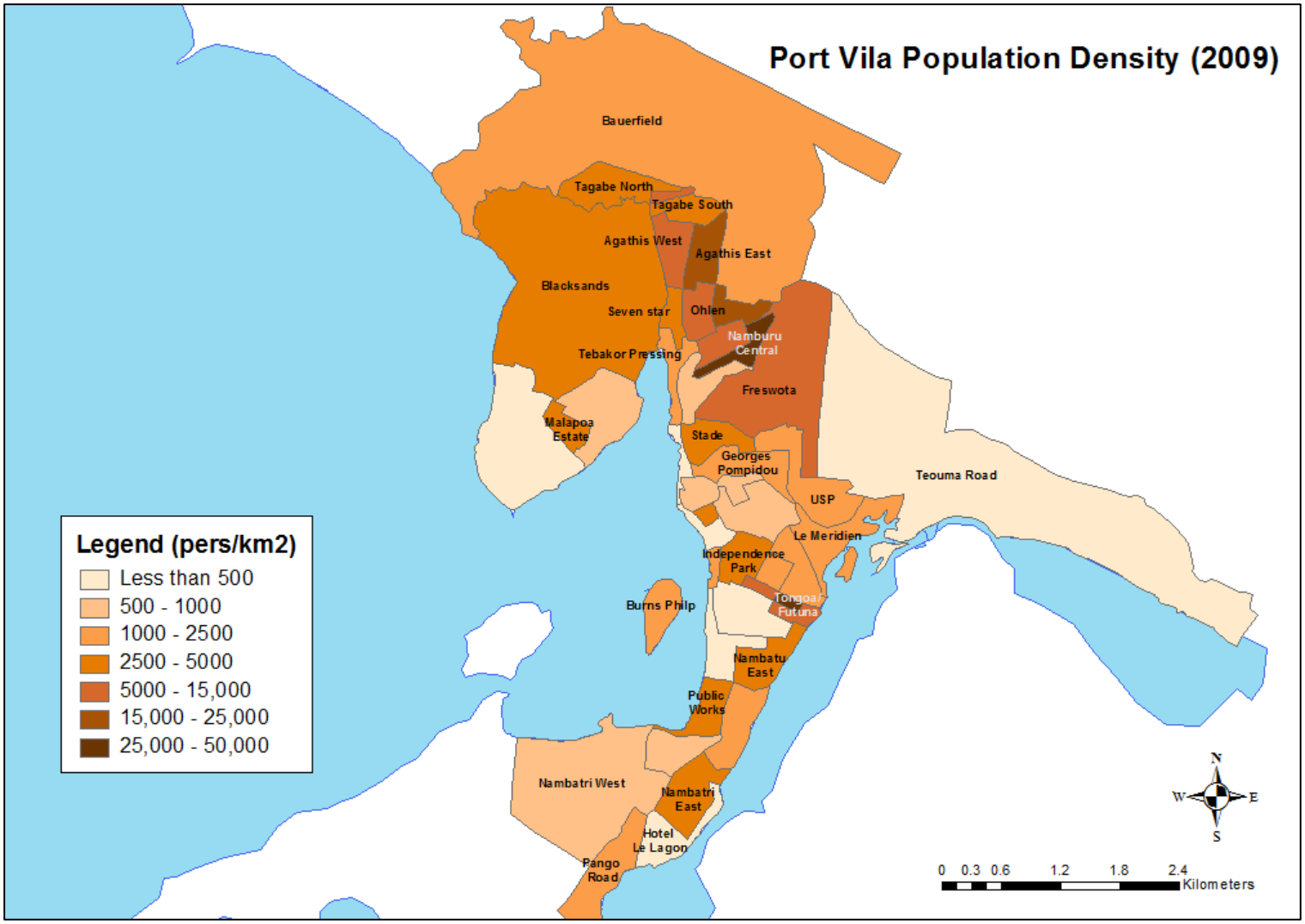

Figure 7: 2009 population densities across Greater Port Vila

Assessment of ecosystem services

Following on from the publication of the Millennium Ecosystem Assessment in 2005, considerable scientific and policy efforts have gone into trying to find ways that reverse the decline in the health and diversity of the world's ecosystems, to improve stewardship of our valuable natural resources, and to focus attention on efforts to strengthen socio-ecological resilience.

The valuation of ecosystem services (ES) is one approach that has attempted to develop quantitative evidence that can be introduced into decision-making processes in order to ensure that the benefits of ES are taken into account better than previously. These benefits not only relate to well-being and generation of income but also to the prevention of damage in the future. However, despite considerable efforts to date, the realisation of effective ES valuation frameworks and their integration into decision making arenas has yet to occur in any meaningful manner.[9]

One commonly used analytical framework, Total Economic Value (TEV), accounts for two types of value that ecosystem services provide to society – use and non-use – that result in a variety of environmental, social, cultural, and economic benefits.[10] However, much of the valuation work that has been attempted has focused only on the direct benefits that derive from provisioning goods and services (as this is where data is easiest to obtain and where some level of quantification can be applied). The valuation of regulating services linked to air, water, soil, and climate is much more challenging, as is assigning an acceptable value to the indirect values provided by the supporting services. (Defra in the UK has produced a useful guide for understanding some of the limitations of the valuation process and for framing preliminary assessments.[10])

Given the practical constraints – the overwhelming reliance of informal settlers in Greater Port Vila on local ecosystems for basic food and shelter and the considerable importance placed on social and cultural aspects of ecosystems by Ni-Vanuatu, this short scoping study sought to engage directly with ten local communities to generate 'bottom-up' narratives of their relationship with different surrounding ecosystems and the benefits they derive. Summary details for each community are shown in the Appendix.

For broader context, three examples of efforts to quantify ES benefits in Vanuatu are usefully highlighted. The first of these is the *Economic Assessment and Valuation of Marine Ecosystem Services: Vanuatu,*[11] conducted as part of the MACBIO project (Marine and Coastal Biodiversity Management in Pacific Island Countries and Atolls). This provided an evaluation of marine and coastal services (though predominantly concentrating on provisioning services) which can act as a useful reference point. The most relevant services to the Greater Port Vila ESRAM, summarised from the MACBIO assessment, are shown in Table 3.

Other recent efforts at valuing ecosystem services include a mangroves study in Vanuatu by IUCN (2013),[12] which estimated the value of Eratap mangroves at between 190,000 and 340,000 Vatu annually (based on carbon sequestration, tourism revenues, avoided costs from flood protection, and proteins for subsistence fishery), and the estimated costs of displacing the gardens of 40 households caused by a proposed new sewage treatment plant[13] (income from the gardens per household documented as ranging between 10,000 and 30,000 Vatu per month).

[9] De Groot R. S., Alkemade R., L. Braat, L. Hein & L. Willemen (2010) Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making, *Ecological Complexity 7, 260-272*.

[10] Defra (2007) An introductory guide to valuing ecosystem services, Defra, London.

[11] http://www.nab.vu/sites/default/files/documents/Summary%20of%20MESV_VAN_20102015%201_0.pdf

[12] http://www.ircp.pf/wp-content/uploads/20130913_MESCALeconomic-valuation-of-mangrove-ecosystems-in-vanuatu.pdf

[13] https://www.adb.org/sites/default/files/project-document/176793/42391-013-rp-03.pdf

Table 3: Annual economic value of marine and coastal ecosystem services in Vanuatu, 2013

Sector	Ecosystem service	Beneficiaries	Net annual value (2013 adjusted)	Sustainability
Fisheries	Subsistence fishing	Ni-Vanuatu households, particularly rural and low-income	VT 578m (USD 6.5m)	Sufficient inshore habitat for sustainable subsistence harvests, but localised overfishing has reduced productivity, threatening sustainability
	Small-scale commercial reef, invertebrate, and deep-slope fisheries	Ni-Vanuatu fishers and consumers, some restaurants and businesses (only value to fishers is estimated)	VT 294m (USD 3.3m)	As above, reef fishery may receive localised overfishing. Traditional fishing methods and lack of market development limits pressure on deepslope demersal fishery
	Beche-de-mer	Mostly export companies and foreign consumers, some small-scale fishers/divers, some government revenue (value includes fishers and exporters)	VT 4.5m (USD 0.05)	Over-harvesting has led to periodic closures; new management regime should be sustainable if enforced
	Trochus	Small-scale fishers, local and foreign consumers, exporters; some government revenue (value includes fishers and exporters)	VT 8.9m (USD 0.1m)	Historic overharvesting has depleted stocks, but management efforts are being improved
Mining	Sand and aggregate	Data only for modest government benefits and estimated value as a raw product. Costs could not be estimated	VT 15.1m (USD 0.17m)	Beach mining for construction and household uses is unsustainable and needs monitored to prevent diminishing fishing and tourism ecosystem services
Tourism	Tourism and recreation	Vanuatu businesses (local and foreign owned) and government; benefits to international tourists not included	VT 613–1,095m (USD 6.9–12.3m)	Sustainable, if human pollution and damage is prevented
Regulating Services	Coastal protection	Citizens and visitors, in particular owners of coastal properties (measures avoided repair costs)	VT 1,226–2,043m (USD 13.7–23m)	Sustainable if reef is living
	Carbon sequestration	Global benefit; Potential benefit to communities from carbon credits (not included in value)	VT 1.8–451m (USD 0.02–5m)	Sustainable, if mangroves and seagrasses are protected

Case studies

The communities that were chosen as case studies for ESRAM were selected as representative of vulnerability 'hotspot' communities in the Greater Port Vila area. The ten case study communities were: Blacksands, Erakor Bridge, Erakor Village, Etas, Fres Wind, Ifira, Mele, Pango, Seaside (Tongoa, Futuna and Paama) and Tagabe Bridge (see Figure 8). The focus on urban poor communities was intentional, as they rely disproportinately on the continued integrity and functioning of local ecosystems and are often unable to replace critical 'provisioning' services through other means.

The screening and selection of the case study communities was informed by analysis of social, economic and cultural data from the Vanuatu National Statistics Office and other local sources, including information from post Tropical Cyclone Pam (TC Pam) surveys. The mapping of these data – in particular key variables such as crop use, marine resources, energy, water and sanitation, land tenure and population growth – was an important first step in the ESRAM process, as it provided an early illustration of rapid population growth and urban development, as well as observable patterns in water, food and wage-based income dependency and indications of how ecosystem services are utilised in different ways by communities across areas of the city. (See Figure 9 as an example. Full details are contained in an accompanying 'socio-economic atlas' for Greater Port Vila.)

This desktop screening activity was further informed by local knowledge that was provided by the Civil Society Organisation (CSO) project partners through local intelligence and ground-proofing of socio-cultural structures. This not only helped to confirm the case study communities but also ensured that the project was aligned with local governance structures and well-established social and interest groups in Port Vila.

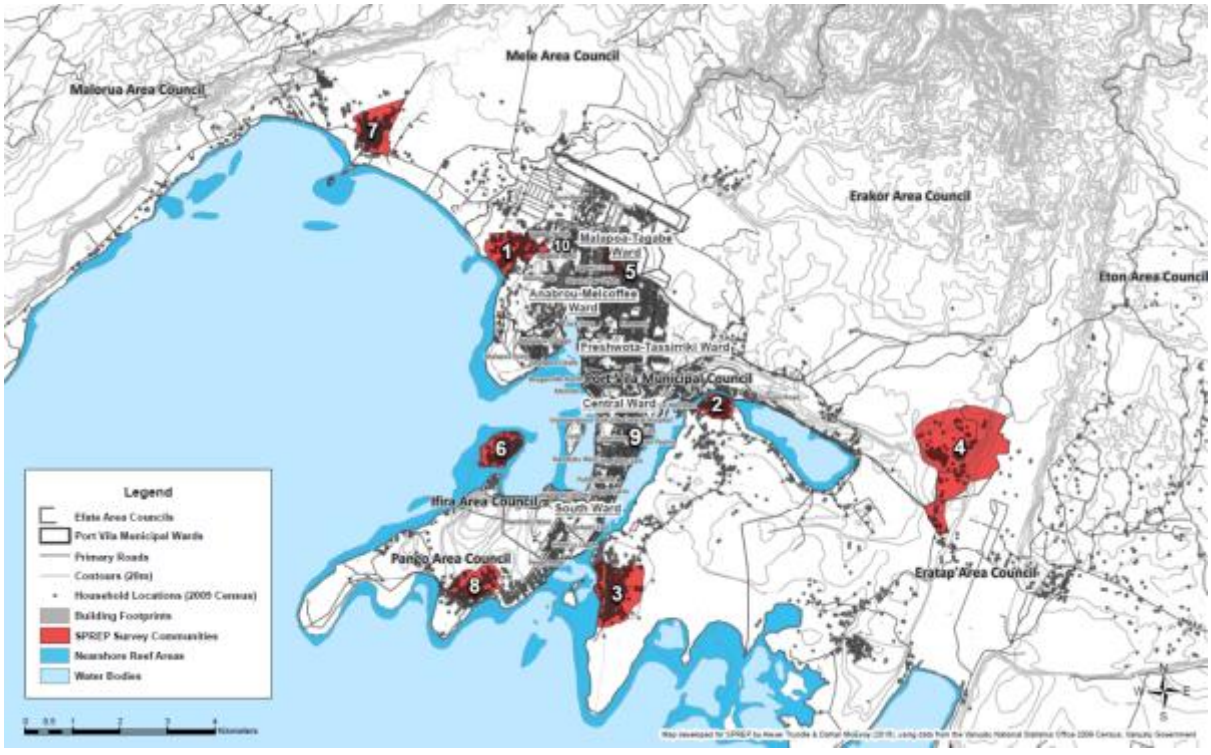

Figure 8: The ESRAM hotspot communities

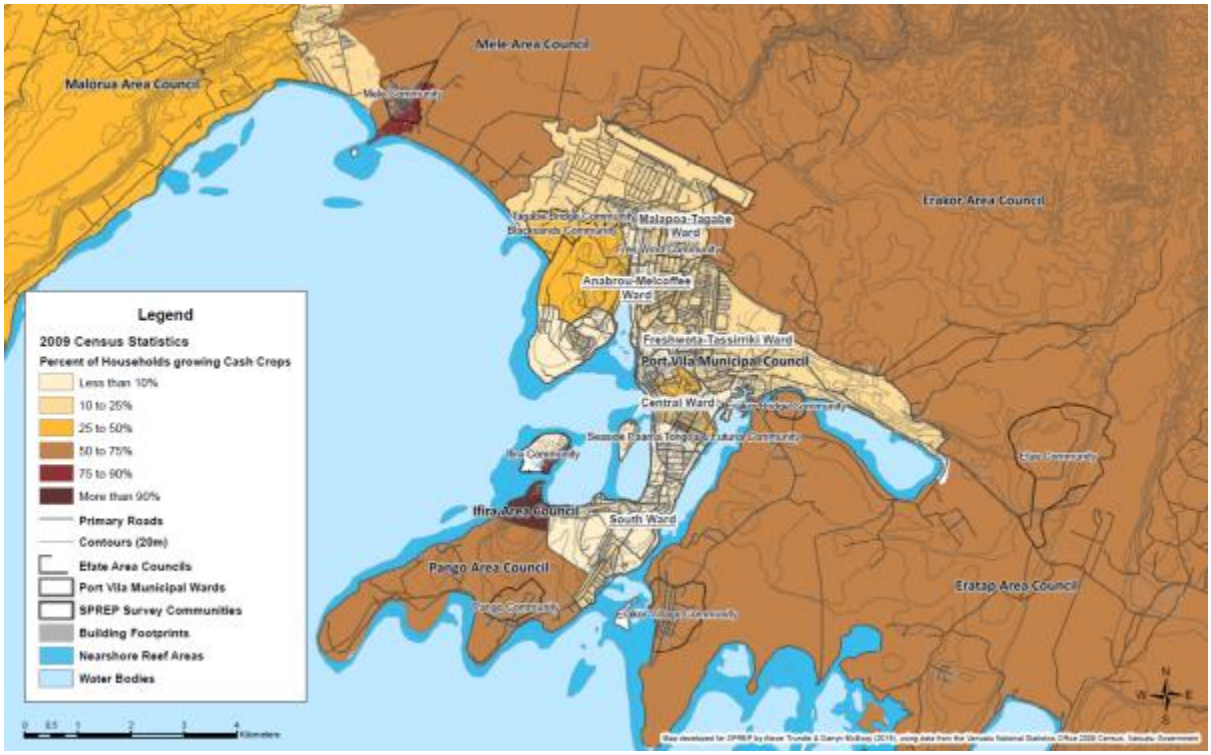

Figure 9: Households in Greater Port Vila growing cash crops

Household surveys

The first stage of fieldwork carried out in Greater Port Vila involved a comprehensive survey of households in each of the selected communities in March and April 2016 (activity shown in Figure 10). The primary purpose of the survey was to identify, document, and map the ecosystem goods and services that are critical to the livelihoods and day-to-day living of the residents of these communities.

The survey (made available in English, French and Bislama) requested feedback on: 1) baseline household information; 2) household use of natural resources from both the land and sea (categorised as: traditional wealth items, forest, marine / coastal, freshwater, bush gardens, and livelihood items); and 3) details of associated ecosystem services. Respondents were finally asked to identify where important natural resources were located on a map. Additional information relating to the impact of TC Pam, where relevant, was also asked for during the survey.

A total of 823 households were interviewed for the ESRAM; which corresponds to approximately 32% of total households (2009 census). This is an evidence base that is representative of between 4,500-5,000 Port Vila citizens (assuming an average of 5.5 to 6 residents per household). Survey data also provided valuable local information that was subsequently used to prepare for the workshops in each of the ten communities.

Figure 10: Household survey activity - Erakor Bridge (l) and Etas (r)

Community workshops

The structure and content of each of the community workshops were informed by the survey data which had mapped out a baseline of natural resources that were used by local households, as well as identifying the main ecological services and scoping the priority marine, coastal and terrestrial ecological issues for each community. The ten community workshops were designed to not only raise awareness about the importance of ecosystem goods and services, and the potential role of ecosystem-based adaptation (EbA) in enhancing resilience, but also to create a space for community dialogue on the multitude of threats to the natural resources that they rely on, current management practice, and potential adaptation options that would act to strengthen community resilience. Arranged through local chief structures, these community events were successful in enabling the communication and sharing of local visions of resilience and to start the process of considering appropriate action plans for protecting local natural resources and the valuable ecological services they provide. Details of ESRAM project engagement with the local communities through a combination of surveys and workshops are shown in Table 4.

Table 4: Breakdown of ESRAM survey and workshop engagement

Community area	Households surveyed	Survey sample as a % of households (2009 census)	Female	Male	Workshop participants
Blacksands	117	26.2%	31%	69%	22 (of 25)
Erakor Bridge	58	34.9%	72%	28%	18
Erakor Village	74	29.8%	57%	43%	38
Etas	111	61.7%	66%	34%	34
Fres Wind	91	20.4%	63%	37%	31
Ifira	57	33.9%	58%	42%	15 (+ 4 from Blacksands)
Mele	102	28.2%	68%	32%	28
Pango	73	52.9%	60%	40%	15
Seaside	93	34.4%	66%	34%	22
Tagabe Bridge	45	40.5%	62%	38%	3 (of 25)
TOTAL	**821**				**260**

Findings from the assessment indicate that the resilience challenges for these urban and peri-urban communities are already considerable but will be further amplified by continuing urbanisation and climate change in the years and decades to come. The wealth of information that was elicited and collated through these 'bottom-up' engagement activities now acts as a valuable evidence base to inform phase 2 of the PEBACC project.

Consolidated survey findings: Ecosystem goods and services

Gardens and forests were found to be critical terrestrial ecosystems in the survey, providing a wide range of goods and services to all of the communities, in particular the provision of food, materials, and traditional wealth and livelihood items.

The contribution of marine and coastal environments to socio-ecological resilience is also highly significant and reflective of Vanuatu's island character and cultural heritage (e.g. over 97% of households in Ifira, Erakor Village and Pango were found to use resources from the sea).

Gardens

Gardens were a combination of home and bush gardens (see Table 5) and primarily provide households with food for either subsistence or as cash crops. The findings indicate that some communities utilise both home and bush gardens (e.g. Erakor Bridge, Erakor Village, Etas and Pango), some rely predominantly on home gardens (e.g. Blacksands and Ifira), whilst those with limited home backyard space are shown to be highly dependent on access to bush gardens (all communities make use of bush gardens although the most significant users include Erakor Village, Fres Wind, Mele, Pango, Tagabe Bridge and Seaside; see Figure 11). Seaside has the least access of the communities to home gardens and is also one of three communities in this study (the others being Ifira and Tagabe Bridge) where a quarter of the community has no access to a garden at all.

As emphasised by these results, ensuring continued access to bush garden resources in Greater Port Vila is critically important in the face of development pressure, especially for those in high density areas with restricted opportunity for gardens at home.

Table 5: Home and bush garden resources

Community area	Gardens absent	Home garden	Bush garden	Have both gardens
Blacksands	4%	45%	32%	5%
Erakor Bridge	19%	71%	62%	50%
Erakor Village	0%	75%	96%	72%
Etas	4%	75%	67%	48%
Fres Wind	15%	53%	85%	14%
Ifira	23%	67%	21%	11%
Mele	0%	25%	96%	23%
Pango	1%	75%	85%	51%
Seaside	27%	2%	72%	1%
Tagabe Bridge	31%	44%	64%	38%

In terms of crops grown, banana and pawpaw stand out as the most popular (Table 6).

They are grown by over 50% of those surveyed in all the hotspot communities. Also popular are manioc, island cabbage, yams, kumala and taro, which are grown in all areas.

Sugar cane, also considered a traditional wealth crop, is cultivated by all communities except Ifira. Beans, corn, onion and vegetables are widespread, but grown by less than 10% of the communities.

More specialist crops are grown by individual communities, e.g. Fijian cabbage and ginger (Ifira), chilli (Seaside) and rice (Mele).

In addition to the provision of food, other garden services that were identified included regulating services such as soil fertility, protection against erosion, reducing pests and crop diseases and increasing the cycling of nutrients for improving soils. These services were actively promoted by local communities through the use of mulching, composting, and integrating with animal husbandry.

Table 6: Crops grown in home and bush gardens

Percentages of households surveyed *	Crops list of species	Community areas
> 50%	Banana, pawpaw	All areas
30 to 85%	Manioc	All areas
10 to 60%	Yam	All areas; Mele (93%)
15 to 50%	Island Cabbage	All areas; EV (62%)
10 to 50%	Kumala, taro	All areas; Kumala Etas (79%)
8 to 50%	Sugarcane	All except Ifira
Less than 10%	Corn	All areas; Etas (21%)
	Garlic	EV, FW, Ifira, Mele, Pango
	Vegetables	All except SS, Etas (26%)
Less than 5%	Beans	Widespread; Etas (12%)
	Cabbage (incl. Fijian), ginger	Ifira
	Carrot	EV, Ifira, Mele, Pango
	Chili	SS
	Cucumber	EV, Etas, Mele
	Lap lap leaf	Ifira, Pango, Mele
	Melon, watermelon	EV, Mele, Pango
	Onion (inc. spring), pumpkin	Widespread
	Pineapple	EB, EV (12%), Etas, Pango
	Rice	Mele
	Tomato	EB, EV, Ifira, Mele, Pango
	Water taro & water cress	Et, FW, Ifira

Area codes: (BS) Blacksands, (EB) Erakor, (EV) Erakor Village, (FW) Fres Wind, (SS) Seaside, (TB) Tagabe Bridge

Note Percentages and crop lists are indicative only, since the data were not always recorded during the surveys and validation of this information during the workshops was done in larger groups and therefore should be considered as approximate.*

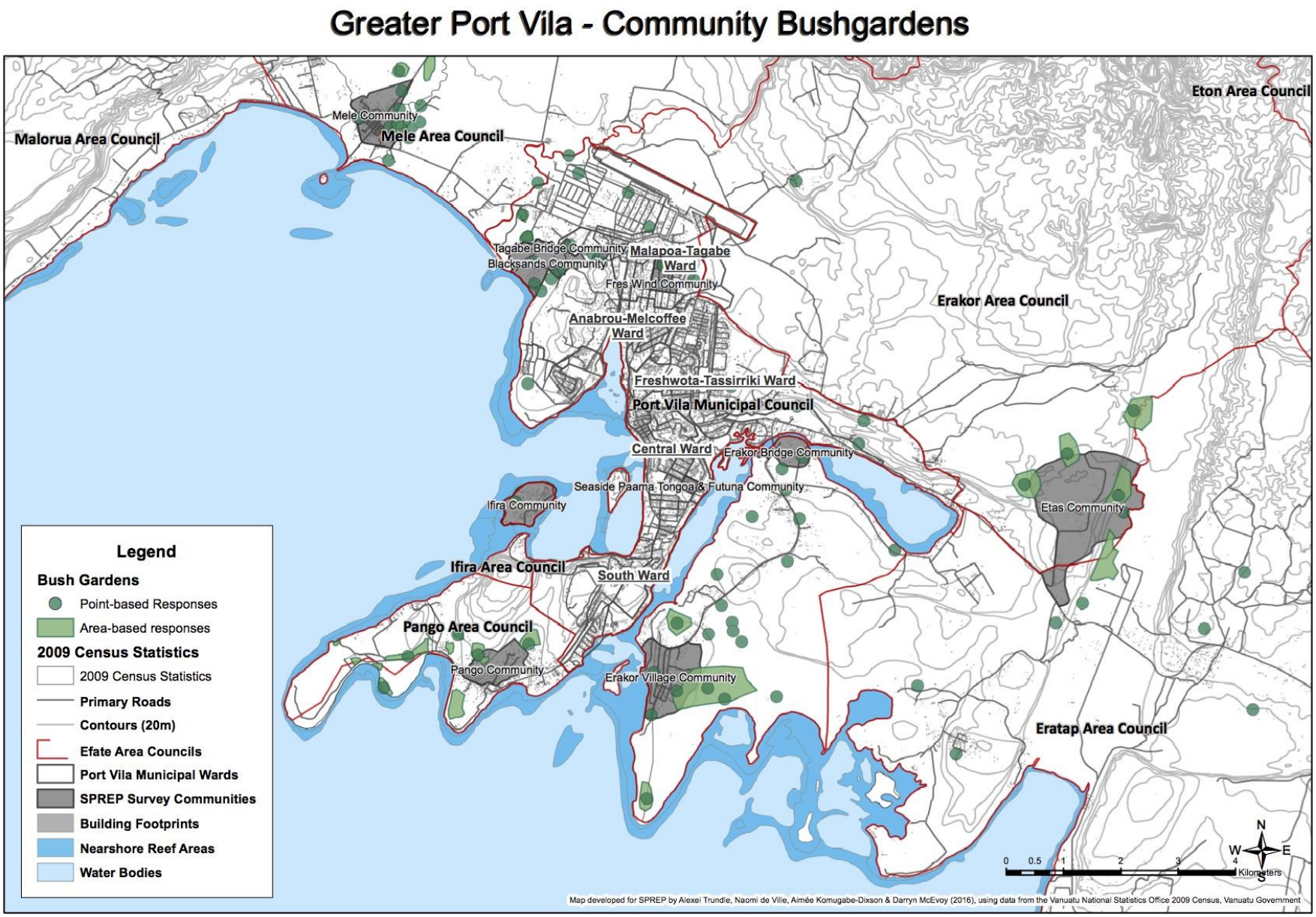

Figure 11: Locations of community bush gardens

Forests

Forest resources play a crucial role in the day-to-day lives of many ni-Vanuatu. It is the most important ecosystem resource category with over 80% of all the communities using the forest (100% for Erakor Bridge, Erakor Village, Etas, Ifira and Mele). Trees, palms and other perennial plant species such as fruits and nuts, bamboo, natangura, coconut, and pandanus are not only sources of food but also sources of firewood and fuel, medicines, timber for carving, housing and other constructions, and the raw material for mats, baskets, handicrafts, and other manufactured goods. Table 7 illustrates the range of forest resources that are used by each community, with Figure 12 mapping the location of key 'non-garden' resources.

Table 7: Forest resources used by communities

Community	Forest resources	Bamboo	Natangura	Coconut leaves	Pandanus	Firewood	Timber	Medicine	Fruit & nuts
Blacksands	96%	18%	9%	16%	8%	81%	2%	31%	51%
Erakor Bridge	100%	7%	17%	38%	17%	90%	12%	19%	59%
Erakor Village	100%	53%	63%	88%	49%	89%	43%	55%	99%
Etas	100%	38%	56%	78%	44%	94%	35%	59%	84%
Fres Wind	89%	10%	16%	33%	15%	69%	10%	29%	64%
Ifira	100%	52%	44%	79%	18%	98%	23%	44%	91%
Mele	100%	78%	71%	81%	27%	95%	31%	50%	91%
Pango	94%	51%	44%	67%	45%	74%	27%	45%	75%
Seaside	83%	4%	3%	19%	8%	69%	3%	13%	44%
Tagabe Bridge	80%	13%	7%	11%	7%	58%	4%	36%	47%

The three most urbanised communities (Seaside, Fres Wind, and Tagabe Bridge) collect firewood the least, and were also the communities that voiced the greatest concern over limited access to firewood (and the expense of having to purchase it often).

In terms of fruits and nuts, usage and collection occurs in over 75% of the communities of Erakor Village, Etas, Ifira, Mele and Pango. The most common and abundant species – found in all areas – were banana, mango, pawpaw, grapefruit, orange, naus, and the favoured tree for roasting nuts (locally known as 'navel').

Bamboo is used by over 50% of households in Pango, Ifira, Erakor Village and 78% of households in Mele. These communities also have significant access to timber resources which provide various building and housing project services. Timber is also used for carvings and building canoes. On the other hand, the communities of Seaside, Erakor Bridge, Fres Wind, Tagabe Bridge, and Blacksands all use considerably less timber and bamboo.

The Seaside area does not get much of these resources from surrounding forest ecosystems, but 58% of the community do benefit from the provisioning service of raw materials. Most of these individual resources are not directly tied to one ecosystem service per se. Raw material services for

housing may also be harvested from leaves of natangura, for example, which are thatched into traditional roofing (therefore also providing a cultural service).

Overall, firewood, fruits, nuts, medicines, natangura, pandanus and coconut leaf materials used for mats etc., were noted as key resources.

The ecosystem services provided by forests were noted as ceremonial, recreation, tourism, art experience and values, purification of air and water, protection from flooding, prevention of erosion, wind barriers, provision of shade and regulation of microclimates, diverse habitat for flora and fauna, and improved soil and biomass.

Traditional wealth and livelihood items

Over 90% of the communities of Erakor Village, Ifira, Pango and Mele make use of traditional wealth items, including pigs, chickens, other animals (ducks, birds, cats, dogs, etc.), yams, kava, sugar cane, and mats (Table 8). Mats and baskets are common livelihood items, along with general handicrafts, but Ifira is the dominant community, with over 50% of respondents listing handicrafts as a livelihood item.

Community livelihoods also depend on a range of other natural resources, including: pig tusks (Ifira), livestock (Ifira, Mele and Pango), cash crops (most common in the communities of Erakor Village, Erakor Bridge, Blacksands and Mele), home-based manufacturing (Ifira, Pango and Mele, with small levels of activity elsewhere), carving (Tagabe Bridge, Fres Wind and Erakor Bridge), and limited amounts of sandalwood (Fres Wind, Seaside and Erakor Village). Ifira and Mele are the two communities that stand out as being most dependent on animals for their wellbeing.

Table 8: Traditional wealth and livelihood items

Community	Traditional wealth	Pigs	Chickens	Yams	Kava	Sugar cane	Mats	Baskets/other handicrafts
Blacksands	63%	23%	33%	18%	7%	10%	13%	22%
Erakor Bridge	66%	33%	43%	19%	7%	21%	12%	29%
Erakor Village	91%	46%	36%	68%	3%	47%	29%	21%
Etas	77%	37%	62%	34%	18%	52%	37%	29%
Fres Wind	57%	9%	32%	21%	10%	16%	18%	15%
Ifira	91%	82%	54%	39%	7%	0%	19%	54%
Mele	98%	75%	37%	93%	5%	36%	21%	14%
Pango	93%	47%	55%	63%	0%	32%	34%	25%
Seaside	30%	1%	12%	16%	4%	8%	5%	28%
Tagabe Bridge	62%	29%	24%	9%	0%	20%	7%	22%

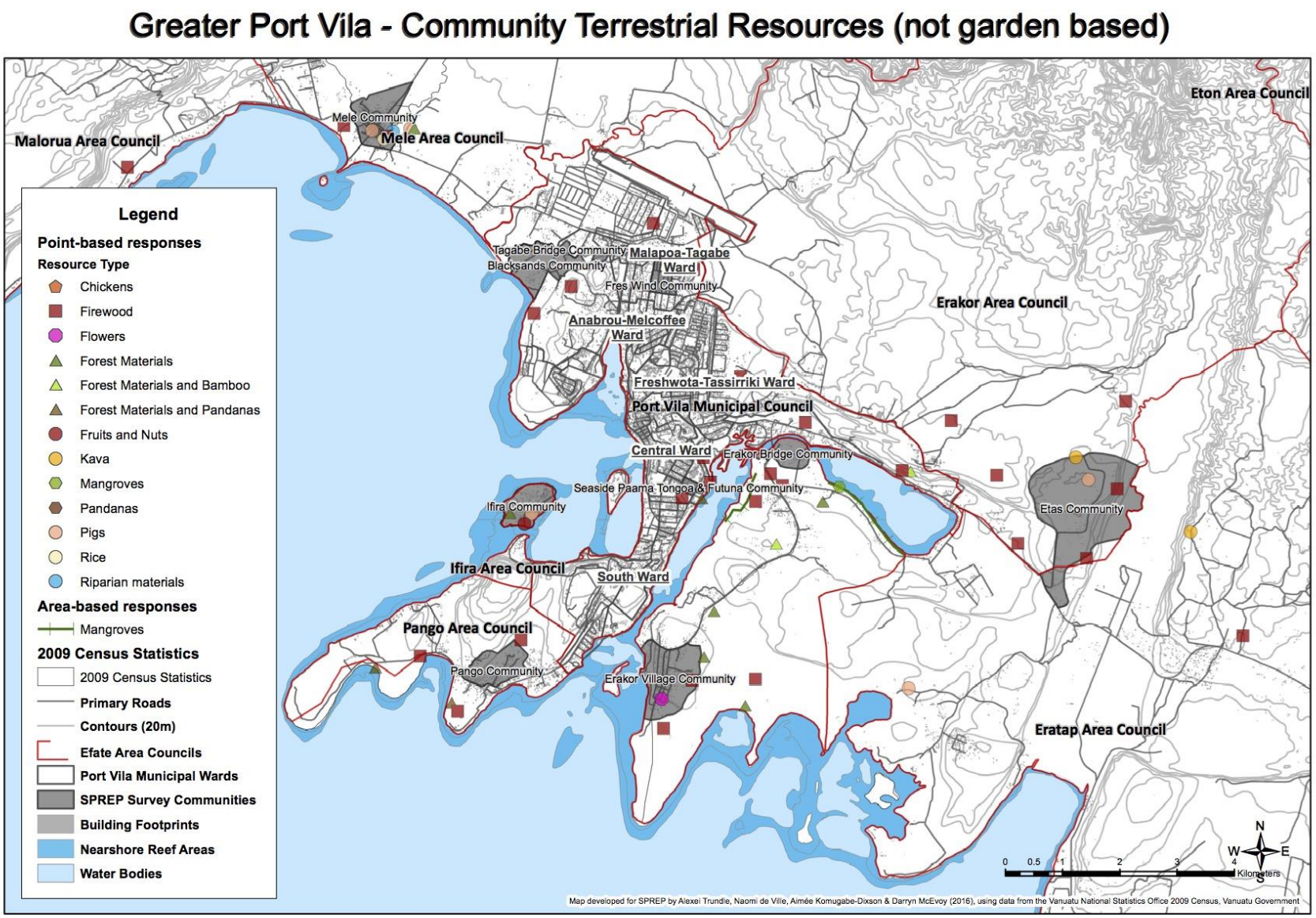

Figure 12: 'Non-garden' terrestrial resources

Marine and freshwater

The main fishing areas accessed by the surveyed communities are: Ifira, Pango, Mele, Erakor Lagoon, Emten (Nambatu) Lagoon, Blacksands, Eratap, Whitesands, Devil's Point and North Efate (Figure 13). The main fish species harvested in most areas are: piko (rabbitfish), mangru, malet (mullet), moustasfish (goatfish), bluefish (parrotfish), redmouth, karong and sardines. Deep-sea fishing is mainly carried out by Mele, Blacksands and Ifira communities, and the main fish caught are tuna and poulet, which are sold at a premium. Octopus is also widely caught and eaten as a delicacy.

Household reliance on fish and shellfish resources is significant (Table 9). Green snail and trochus are mainly harvested around Mele, Pango and Ifira. Findings, confirmed at the workshops, show that green snail and trochus have been heavily depleted over the last decade in Blacksands, and parts of Pango, Erakor and Nambatu lagoon. The abundance of green snail and trochus correlate with combined water regulating services (flood protection, purification and treatment) as identified in the surveys. This underscores the fact that these species are vulnerable in degraded habitats, as they are the first to disappear, and active efforts need to be made to keep their populations viable.

Table 9: Marine resources used by communities

Community	Marine resources	Fish	Shellfish	Sand	Dead Coral	Green Snail	Trochus	Turtles	Crabs
Blacksands	86%	45%	24%	23%	4%	-	1%	-	3%
Erakor Bridge	95%	81%	69%	2%	2%	2%	-	-	28%
Erakor Village	97%	91%	67%	76%	76%	22%	9%	8%	58%
Etas	<78%	62%	44%	24%	12%	7%	4%	1%	28%
Fres Wind	63%	27%	16%	3%	6%	6%	1%	1%	10%
Ifira	98%	93%	72%	80%	86%	22%	15%	15%	61%
Mele	94%	79%	45%	76%	38%	15%	19%	1%	65%
Pango	97%	92%	68%	77%	86%	27%	11%	-	53%
Seaside	57%	51%	27%	-	1%	1%	-	-	4%
Tagabe Bridge	33%	27%	16%	-	-	-	-	-	-

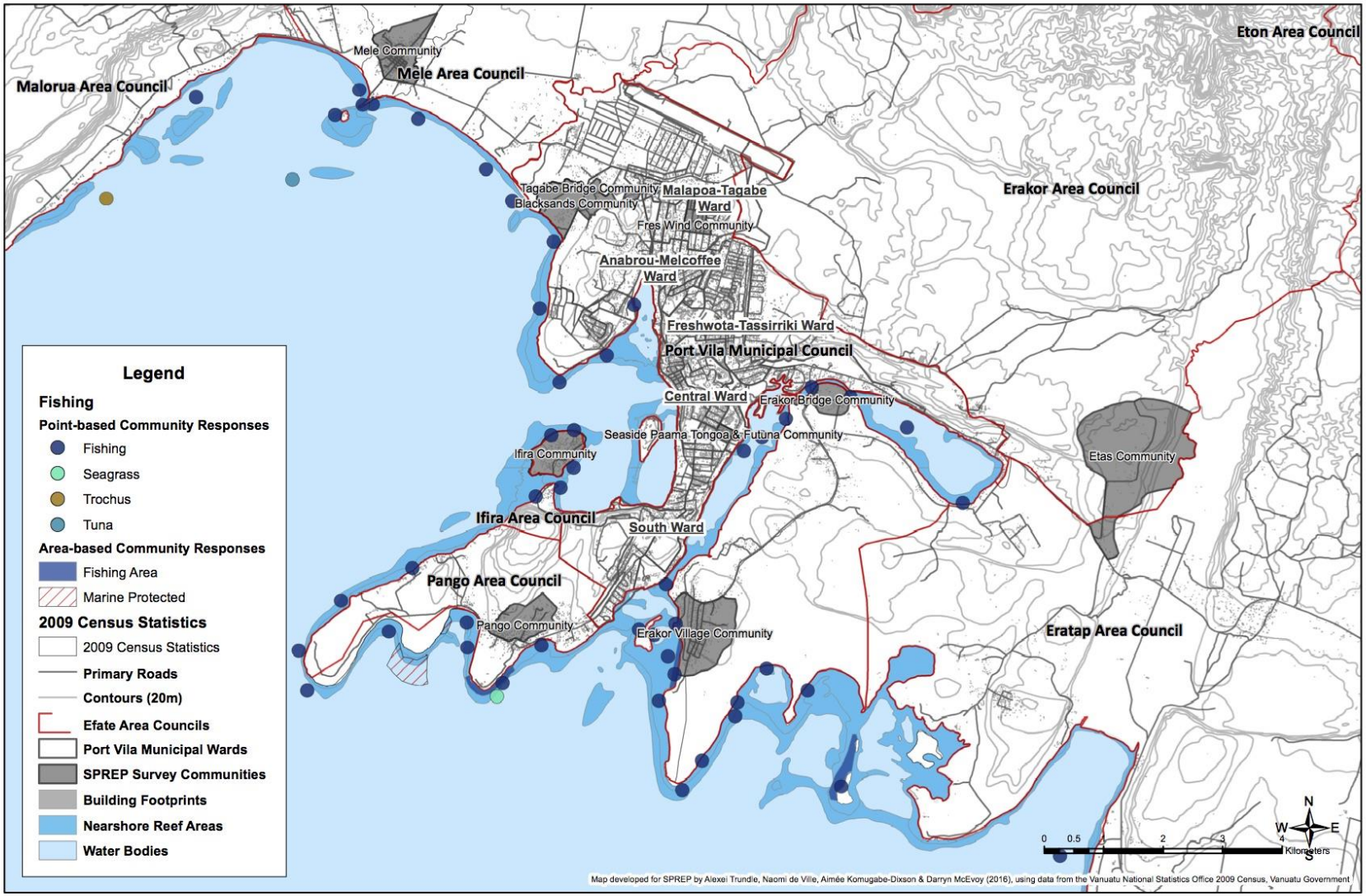

Figure 13: Key fishing locations

Etas and Mele are the communities with the highest usage of freshwater resources (Table 10). Seaside and Ifira residents have the most limited access to freshwater resources, with only 5% and 19% using these resources respectively. The main freshwater areas that are used are: Mele River, Mele Cascades, Prima River, Tagabe River, Teouma River, Etas Springs and North Efate (Forary and Eton). Water sources and catchment zones are shown in Figure 14. The main resources harvested are water, fish, crustaceans (e.g. *naura*), and to a smaller extent, plants (watercress, water taro) and rocks.

Table 10: Freshwater resources used by communities

Community	Freshwater resources	Water	Fish & prawns	Plant material	Rock & non-living material
Blacksands	50%	42%	7%	-	-
Erakor Bridge	48%	38%	7%	7%	-
Erakor Village	36%	7%	4%	1%	1%
Etas	87%	60%	31%	26%	3%
Fres Wind	89%	30%	8%	8%	2%
Ifira	19%	7%	-	2%	-
Mele	95%	58%	46%	31%	2%
Pango	37%	10%	3%	1%	1%
Seaside	16%	4%	4%	-	-
Tagabe Bridge	73%	60%	13%	yes	-

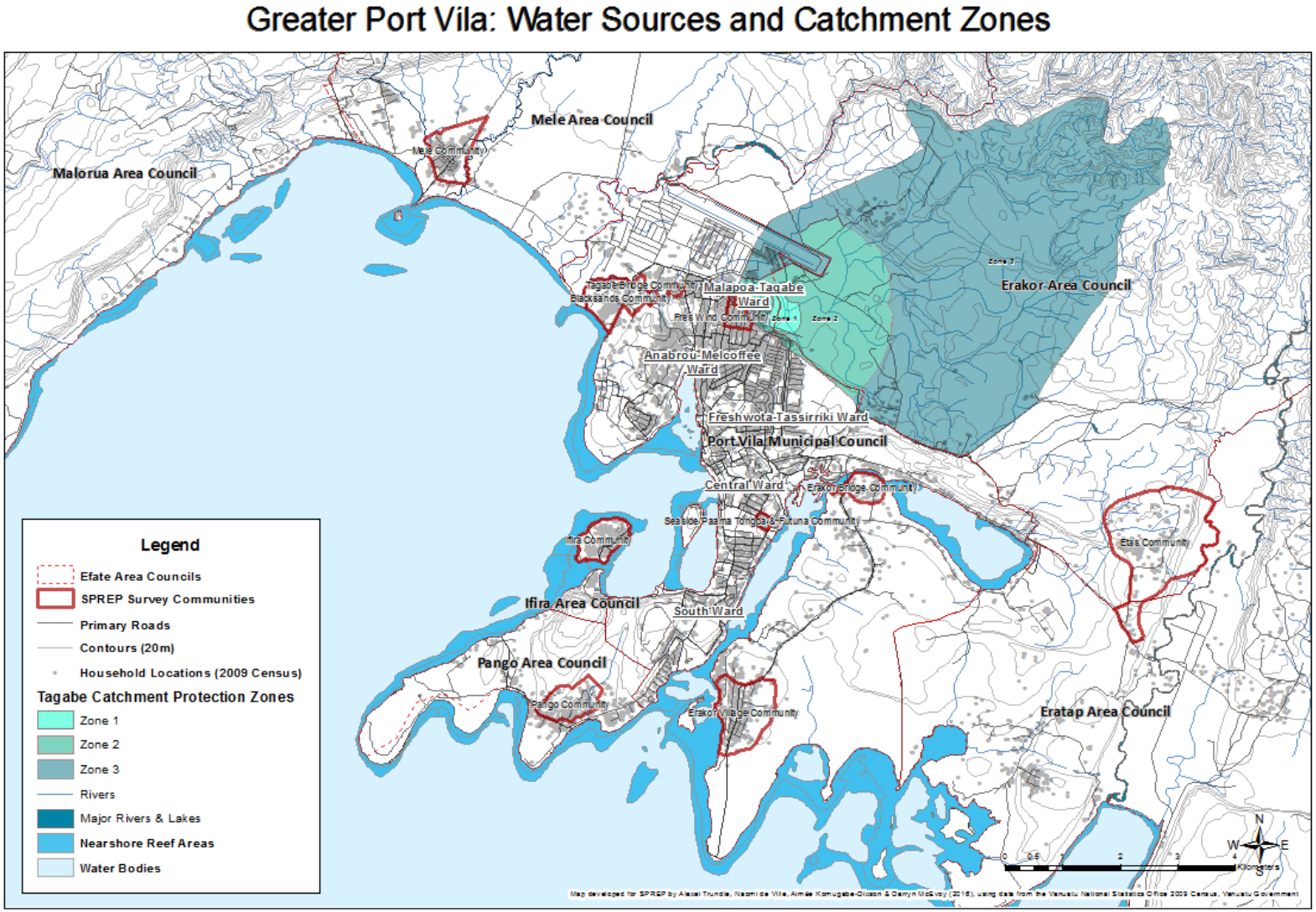

Figure 14: Water sources and catchment zones

Food resources and services

A range and diversity of key terrestrial and aquatic resources are important food sources for all communities in Greater Port Vila to meet the nutritional needs of their families and animals (Table 11). More than half of the communities (Erakor Bridge, Erakor Village, Etas, Ifira, Mele and Pango) are getting their combined food resources from surrounding ecosystems. It is therefore also important to maintain and increase the resilience of these ecosystems so that they provide abundant and high quality food, especially as over 50% of families in each community rely on these ecosystem resources for subsistence food.

Almost 100% in the communities of Erakor Bridge, Erakor Village, Pango, Etas, and Mele get a significant portion of their food needs from local ecosystems. For Fres Wind and Seaside, the gap in resources to meet their provisioning needs is apparent, with only 34% and 23% of residents respectively getting their food from nature, yet 87% and 80% of these communities rely on subsistence food services.

Also, over 40% of the Erakor Village community, and about a third of Erakor Bridge, Etas and Mele, harvest fish, grow crops in their gardens, or raise animals for cash. Erakor Village, Etas, Mele and Pango also identified ecosystems as providing fodder for their animals.

Table 11: Sources of food from local ecosystems

Community	Gardens	Fruit & nuts	Pigs	Chickens	Marine fish	Shellfish	Crabs	Fresh-water fish & prawns
Blacksands	96%	51%	23%	33%	45%	24%	3%	7%
Erakor Bridge	81%	59%	33%	43%	81%	69%	28%	7%
Erakor Village	100%	99%	46%	36%	91%	67%	58%	4%
Etas	96%	84%	37%	62%	62%	44%	28%	31%
Fres Wind	85%	64%	9%	32%	38%	23%	10%	8%
Ifira	77%	91%	82%	54%	93%	72%	61%	0%
Mele	100%	91%	75%	37%	79%	45%	65%	46%
Pango	99%	75%	47%	55%	92%	68%	53%	3%
Seaside	73%	44%	1%	12%	27%	16%	0%	13%
Tagabe Bridge	69%	47%	29%	24%	51%	27%	4%	4%

Community Workshops: Ecosystem and Socio-economic Resilience

The workshops held with each of the local communities were arranged through Vatu Mauri Council (VMC) networks and facilitated by the team ecologist and marine scientist experts with support from members of the VEPAC survey team (Figure 15). VMC and VEPAC jointly ran the final workshop in Ifira after training and their involvement with earlier workshop activity. Relevant government officials and NGOs were also invited to participate in these community events.

Each interactive workshop was structured to first confirm the ecosystem information that had been recorded by the survey and then to provide an opportunity to further elaborate on the human and climate-related pressures that are affecting the integrity of local ecosystem goods and services. Break-out group discussions (split into terrestrial and marine themes) then focused on current management practice and allowed for community input on possible ecosystem-based adaptation actions that would help to strengthen their resilience. The discussions were mostly conducted in the local language, Bislama, typically led by a community member, with note-taking done by a local project member.

Figure 15: A selection of community workshops and participants

Findings from each of the ten individual workshops – highlighting key resources used, human and climate-related pressures, and potential community-based adaptation options – are contained in the Appendix of this report.

Synthesis: Terrestrial

Terrestrial ecosystems integral to the Greater Port Vila communities include: nature patches within the urban boundaries, 'wild' areas surrounding villages and settlements such as bush, riparian and coastal vegetation, as well as cultivated plantations and gardens which range in size from a patch of a few plants and trees in the backyard to an acre or more within the bush (Figure 16).

When the four ecosystem categories (traditional wealth, forests, gardens and livelihood) are combined, over 80% of the communities of Erakor Village, Etas, Ifira, Mele and Pango utilise and benefit from terrestrial ecosystems.

Traditional wealth items are almost exclusively sourced from terrestrial ecosystems. With the exception of a small amount of water taro or water cress that may be cultivated and the money made from the sale of fish, livelihood items are almost entirely terrestrial.

When access is possible, either through ownership or permission, all communities tend to prefer to go to the bush near their households for their gardens and firewood collection, and to harvest fruits, nuts, medicines, and materials for mat making and various construction projects. Further afield, some of the most frequented bush garden areas accessed by the communities surveyed are: Teouma, Etas, Eratap, Erakor, Club Hippique, Batlalue, Tafu, Prima, Airport, Bellevue, Bladinier and Whitesands. Areas more commonly visited for firewood are: North Efate, Devil's Point, Randapoa, Tassiriki, Korman and Montmartre.

The main crops grown are banana, pawpaw and sugarcane, island cabbage for greens, and the traditional root staples of yams, manioc and taro. All communities however grow some amount of annual vegetables including corn, garlic, onions, beans, carrots, cucumbers and pumpkins, and all would like to grow much more.

Although kava is an important traditional wealth item and several communities (Fres Wind, Seaside, Blacksands, and Erakor Bridge) make supplemental cash through their *nakamals*, it appears that Etas is the community that is able to grow a decent amount of it (18% of households).

Chickens and pigs are reared by over a third of all communities with the exception of Tagabe Bridge with chickens (24%), and Fres Wind (9%) and Blacksands (23%) rearing pigs. Seaside has the least capacity to keep any animals with only 12% owning chickens and 1% pigs.

The main fruit and nut species harvested are: mango, grapefruit, orange, *naus* (*Spondees dulcis)*, and wild nut species navel (*Barringtonia sp)*, *nangae* (*Canarium spp*.) and *natapoa* (*Terminalia catappa)*.

Crops from gardens, fruits and nuts, pigs and chickens for subsistence food and (for 20 Vatu) food packs and other cash sales, were among the primary provisioning services by terrestrial ecosystems.

Participants identified these terrestrial ecosystems as important for all provisioning services, particularly fuel and medicine, with low anomalies for fuel services in Fres Wind (33%) and Seaside (12%). These values were subsequently identified as much higher in the workshops. However, the cumulative effect of lack of bush land access and reliance on firewood purchase are likely reasons for the value being much lower than all other communities (58% – Tagabe Bridge through to 98% – Mele).

Raw material services were important for approximately half of each of the communities of Erakor Village, Etas, Mele, Pango and Tagabe Bridge, with most of the resources being understood as coming from a mixture of timbers, bamboo, coconut, natangura, and pandanus, which were also high for each of those communities except Tagabe Bridge.

Leaves from the latter three items are also the primary raw materials for mats, baskets and handicrafts, which are tied to other services like ornaments and have the strongest correlation with spiritual, cultural values and tourism experience.

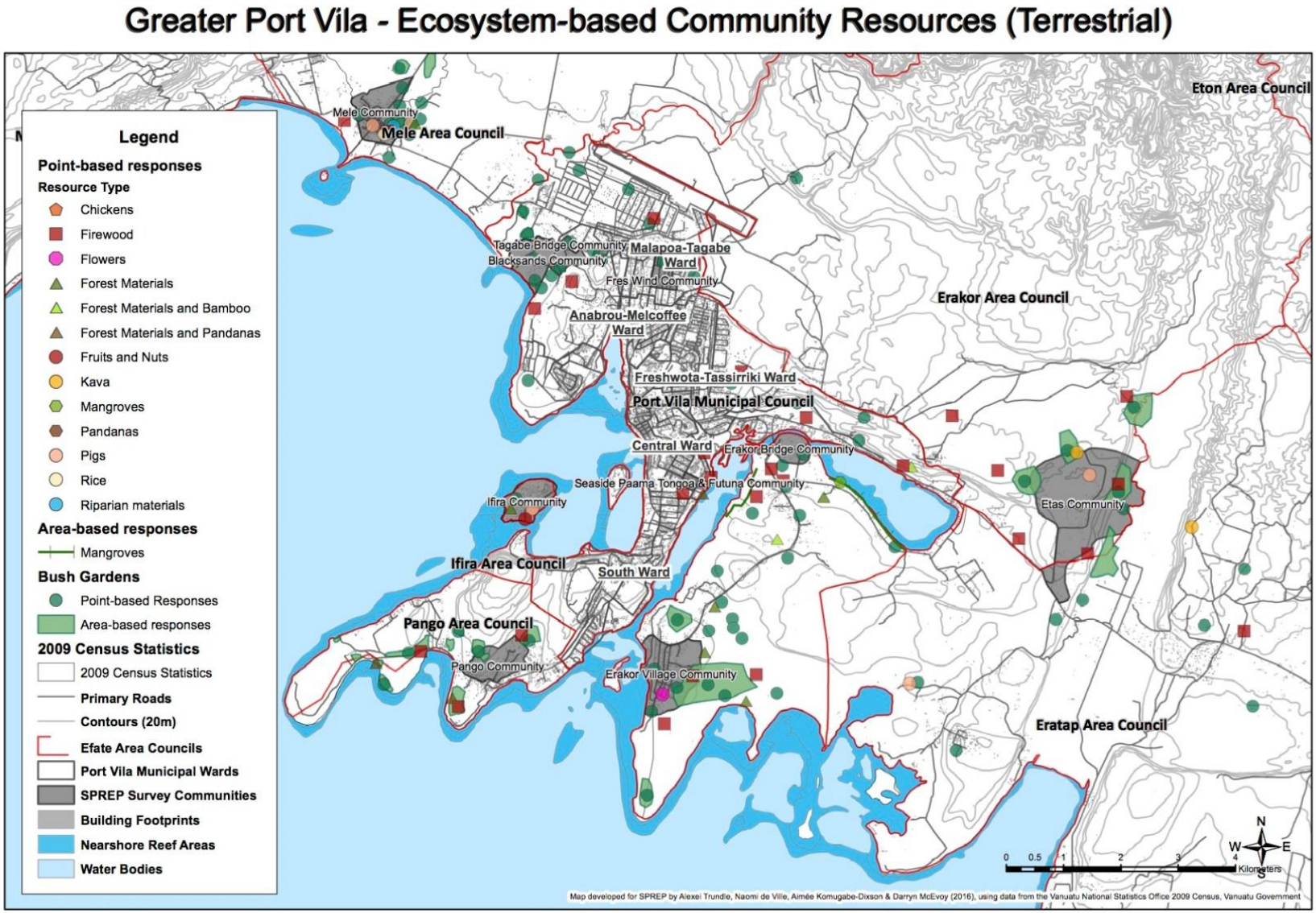

Figure 16: Location of terrestrial resources

Survey and workshop participants generally understood the role of terrestrial ecosystems in supporting biodiversity and as a habitat for numerous organisms, with birds, butterflies and lizards often mentioned (birds and butterflies being essential to pollination processes). Other recorded services included trees regulating air quality, micro-climates (in the form of shade and wind-breaks), preventing erosion, and providing flood protection.

The intactness and condition of bush land seemed to be related to whether there were good or bad soils for growing crops. The supporting benefits of terrestrial ecosystems for healthy soils were most evident in Pango, Ifira, Erakor Village and Mele, with the majority (50–90%) of households identifying nutrient cycling, soil and biomass formation and soil fertility processes.

The communities that most often mentioned problems with pest and disease on crops and fruit, and the highest incidence of and concern about malaria, were also among the communities attributing most pest and disease regulation benefits (Etas, Mele, Erakor Village, Pango – 72% to 94%). This supports the observations from the study that regulating services - and pest and disease regulation specifically - were the services that were most misunderstood. All communities would benefit from improvements in understanding the 'regulating' and 'supporting' services that ecosystems provide.

Current management practice

Gardens:

The most common species in home gardens are fruits, banana, pawpaw, and flowers. Bush gardens, often only visited at weekends, are primarily for root / staple crops, as vegetables do not tend to grow well. There is a low diversity of crops, although banana, pawpaw, and citrus are sometimes grown at the edges of gardens. There is also limited mulching and composting, with bare soil often exposed, and this is a clear opportunity for improvement. Leaf debris is raked and burned, sometimes in mixed material piles.

The primary method of clearing for new gardens is to cut and burn trees, with gardens also developed right up to the edge of rivers.

If communities are not connected to the water supply, they will not attempt to grow annuals.

Firewood:

This resource is critical to everyday cooking and is also important to communities for ceremonies. The local preference is for wood / charcoal cooked food, although charcoal can be difficult to make and comes mostly from north Efate. However, anything that can be collected is used as fuel, including material from bush gardens, and quality can be variable. Good quality firewood options were identified as kasis *Leucaena leucocephala* and orange *Citrus sinensis*, although permission is often needed to access this resource. It was found that firewood is often not stored or dried properly. Again, this is an area for potential improvement.

Materials:

There are several different kinds of bamboo (two main types are used), three types of pandanus, and two types of natangura, which all are easy to plant and propagate. It was found through the ESRAM engagement process that coconut trees are generally not being replanted.

Goods that are derived from forest resources – such as mats, baskets, carvings and handicrafts – can provide good incomes to households but are increasingly under threat.

A lack of skill-sharing of traditional methods, e.g. thatch roofing, mat / baskets, canoe building, wood carving, etc. is a further cause of concern.

Synthesis: Marine, coastal, lagoon and freshwater

Marine and freshwater ecosystems form an integral part of the lives of the Greater Port Vila communities (Figure 17). Over 85% of households in the coastal communities of Blacksands, Erakor Village, Erakor Bridge, Ifira, Mele and Pango utilise and benefit from marine ecosystems.

The main fishing areas accessed by the communities surveyed are: Ifira, Pango, Mele, Erakor Lagoon, Emten (Nambatu) Lagoon, Blacksands, Eratap, Whitesands, Devil's Point and North Efate. The main fish species harvested are: *Piko* (Rabbitfish – *Siganus vermiculatus*), *Mangru* (*Scatophagus* sp.), *Malet* (mullet), *Moustasfish* (goatfish – *Parupeneus spirulus*), *Bluefish* (parrotfish) and *Redmouth*.

Green snail and trochus are mainly harvested around Mele, Pango and Ifira. The abundance of green snail and trochus correlate with combined water regulating services (flood protection, purification and treatment) that were identified in the surveys. This supports the workshop findings and underscores the fact that these species are vulnerable in degraded habitats, as they are the first to disappear, and active efforts need to be made to keep their populations viable.

Turtles are caught in Erakor Village and Mele Reef sharks are caught in Pango whenever they are sighted, and killed (for consumption) because they are presumed to be a threat. In Mele, shark jaws are sold to tourists.

Fish and shellfish for subsistence and sale is one of the primary provisioning services by marine and lagoon ecosystems.

Participants identified mangroves as important sources of firewood, medicine and raw materials.

Sand and dead coral are important as raw material for building, and for ornaments. About 80% of households in Mele, Ifira, Fres Wind, Erakor Village and Pango collect sand. Sand is collected at Blacksands, Mele and Shark Bay/Eratap, where the beaches have sand mixed with silt which makes it conducive for mixing with cement for construction.

Households recognised the role ecosystems play in supporting biodiversity and as a habitat for numerous organisms. The sighting of dugongs at Seaside, Erakor Bridge, and Mele is linked to healthy ecosystems, as well as diversity of reef fish at Mele.

Survey and workshop participants generally understood the role of ecosystems in regulating air and water quality, water purification, prevention of coastal erosion and flood protection. At Pango, the regulating benefits of the coastal ecosystems were evident, with the majority (75–100%) of households highlighting fresh air and clean water surrounds.

The coastal communities (and especially the lagoon communities of Seaside, Erakor Bridge and Erakor Village) recognised the importance of mangroves and seagrass meadows in filtering pollutants, nutrients, and sediments carried from wastewater inland and storm water runoff.

The beaches around Port Vila provide an important cultural service to residents in the communities surveyed. Beaches around Mele, Erakor and Eratap (near Etas) are frequented for recreation purposes, as there is still public access to these areas, which boast good water and air quality.

Mele and Etas are the communities with the highest usage of freshwater resources (95% and 87% respectively). Seaside and Ifira residents have limited access to freshwater resources, with only 5% and 19% using these resources respectively. The main freshwater areas visited include: Mele River, Mele Cascades, Prima River, Tagabe River, Teouma River, Etas Springs and North Efate (Forary and Eton).

Most of the fresh water fish and crustaceans have been depleted in Port Vila communities, and more people now have to travel to the north of the island to obtain water and freshwater fish.

Water for domestic and agricultural use is critical for the ridge communities of Etas and Fres Wind, as well as down-stream communities of Tagabe Bridge, Blacksands and Mele. Additionally, raw material, medicines, and food such as fish, watercress, water taro, and *naura* are obtained from rivers and springs.

Communities that primarily depend on fresh water resources simultaneously reported low water purification services, highlighting the need to improve and strengthen underlying ecosystems. These ecosystems have an important role in spiritual and cultural well-being, recreation, and tourism.

Current management practice

Marine and freshwater areas are locally managed by the chief. Chiefs declare no-take 'tabu' areas, where fishing is prohibited. These sanctions last a set period of time, and may be lifted during festive seasons, such as Easter. This traditional structure allows for the ecosystems to recover, and enables sustainable fishing practices.

Erakor Bridge is currently protected by the Erakor Village Paramount Chief, and this area will be extended to the entire Erakor and Emten (*Nambatu*) Lagoons. In Pango, after the failure of the chief to enforce the no-take area he proposed on the surrounding reefs, households have taken to making *tabu* areas adjacent to their property, with positive results for species recovery. The Ifira Paramount Chief will be declaring a tabu area around Blacksands. There is a need to protect the sand as well, given that continued mining will degrade the area and the reefs will not recover, despite reduced fishing activity.

The Department of Fisheries is involved in projects to reseed giant clams and trochus on reefs around Efate. Mele residents benefit greatly from this. However, the department's projects do not extend to other communities within Port Vila, although communities such as Erakor Bridge, Erakor Village, Pango and Seaside would all benefit from these reseeding projects.

In 2015, the department implemented seasons for bêche-de-mer harvesting in order to reduce overharvesting. Survey and workshop participants differed on when these seasons occurred, how much to take, and in which areas bêche-de-mer harvesting was completely prohibited.

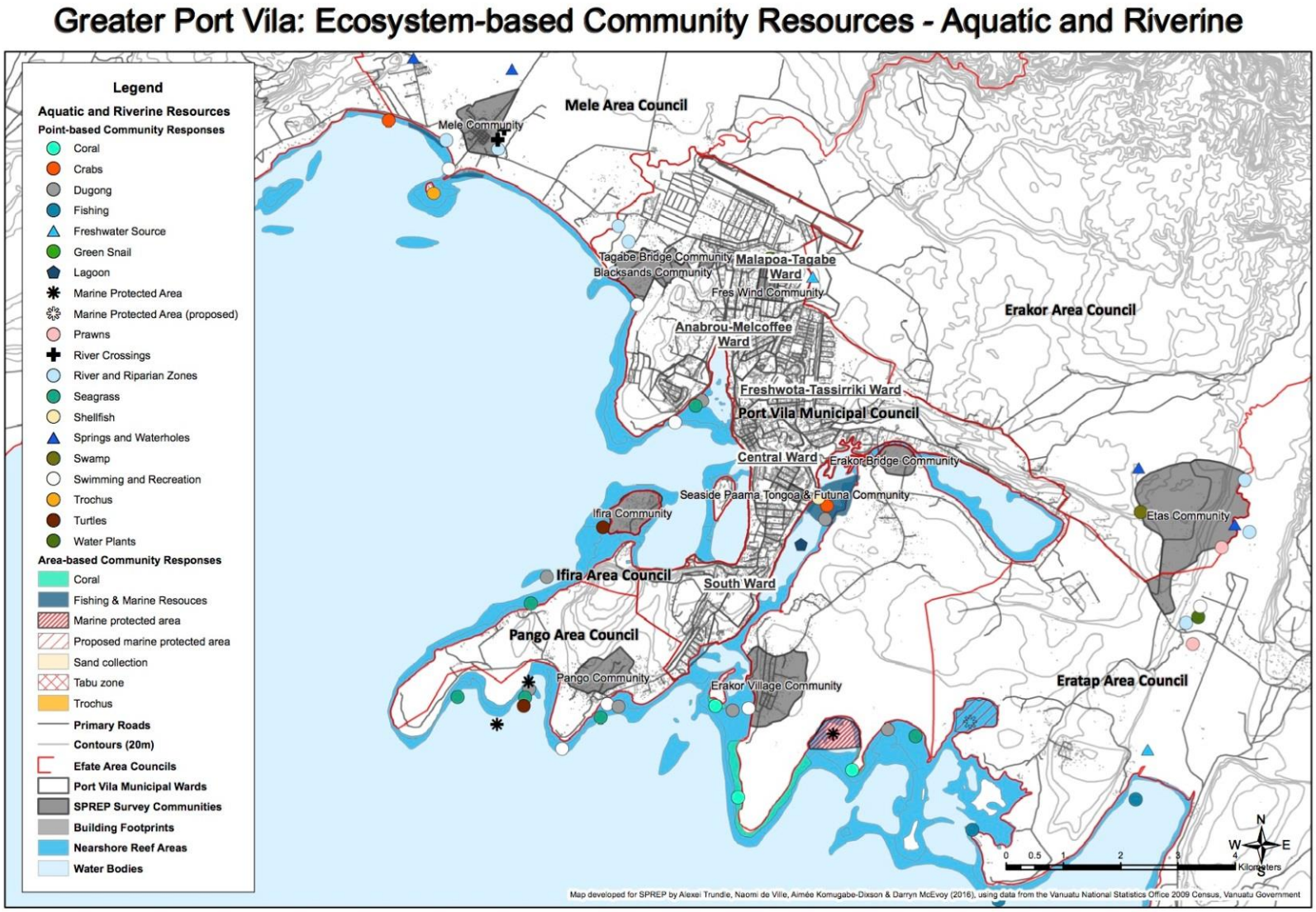

Figure 17: Aquatic and riverine resources

Contemporary Pressures

The primary drivers of change that were identified for the communities of Greater Port Vila overwhelmingly relate to population growth / urbanisation pressures. The communities that were surveyed have grown as much as 20% in the past five years, and this has considerable economic repercussions, as most of the immigrants are unskilled and do not have formal employment. Rising consumption, increased pressure on resources, and transient communities (e.g. in Etas), all contribute to short and long-term stresses on local ecosystems. Threats are also being amplified by climate-related impacts, and a changing climate will act as a catalyst to further undermine socio-ecological resilience in the future.

Threats to ecosystem processes can also be socio-political, e.g. unclear policies regarding waste water treatment, encouragement of foreign investment and construction of resorts at waterfronts, and a lack of working partnerships between government and traditional leaders.

The following six pressures were found to be the most prevalent among the hotspot communities during the ESRAM engagement. Mapping of the hotspot areas, where these drivers affect communities the most, is presented in Figure 18.

Urban development

Increasing population numbers, rural-urban migration, and development pressures are all reducing access to, and the amount and quality of natural resources for the residents of Greater Port Vila.

Backyard space in homes is often considered 'too small' for gardens (e.g. natangura, which typically requires a larger space to grow) so access to these resources is particularly limited in high density settlements or in areas subject to rent / lease arrangements (Fres Wind, Etas, Seaside, and Tagabe Bridge). There are also instances of the stealing crops from bush gardens (all communities), and pigs (Mele). Availability of seeds and seedling supply is also restricted in several communities (Fres Wind and Etas).

Common or previous land access which is now restricted, or being sold and cleared, is a problem, particularly for coastal development. Due to low employment opportunities, limited entrepreneurial incentives, and increasing population, many residents in Pango, Mele, Erakor Village, Erakor Bridge, are selling their land to earn money. In Pango about 90% of the coastal land has been sold to foreign investors, and resorts and private residences have been developed, restricting public access to the sea. The sale of land is usually not a financially astute decision, as the earnings are not invested, and are typically used up in one or two years. (An Erakor Bridge resident recounted how he sold his land to an Asian investor, used the proceeds for his children's fees and other domestic expenses, and three years later he had no money, no land and no job).

Urban development has also adversely affected the lagoon environments of Seaside and Erakor Bridge, as well as Pango and Mele. Here, coastal vegetation and wetlands have been cleared in favour of concrete structures that interrupt natural coastal processes, leading to poor water quality, flooding, erosion, and an overall loss of coastal protection (and hence a reduced buffer from storms and cyclones).

Pollution

Pollution – the introduction by humans of materials that are toxic or harmful to natural organisms - is one of the biggest threats to Port Vila terrestrial, coastal and freshwater ecosystems. The increase of nutrients (through human and factory waste) encourages the growth of invasive weeds and harmful

algae and bacteria. This has been detrimental to seagrass and other marine species, and has resulted in reduced water and air quality in these areas.

Bio-magnification of toxic pollutants up the food chain has caused fish poisoning outbreaks at Seaside, Erakor Bridge and other communities. Annual vegetable plants in gardens are particularly sensitive to absorbing toxic metals within the soil and crops contaminated with harmful bacteria can cause sickness if eaten. Other pollutants (e.g. excess silt from erosion, oil, plastic and tin) may directly smother reefs and other marine organisms or have indirect effects through reducing light penetration.

Most pollutants identified were from local sources: hospital waste (Seaside), factory waste (Tagabe Bridge, Blacksands), human waste (Tagabe Bridge, Blacksands, Seaside, Fres Wind), animal waste (Mele, Ifira, Erakor Village), landfill (Etas), plastics and mixed product burn piles (all communities), oil spills (Ifira, Erakor Village) and increased sediment influx due to clearance of riparian areas to make gardens (Tagabe Bridge, Blacksands, Etas, Fres Wind, and Mele).

Access to clean water

Access to clean water was found to be a priority issue for Fres Wind, Etas, Blacksands and Tagabe Bridge. For Fres Wind and Etas, water issues are compounded because these households are not connected to piped (UNELCO) water supply, and have to solely rely on alternative water sources. For Fres Wind, access to the Tagabe River has been restricted by the construction of a fence around the source (water pump), so households have to travel much further to fetch water. In Etas, households typically travel three km to collect water from Etas Springs or Teouma River. For Blacksands and Tagabe Bridge, clean water access is restricted due to the heavy riverine pollution, most of which occurs further upstream.

In all communities, there is ineffective rainwater harvesting. Many community buildings have potential rooftop catchment areas, but rain water tanks are yet to be installed. Private households in all communities surveyed have containers that – inadequately – collect rainwater. The water that is collected is prioritised for drinking and cooking, which leaves little capacity to properly irrigate vegetable gardens at home, thus compounding the lack of food production in these communities' backyards.

Overharvesting and poor management practice

In the case of gardens, compacted or poor soils around the home are problematic in Fres Wind and Seaside; limited water availability affects Etas, Fres Wind, and Seaside; and damage by pigs / other animals and limited materials / expenses for fencing are listed as problems for Erakor Bridge, Etas, Ifira, and Mele. Planting in the same spot without leaving land fallow for an adequate period also depletes soil quality.

Cutting down trees for firewood is recognised as damaging the health of the forest ecosystem (all) and although TC Pam created a temporary surplus of firewood this resource is now running out. Many now regularly purchase firewood (all except Ifira, Erakor Village and Pango) although this is considered expensive (a 300 Vatu bundle lasts one to two days).

Cooking facilities are typically open fire (all) and require a lot of fuel (which burns quickly, especially when pieces are small and the quality of fuelwood variable), and collecting / cutting takes time and distances are long to walk or travel – Blacksands, Erakor Bridge, and Etas being the most affected communities). Smoke inhalation was also noted as causing health problems and may be particularly harmful when plastics and other non-organic products are burned with organic fuels (all).

Natangura / pandanus are sometimes overharvested, not only in amount but also in timing, which can kill off the plant (Erakor Bridge, Erakor Village, Mele, Pango, and Seaside). It was also found that the

supply for natangura for traditional roof thatching is not meeting local demands and as a consequence costs are rising (Mele).

For communities reliant on fishing (Pango, Blacksands, Seaside, Erakor Bridge, and Erakor Village) the fish size has decreased, with localised depletion affecting the following species: freshwater prawns - *naura* (Fres Wind, Blacksands, Mele, and Etas), sea birds (Pango), sea cucumber (Seaside, Erakor Bridge), trochus (Blacksands, Seaside) and green snail (Blacksands). Non-discriminatory fishing practices, especially at Pango, have depleted smaller fish that are not typically caught. Fishing activity has increased, with women and children engaging in what traditionally was a man's occupation. As a result of this, there is a loss of local knowledge and understanding of fisheries, as this knowledge is not being appropriately passed down. Fish that were not traditionally caught are now being landed, and there is a lack of understanding about the right size to catch and the right areas to fish.

Sand mining

Sand mining in Efate is mainly carried out on the Mele and Blacksands beaches by Port Vila residents and also by construction companies who use forklifts to collect the sand. This has caused extreme changes in the morphology of the coastline between Blacksands and Mele. Over the last 50 years, the shoreline has receded inland, and Mele, Prima, and Tagabe River mouths have degraded noticeably.

Water quality in these areas has decreased (due to reduced light penetration), and in Blacksands this has led to the loss of several marine species. Sand mining has also destroyed habitats for land crabs and residents have noted a marked reduction in crabs in the last decade, which they rely on for subsistence.

These findings are supported by the MACBIO economic assessment of marine ecosystem services, which also noted extraction of coastal aggregate close to Port Vila, estimating a net producer benefit of sand mining as approximately VT 15.1 million in 2013 (nationally). This assessment also highlighted probable impacts, such as beach erosion and destruction and siltation of reef and lagoon habitat, with implications for marine ecosystem services: inshore fisheries and tourism. Further investigation was recommended.

Climate-related impacts

TC Pam damaged a lot of trees, gardens, crops, and other vegetation, especially along the coast and in flood zones (all communities were affected), and was also found to have had a mixed effect on the quality of soils. Subsequent effects from the El Niño drought (all communities) and seasonal shifts affecting the timing of fruiting (Erakor Village, Pango) and the suitability for planting of certain crops (Fres Wind, Mele, Etas).were noted. Pest damage on island cabbage and vegetables were also linked to the effects of climate change (all communities).

Whilst all communities identified substantial climate-related changes in the ecosystems they rely on over the past decade(s), the lagoon communities are especially vulnerable to these threats, as the shallow waters are more susceptible to higher temperatures, salinity and sea-level rise. The recent 'super' El Niño prolonged the anomalously high sea temperatures, and the lagoon communities were most affected. Fish kills (due to temperature, salinity, oxygen loss) were reported at Seaside, Erakor Bridge, Erakor Village, and at some places in Pango.

The incidence of coral bleaching due to high temperatures has increased over the past two decades, and prolonged bleaching has killed reefs around Pango, Ifira and Mele. Outbreaks of the invasive species *Acanthaster planci* (crown-of-thorns star) have increased over the decades, and are now more extensive than previously.

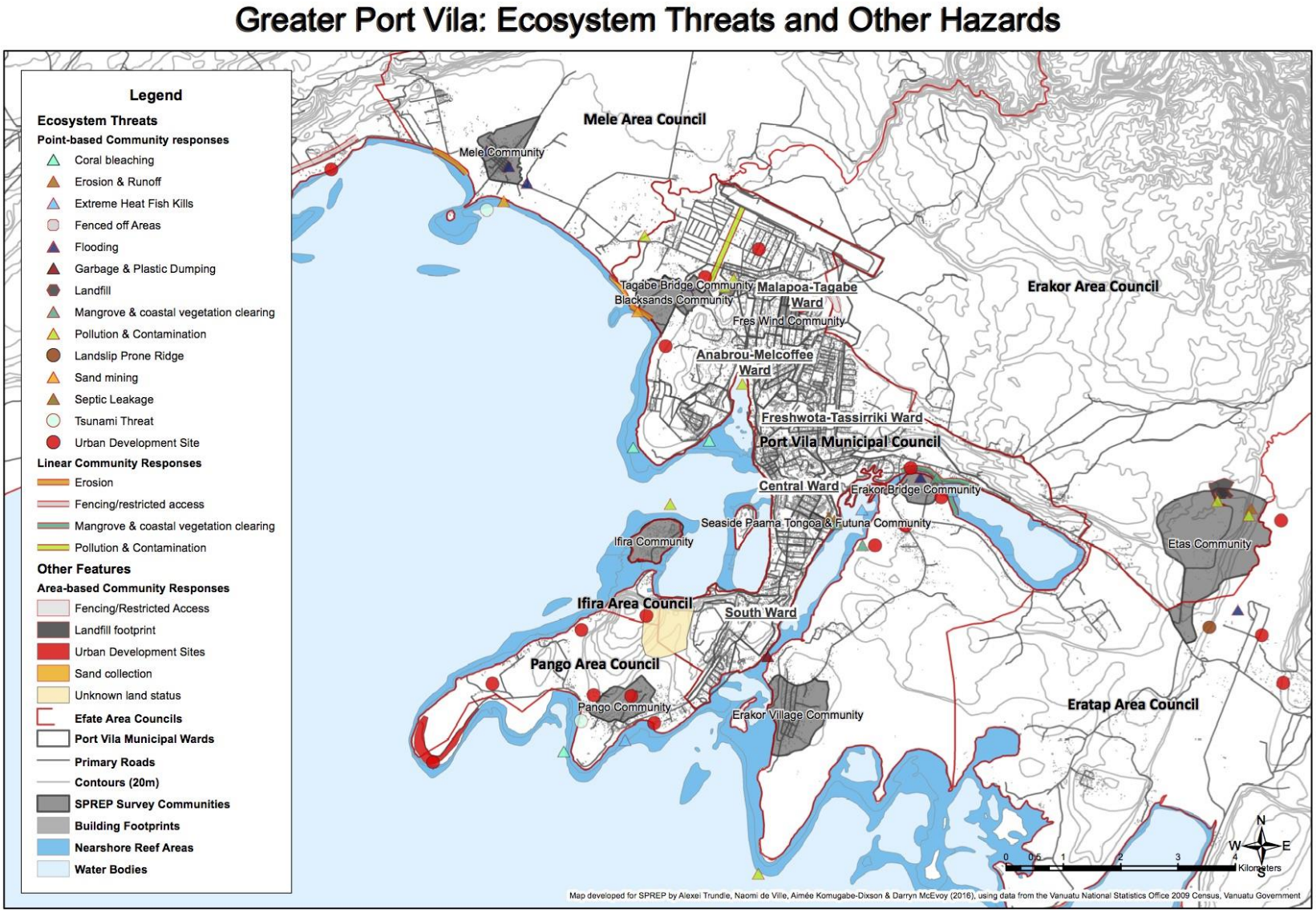

Figure 18: Threats to ecosystems in Greater Port Vila

Priority community actions and potential PEBACC pilot studies

Priority actions, and local needs for training and capacity building, have been identified and documented by the ESRAM activity for each of the individual communities. Overall, the most important of these relate to marine and coastal issues, access to freshwater, forests, and gardens (an overlay of ecosystem clusters and risks is shown in Figure 19).

Not surprisingly, the marine / coastal interface is integral to the lives of ni-Vanuatu, with over 85% of coastal communities reliant on marine resources. For a number of communities, typically those not connected to the water supply system, access to fresh water is already compromised and is likely to worsen as a combined consequence of increasing urbanisation and climate change.

In terms of terrestrial resources, the products from forests and gardens are central to many lives. Home and bush gardens provide food for subsistence and sale, whilst forests provide firewood (found to be a particularly acute issue for many), material for construction and handicraft products, and an array of nuts, fruits, and medicines. Continued and equitable access to these critical terrestrial and marine resources, given multiple drivers of change, will be an important factor in ensuring community resilience.

Table 12 highlights the compilation of priority issues for each community, with marine, freshwater, firewood / forests, and gardens found to be the most common priority for all the communities.

Table 12: Priority issues identified during the community workshops

Priority Issues	BS	EB	EV	Et	FW	If	M	P	SS	TB
Marine / coastal	✓	✓	✓			✓			✓	
Freshwater	✓			✓	✓					✓
General aquatic							✓	✓		
Gardens			✓	✓	✓					
Firewood	✓	✓		✓	✓				✓	✓
Materials (pandanus for mats etc.)		✓							✓	
General forest (firewood & materials)			✓				✓	✓		
Pigs						✓	✓			
Institutional concerns						✓				

Area/Community codes: BS – Blacksands, EB – Erakor Bridge, EV – Erakor Village, Et – Etas, FW – Fres Wind, If – Ifira, M – Mele, P – Pango, SS – Seaside, TB – Tagabe Bridge

Continued access to gardens is vital for both subsistence and for offering ways to generate alternative income. Training in urban agriculture practices, mulching and composting methods, drought-resistant crops, cover cropping, rotation, integrating with animals, and natural pest control techniques, are all actions that would benefit local communities. Increasing awareness on seed saving, food preservation, starting nurseries, promoting vegetation buffers for gardens along river banks and in high wind exposure areas, and training in rainwater harvesting techniques, would also be valuable.

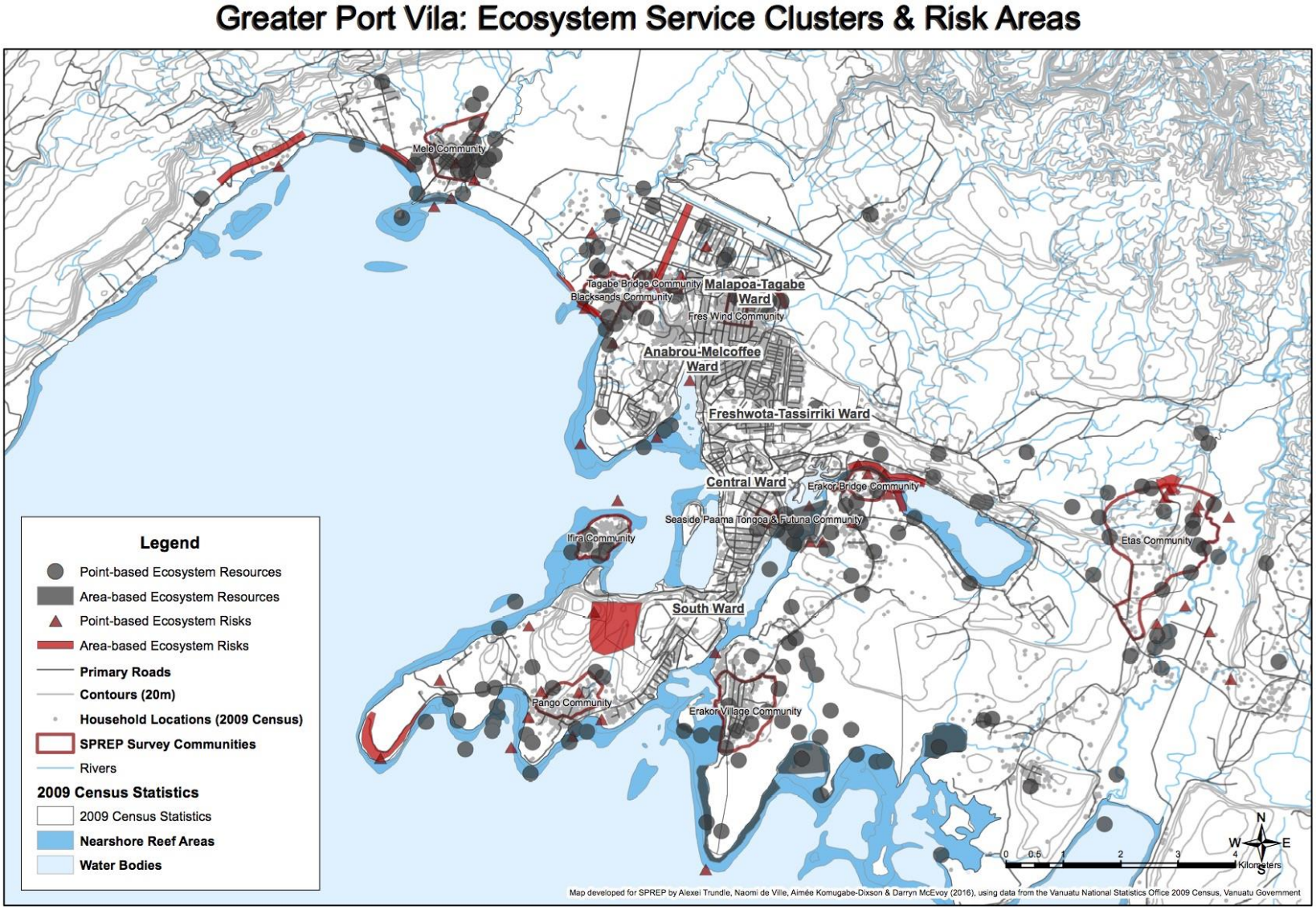

Figure 19: Ecosystem service clusters and risk areas

Firewood is an essential element of day-to-day living for many ni-Vanuatu (*kasis*, orange, *natora (Intsia bijuga*), *burao* (*Hibiscus tiliaceus*), *namamau (Flueggea flexuosa*), and *navasvas (Alphitonia zizyphoides*) are all species good for firewood), although continued access to this resource is clearly under threat. Actions that improve woodlot management and provide education about better quality firewood could usefully be carried out in collaboration with the Department of Forestry. Other possible initiatives include planting fast-growing firewood trees in gardens to increase personal firewood supply (e.g. leguminous trees will also have other uses and provide additional services – nitrogen fixing, building soils, high nutrient and health values, food for pigs, shade during hot winter months, etc.), as well as advocating private landowner arrangements such as trading firewood for work on farm / property and continued access to firewood resources. Alternative cooking methods such as charcoal or rocket stoves, solar cookers, deeper cone pits, will also reduce the pressure on limited firewood reserves.

Training to improve forestry management was also identified, particularly to avoid overharvesting of pandanus and natangura, with support for mentoring arrangements between elders and youth (natangura roofing, carving, weaving, canoe building, etc.). Other possible initiatives are planting programmes, especially involving youth, and the establishment of women co-operatives for the production of baskets / mats, which raise income from tourism. A longer-term goal would be collaboration with the Department of Forestry to promote / plant priority species like sandalwood *Santalum austrocaledonicum*, and other timber trees, e.g. whitewood *Endospermum medullosum*, mahogany *Swietenia macrophylla*, and kauri *Agathis macrophylla.*

All coastal communities agreed that more marine areas need to be protected to allow coral reefs and fish stocks to recover. Chiefs need to be able to get involved and enforce these sanctions through working closely with the government. In Mele, for example, there is opportunity for the chief and the government to work together and not only ensure no-take areas in the appropriate places, but also to control sand mining activities in the area.

One of the projects that recurred as a priority in all communities was replanting coastal and riparian vegetation. Workshop participants understood the benefits provided by mangroves, pandanus, bamboo and other such vegetation, and also noted that some of these trees could provide raw materials for local crafts.

The communities of Seaside, Fres Wind, Erakor Bridge and Pango would be interested in fish farming projects. In Pango, the youth started one that dried out, but they are prepared to try again with adequate training and equipment. Fres Wind participants suggested that individual – as opposed to community - fish farms were preferred, as there was not enough community cohesion to run such a project, and it would ultimately be mismanaged.

The need for training was a common request from all communities. Training to improve urban agricultural methods was suggested for Fres Wind, Etas, Erakor Bridge, Tagabe Bridge, Seaside and Pango. Training was also requested in pig-fencing and better livestock husbandry (Mele, Ifira), in alternative stoves (Erakor Bridge, Blacksands, Fres Wind), and in fuel-wood species (Blacksands, Erakor Bridge, Etas, Fres Wind, Seaside, Tagabe Bridge).

Training in better fishing practices was suggested for Mele, Ifira, Pango, Blacksands, Erakor Village, and Erakor Bridge. In Pango, the community requested training in deep-sea fishing methods to provide an alternative to fishing on the coastal reefs. Training was also requested in aquaculture (Fres Wind, Seaside, Pango), water management practices (Fres Wind, Etas, Pango) and on the use and making of compost toilets (Tagabe Bridge, Blacksands).

Recommendations for awareness programmes included: clean-up programmes (Erakor Bridge, Pango, Seaside, Erakor Village) and pollution and proper waste disposal programmes (Tagabe Bridge, Blacksands, Seaside, Etas).

Based on the initial surveys, and then followed up through interactive discussions with each of the ten communities, a portfolio of potential pilot projects that addressed priority needs in each community has been put forward for consideration by the PEBACC initiative. As noted in the preceding text, these comprise a mix of actions, awareness-raising, training and capacity-building. These suggested pilot projects are now showcased (with details of possible support partners) in an aggregated table to illustrate the portfolio of EbA options that have identified desired actions to enhance the resilience of poorer communities in Greater Port Vila (Table 13).

Table 13: List of potential PEBACC pilot projects (as determined by communities)

Potential adaptation options	Support Organisation	BS	EB	EV	Et	FW	If	M	P	SS	TB
Actions											
Planting/reforestation projects (riparian, mangroves, coastal vegetation, firewood, pandanus, etc.)	Forestry, Lands, Environment, NGOs, Tagabe Water Board	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Collaborate with government and other agencies to get more community **water** tanks and/or WASH projects	Live & Learn, Tagabe Water Board, Dept of Water				✓						✓
Fundraise / apply for grant: community **firewood** access or land fund	Forestry, NGOs				✓						
Promotion of efficient cooking methods including stick/charcoal or rocket stoves and better **firewood** management	Forestry, NGOs		✓		✓	✓					✓
Partner with government to ensure **protection** of Erakor and Emten Lagoons/ sections of Mele Bay/ reefs along Pango shore	Chiefs, Fisheries, Tourism	✓	✓	✓				✓	✓	✓	
Investigate backyard **aquaculture** project suitability	Fisheries					✓					
Training in fish-farming techniques, deep-sea **fishing** and donation of materials and equipment	Fisheries, SPC								✓		
Capacity-building / awareness											
Awareness programmes for climate smart and/or **urban agricultural methods**	DARD		✓	✓	✓	✓			✓		
Awareness programmess for **washing and sanitation**	Chiefs, CSO, Gov, NGOs	✓			✓	✓		✓			✓
Training/skills development programme for community-based **tourism** and **livelihood** business opportunities	Tourism, CSO, Fisheries		✓	✓				✓	✓		

Training in better **agricultural** techniques and provision of seeds, etc.	DARD, Live & Learn, NGOs				✓	✓			✓		
Training in **composting**, 'humanure' toilets	Live & Learn, DARD, NGO	✓				✓					✓
Training / awareness programme for improved **pig management**, fencing and health	Dept of Livestock						✓	✓			
Awareness / community-based/ youth driven programmes for **coastal protection** and **fishing** catch & size limits	Chiefs, CSO, Fisheries, VESS	✓		✓					✓		
Training/skills development programmes on **climate change** and environmental protection and awareness	Gov, NGOs		✓				✓				
Institutional											
Review and/or discussions/joint-committee to tighten up **waste** disposal controls (factories) and **pollution** controls (port & shipping lanes)	Gov	✓					✓				✓
Form a community body to prioritise and monitor projects, review and promote **livelihood opportunities** and awareness programming	Chiefs, CSO, Gov, NGOs									✓	

Mainstreaming resilience objectives into policy and practice

The findings of the Greater Port Vila ESRAM exercise provide stark illustration of the importance of local ecosystems and the significant reliance of many ni-Vanuatu on the direct goods and services they provide in terms of subsistence, cash income, and cultural and social benefits. Each of these services contributes to the overall social resilience of urban and peri-urban communities (narratives for each individual community are detailed in the Appendix).

In addition to reducing the sensitivity of communities to climate-related shocks and stresses, ecosystem-based adaptation options can also help to reduce exposure to future risks, e.g. urban trees acting as flood defence, ameliorating urban heat, thus generating win-win situations. Maintaining the integrity of local ecosystems is therefore a critical component of strengthening the socio-economic resilience of Greater Port Vila residents.

However, the analysis has also documented the considerable socio-ecological challenges that face communities in the city, primarily a combination of population growth and urbanisation pressures (and resultant outcomes such as pollution) but also to a lesser extent climate-related impacts (though these risks will increase with future climate change). As was evidenced by this scoping phase, a swathe of 'ridge-to-reef' resources – from marine and coastal areas through to forests, bush and home gardens – are already being adversely affected and the integrity of these ecosystems will continue to be degraded without appropriate management interventions.

Critically, access to fresh water is already a pressing problem for some Port Vila communities (which became an acute concern for many during the recent El Niño period). In addition to increasing demands caused by a growing population, this is a resource 'supply' problem that will intensify yet further with the effects of a changing climate.

Local level partnerships

Working closely with ten vulnerable communities across Greater Port Vila the ESRAM has identified a list of priority ecosystem issues and potential resilience-building initiatives for consideration as pilot studies by the PEBACC programme. Although these are predominantly discrete projects to be implemented at the community level, it is recognised that new working partnerships will be needed to support the effective implementation of actions, as well as providing the necessary training and capacity building that communities have identified as being important to them. Named support organisations have been suggested previously in Table 13; however, integration with local and provincial government agendas is also desirable for the longer-term sustainability of community resilience actions.

Port Vila Municipal Council (PVMC) holds jurisdiction over the formal municipal area of the city, as legislated under the Municipalities Act, Cap. 126. The boundaries of this area are set out in the Port Vila Municipality (Composition of Council and Wards) Order 21 of 1980, originally setting out four wards with the city. This was amended on 20 May 2013, creating an additional 5th ward within the city with only minor adjustments of the overall municipal area.

Ward Councils were set up by the new Lord Mayor in July 2014, with the aim of providing local focal points for the community, comprising representatives from the Council of Chiefs, the Vanuatu National Women's Council, Church Groups, youth organisations and the Disabled Persons Association of Vanuatu. This new urban governance structure, which provides a valuable new 'bridge' between PVMC and local communities, holds considerable potential for supporting resource management initiatives in the Greater Port Vila area.

- *Malapoa-Tagabe ward* and its peri-urban extension represents the largest of the ward-provincial fringe groupings, including the extensive, well-established informal settlements centred upon the coastal plains of Blacksands, more recent urban subdivisions of Bladinieres Estate, as well as significant infrastructure, including the capital's international airport, heavy industry and extensive plantation and household garden areas. The much more heavily urbanised informal settlement of Fres Wind is also located at the ward's south-eastern edge.
- *Anabrou-Melcoffee ward* is encircled by adjacent municipal areas and as such does not include a peri-urban component, but rather falls entirely within the jurisdiction of PVMC and comprises predominantly residential housing.

- The *Greater Fresh Wota Tassiriki ward* includes the large peri-urban area of Teouma Road. Its geography is highly varied and heavily sloped, rising to more than 100 m above sea level at its most eastern extremity, while the entire suburb of Le Meridien has an average elevation of only 10 m. Non-residential land uses include agriculture at the north-eastern edge of the city, as well as forest throughout the peri-urban eastern fringe.
- *Central ward* encompasses Port Vila's central business district, including the waterfront and 24-hour markets, the Vila Central Hospital, and the bulk of the city's bureaucratic and diplomatic institutions. The area has a steep topography, with extensive critical infrastructure located along the wards western, coastal edge. The ward also includes the city's most densely populated informal settlements, Tongoa/Futuna and Seaside Paama, although some parts of these areas fall under formal lease arrangements.
- *South ward* is predominantly composed of formal residential tenure arrangements, with some industrial zones along the ward's coastline. The ward also includes the country's main port and only container port, which account for over 85% of the country's imports, and facilitate a significant share of tourism income through the cruise ship terminal. Although largely covered by forest, the peri-urban area of Nambatri West has also been included in this division.

Shefa Provincial Council governs the area of Efate Island outside the municipality of Port Vila, including the peri-urban areas. Land outside the city is governed under customary law by members of the *Malvatumauri* or the National Council of Chiefs (NCC) with any modifications to these *kastom* land uses and management regimes requiring compensation. As a result, proposals to expand the Port Vila municipal boundary to integrate peri-urban areas remain highly contested by stakeholders, with the differing governance systems acting as a barrier to cross-border provision of services and strategic planning for ongoing urbanisation (and hence also having implications for resource management initiatives).

Local and International non-government organisations also play an important role in community resilience actions in the city. For example, the Wan Smolbag Theatre Company provides education on sustainable use of resources and also provides waste collection services for the Blacksands Informal Settlement, while organisations such as ADRA and Save the Children provide youth support and educational services in various locales across Port Vila.

Despite the value of strengthened local partnerships, there is clearly institutional weakness and a lack of operational capacity at the local level, which affects policy-making in the city. In particular, the development of an effective – and enforced – land use plan for the growing city would be highly beneficial, particularly in seeking to protect high priority terrestrial and freshwater ecosystem areas (bushgardens, forests, sources of drinking water, etc.) from inappropriate urban development and activity. Two other areas that should be addressed by local action are a strengthened waste management policy for the city (hospital waste was identified as a particular concern, although, encouragingly discussions between an affected community with the hospital since their ESRAM workshop has led to a commitment to upgrade waste treatment before release into the lagoon environment) and a regulatory environment for sand mining that adheres to sustainable extraction and environmental protection guidelines.

Given that many of the identified threats to valued local ecosystems do not respect municipal boundaries, e.g. water catchments, there is also value (and opportunity) for cross-boundary initiatives that could be undertaken collaboratively by PVMC and Shefa Provincial Council. As noted previously, integrating 'western style' urban planning and management with customary practice outside the city boundaries will not be without its challenges but critical ecosystem issues are likely to intensify in peri-urban areas and will need to be addressed, as Greater Port Vila's population continues to grow rapidly. Indeed, more effective engagement and cooperation with traditional chief structures was a common narrative during the community workshop activity and could be more effectively harnessed for sustainable resource management purposes, such as the use of customary *tabu* in vulnerable marine and lagoon locations or in restricting the mining of sand.

As a consequence of urbanisation pressures, land tenure arrangements will also need to be part of considerations to ensure continued, equitable access to ecosystem goods and services.

Multi-level policy integration

Given capacity limitations at the local level, and the scale and complexity of socio-ecological issues affecting Greater Port Vila, actions to better manage ecosystems and strengthen community resilience will benefit immensely from being aligned with national and sectoral policies. Integration of socio-ecological resilience objectives with multiple government agencies and policy portfolios is needed (the national government already maintains oversight of both PVMC and Shefa Provincial Council, with reporting done to the Department of Local Authorities). Figure 20 emphasises the importance of government agencies and NGOs in 'environmental' networks (as well as the need to strengthen involvement with civil society and private sector groups).

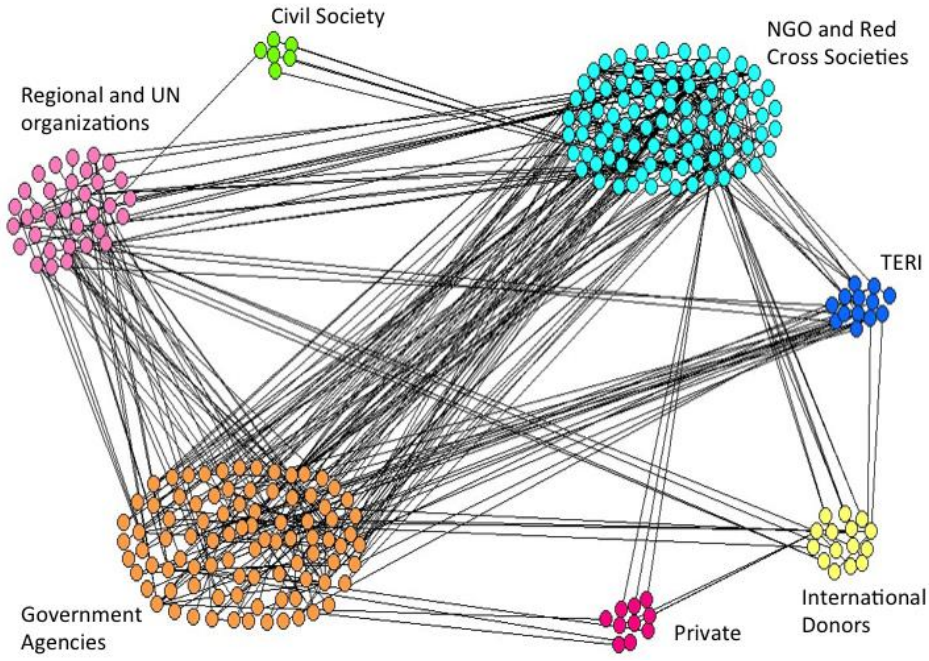

Figure 20: Interaction between different types of organisations (DDR and CCA)[14]

Although not restricted to those listed here, the main government agencies that should be engaged with include the Departments of Agriculture and Rural Development, Livestock, Forests, Fisheries and Biosecurity (integrated into one ministry).

Others agencies with closely aligned remits include the Ministry of Lands and Natural Resources (with responsibility for the National Water Strategy), the Ministry for Climate Change (and National Advisory Board on Climate Change and Disaster Risk Reduction), and the Department of Environmental Protection and Conservation.

Sectoral agencies, such as the Department of Tourism, can also have a valuable role to play in supporting activity that promotes ecosystem and socio-economic resilience.

With mainstreaming of ecological and socio-economic resilience in mind, eight overarching national policies are particularly noteworthy.

[14] Vachette A. (2015) The little handbook of disaster and climate change networked governance structure in Vanuatu. Centre for Disaster Studies of James Cook University and Vanuatu SPC/GIZ Coping with Climate Change in the Pacific Island Region program.

These include the *National Environment Policy* (draft 2013), the *National Water Strategy* (2008–2018), the *Forest Policy* (2013–2023) the *National Adaptation Programme for Action* (2007)*, the Climate Change and Disaster Risk Reduction Policy* (2016–2030), the *National Coastal Management Framework* (2010), the *Biodiversity Conservation Strategy* (1999), and the pending 15-year *National Sustainable Development Plan* (being prepared for endorsement). Each live policy / strategy is now summarised with the key components relating to the PEBACC programme highlighted.

The ***National Environment Policy*** notes that Vanuatu has a wide range of natural resources and that the use of these can contribute to raising incomes and creating employment, and that by focusing on green growth, development can be achieved without the loss of biodiversity and unsustainable use of natural resources. Green Growth (PO4) states that sustainable business opportunities exist and are growing (expand the productivity of key sectors to meet food security needs, avoid costly imports, and relieve harvest pressure from wild natural ecosystems), and planning for green growth should be integrated across sectors whilst striving towards balanced and sustainable development (PO5 – support and expand implementation of the Integrated Coastal Management Framework at all levels, especially provisions on coastal resource management and ecosystem services; and ensure that all government policies and frameworks outline their consideration of environmental needs, indigenous peoples' rights, land issues and resource rights).

Under the objective of conservation of biological, ecosystem, genetic, human and cultural diversity, (PO1) states that 'biodiversity management areas are locally established throughout the country and maintained and supported at the national and provincial levels'; (PO2): forest ecosystems are protected and play a significant cultural, social and environmental role; (PO3): endangered, threatened or endemic biodiversity and ecosystems are managed locally and maintained and supported at the national and provincial levels; and (PO5): traditional knowledge and practices related to biodiversity conservation are used and promoted and are of high research priority.

For sustainable resource management, policies include: tools and approaches that enable sustainable resource management are fully implemented and complied with (PO1); vulnerable watersheds, catchments and freshwater resources are well managed and protected (PO4); the fisheries sector develops in a sustainable manner that values the protection and conservation of finite marine and freshwater resources (PO7); and degradation and erosion of foreshore and coastal areas is minimal and rehabilitation is commonplace (PO8).

Addressing climate change emphasises that initiatives should be designed and implemented according to sound ecosystem-based adaptation approaches (PO1).

The ***National Water Strategy*** recognises that every 'citizen should have access to safe water sufficient to meet basic needs; including drinking, cooking and sanitation', but acknowledges that, as Vanuatu's population grows, so demands on existing water sources will increase, and when 'combined with the increasing risk of pollution and climate related changes could be expected to limit the future availability of potable water, constrain its productive use and impact negatively on Vanuatu's most precious resource, its pristine natural environment'.

The strategy adopts an integrated water resource management approach that requires improved collaboration with communities and other key stakeholders. An important operational element is said to be the devolution of responsibility, authority and resources for water resources management down to provincial government level, with community involvement in the planning, management, and monitoring of water catchment use also highlighted. Two important objectives, from a PEBACC perspective, are: objective 3: infrastructure operated and maintained by the communities with technical and management support from the Provincial Office, private sector partners and the department; and objective 4: available water resources and catchments known, managed and protected.

The ***National Forest Policy*** sets out policy directives for the management of Vanuatu's forests (and forest resources) over a ten-year period. As well as addressing sustainable forest management practice and conservation and environmental considerations, the policy also emphasises the need to incorporate climate change mitigation and adaptation challenges and opportunities. Two directives are of particular relevance for PEBACC. Firstly, one promotes small-holder farmer and community-based forestry, which obviously translates well into the peri-urban and urban settings of the ESRAM (stakeholders and communities actively participate in sustainable forest management and utilisation, and the forestry sector contributes increasingly and equitably to the welfare and livelihoods of

landowners, farmers, industry and communities). The second directive relates to awareness, training, capacity development, and research (forestry stakeholders are competent and qualified, the public is well-informed and educated on all forestry issues, and the forestry sector is well guided by collaborative research and abides by internationally recognised standards). These attributes directly relate to the PEBACC agenda.

The objective of the ***National Adaptation Programme for Action*** (2007) was to develop a national programme of project-based adaptation activities in priority sectors, informed by a comprehensive vulnerability assessment. The final list of projects was determined to be:

- agriculture and food security;
- water management policies / programmes;
- sustainable tourism;
- community-based marine resource management programmes; and
- sustainable forestry management.

The ***Climate Change and Disaster Risk Reduction Policy*** (2016–2030) recognises that there is a high level of reliance on natural resources for both livelihoods and food security, and also emphasises that this adds to climate vulnerability. In response, it promotes EbA to 'minimise the risks of climate change and disasters while also enhancing livelihoods', although it also stresses the need 'to build on and share existing traditional knowledge'. Findings from the ESRAM project can be used to inform a range of key actions that were put forward in this new policy, including:

- prioritising actions that incorporate threats and solutions from the 'ridge to reef'' of island communities;
- identifying and minimising negative impacts on the environment from proposed adaptation and risk reduction activities;
- prioritising actions that build on, incorporate and protect taboos, conservation areas, heritage sites, locally managed areas and vulnerable habitats and ecosystems and carbon sinks;
- quantifying the value and benefit of ecosystem services and building this into planning and budgeting;
- prioritising 'soft' ecosystem-based adaptation over 'hard' engineering infrastructure;
- developing advocacy and educational programmes around the value of ecosystem-based adaptation; and
- utilising sound land-use planning approaches, and implementing and enforcing ecosystem-related development policy documents, e.g. the land use planning policy, the foreshore development act and the physical planning act.

In order to promote 'cooperative integrated coastal management' the ***National Coastal Management Framework*** was introduced in 2010. It seeks to integrate the goals of multiple policies and enhance partnerships between different actors in order to protect the integrity of marine and coastal ecosystems and seek to balance ecological, biodiversity and livelihood goals. The specific objectives of the framework are to:

- maintain the functional integrity and health of coastal ecosystems and environments through maintenance of ecological balance, protection of biodiversity, preservation of resources and sustainable fisheries and livelihoods of communities;
- harmonise coastal management processes provided for by relevant legislation, strategies, policies and plans;
- enhance and strengthen collaboration of all actors, including government agencies, NGOs and communities, in the management process;
- ensure coastal ecosystem considerations are efficiently and adequately taken into consideration during all stages of development to minimise detrimental impacts on the coastal environment and achieve sustainability;
- facilitate the progress of sustainable multi-sectoral development;

- maintain aesthetic appeal of the coastal environment for the enjoyment of the population and for tourism development;
- preserve customary, cultural and traditional values; and
- facilitate climate change adaptation activities.

The Vanuatu ***Biodiversity Conservation Strategy*** considers terrestrial, freshwater, coastal and marine resources, and its mission statement focuses on managing and safeguarding resources, support for local actors to engage in sustainable management, ensuring equity of access to benefits, and protecting custom and the legal rights of ni-Vanuatu as custodians of resources.

The community-based mapping and analytical data that have been collated for the ESRAM project have established a useful evidence base for consideration by a variety of policy-makers in Port Vila, Shefa Province, and at the national level. The most obvious policies are listed above but, given the diversity of issues linked to different types of ecosystems, the findings will also be of broader relevance. Continued engagement through the extended PEBACC programme provides a valuable mechanism for promoting evidence-based policy that reflects the concerns of local communities amidst the multiple drivers of change that are impacting the ecosystems that they continue to rely on heavily.

PEBACC Stage 2

Although only an initial scoping study to inform the later stages of PEBACC, findings from the Greater Port Vila ESRAM analysis (informed directly by the local communities through participatory approaches) have put in place a valuable evidence base to inform future socio-ecological resilience actions and related capacity-building activity. The household surveys not only documented and mapped out key resources for each individual community but also identified the most important services that they relied on (provisioning benefits were of central importance). Subsequent community workshops then provided a 'space' to invoke community narratives on how they value and make use of ecosystem goods and services, eliciting detail on the contemporary pressures that are affecting the state of the local environment and the traditional management practices being employed (and knowledge that is needed to respond to new challenges). Finally, priority resilience actions (and associated training and awareness raising needs) that would be of most benefit to each local community were also documented.

Implementation of pilot studies

The approach that was undertaken for the Greater Port Vila ESRAM was intentionally bottom-up, designed to better understand ecological and socio-economic resilience through the experiences and perceptions of poor urban communities. For many in these communities, local ecosystems are not only important contributors to their cultural and social well-being but critically are also the main source of provisioning resources that support basic subsistence and livelihoods. It is therefore vitally important that the integrity of urban and peri-urban ecosystems is protected, wherever possible, against the adverse effects of population growth, urbanisation, and future climate change. The implementation of the PEBACC pilot studies will make a small but important contribution to this challenging agenda.

Although the focus of the ESRAM was on community-based issues and resilience actions, it is recognised that the implementation of pilot studies will benefit from additional support achieved through partnerships with the relevant local experts, whether this is through collaboration with government agencies such as the Forestry Department or seeking synergy with NGO programmes on the ground, e.g. existing WASH programmes by ADRA. Findings from both the ESRAM and the follow-up PEBACC pilot studies can provide valuable additional information for policy-makers, as well as local evidence for more informed decision-making. Close engagement with the policy and NGO communities, established by ESRAM activities, will benefit the PEBACC second phase of action.

In addition to greater synergies and integration with national policy agendas and NGO programmes, it is also important to recognise the significant role that international donors play in the context of Small

Island Developing States in the Pacific. In the context of Vanuatu, national government agencies operate in partnership with many donor and loan bodies, such as the World Bank, NZAID, JICA and Australian Aid, on significant infrastructure projects. Given the influence of donors on new development, it would be useful to explore PEBACC opportunities for engagement with the donor bodies, as well as ensuring that ecosystem and socio-economic resilience considerations are incorporated into the planning of future urban development.

As is common in many Pacific Island nations, an important stakeholder group often under-represented in local initiatives is the private sector. It is acknowledged that, although there was limited engagement with the private sector for this ESRAM scoping study (Ifira Wharf stevedores and the Vanuatu Environmental Science Society being the exceptions), there are opportunities for public – private partnerships that could be further explored during the implementation phase of the pilot studies. The most obvious potential partners include those from the tourism and forestry sectors.

Finally, although community resilience actions have been listed, these have not been subject to further prioritisation or ranking as part of the ESRAM, as pilot study decisions will be dependent on wider PEBACC objectives, desired balance between different landscapes and types of action, funding availability for each pilot study, potential for implementation of studies across multiple communities etc. However, new risk maps produced for urban preparedness in 2016, which cover all the ESRAM communities, may be one useful screening overlay in the prioritisation process.

Table 14. Risk map for surveyed communities[15]

Community	Coastal Inundation Risk (100 yr)	Tsunami Inundation Risk	River Flood Risk (50 yr)	Seismic / earthquake Risk (including landslips)	Wind Risk associated with Cyclone (100 yr)*
Blacksands	Very high	Very high	Very high	High	Moderate
Erakor Bridge	Moderate - very high	Moderate - Very high	No data	Moderate	Moderate
Erakor Village	Very low - moderate	Very High	No data	Moderate	High
Etas	No risk	No data	No data	Moderate - high	Moderate
Fres Wind	No risk	Moderate	No data	High	Moderate
Ifira	Moderate	Very High	No data	Moderate	High
Mele	Very high	Very High	Very High	High	High
Pango	Very low - moderate	Very High	No data	Moderate	High
Seaside	Very low - moderate	Very low - moderate	No data	Moderate	Moderate
Tagabe Bridge	No risk	Very High	Very High	High	Moderate

**Only coarse (national-level) projection was available*[16]

[15] Summarised from: Hazard and Risk Maps: Risk Mapping and Planning for Urban Preparedness (2016) Prepared for the Vanuatu Government by Beca International Consultants Ltd, GNS Science Ltd and the National Institute of Water and Atmospheric Research Ltd.

[16] Summarised from: Hazard and Risk Maps: Risk Mapping and Planning for Urban Preparedness (2016) Prepared for the Vanuatu Government by Beca International Consultants Ltd, GNS Science Ltd and the National Institute of Water and Atmospheric Research Ltd.

No Risk / No Potential Damage

Very Low Risk / Insignificant Potential Damage

Low Risk / Very Light to Light Potential Damage

Moderate Risk / Moderate Potential Damage

High Risk / Heavy Potential Damage

Very High Risk / Very Heavy Potential Damage

Metrics

Engagement with the local communities has resulted in a wealth of ecosystem goods and services data that can be used to develop qualitative metrics that will enable metrics for monitoring ecosystem services (and hence community resilience) over time. These indicators will also prove useful for informing policies and evaluating the effect of local practice.

Due to the limited time scale of the ESRAM project and substantive engagement with a number of different communities, the analysis has been necessarily broad. However, the implementation of discrete PEBACC pilot projects with individual communities provides a valuable opportunity to undertake more detailed assessments of ecosystem services in order to illustrate the multiple benefits that derive from each of the pilot studies, e.g. fast growing trees for firewood or planting trees to prevent coastal erosion will have a range of other provisioning, regulating, supporting and cultural benefits. In the context of Port Vila, ensuring that resources continue to meet basic needs is critically important and ideally should form part of any family of indicators that attempt to measure provisioning services. Results from the ESRAM study indicate that access to fresh water, firewood, food (crops and fisheries) for subsistence, and forest products for housing construction, are all essential needs, which could be addressed through a mix of policy (land use planning to protect the most critical ecosystem areas), customary law (the use of local *tabu*), education (improving resource management skills), and community-based adaptation (e.g. the use of buffer gardens to protect against encroachment into critical water source areas).

Pilot projects that involve cash crops from gardens and forests, manufactured goods that produce economic returns, traditional wealth or livelihood options, would all be amenable to some level of quantification for provisioning services. Given the local context, spiritual and cultural well-being, and recreation and tourism, are all important 'non-use' factors to be accounted for.

In the context of PEBACC, concentrating on identifying the regulating benefits that are expressed at the local level – establishing measures and monitoring of soil erosion, flood protection, water quality, micro-climate, etc. – would appear a useful starting point before considering the more complex supporting services.

In terms of capacity building, a simple indicator relating to the number of people trained (including gender and whether they are youth) would also be a valuable metric to account for training and capacity building, whether this is for urban agricultural techniques, animal husbandry, or new fishing skills. Aligned with the training could be a questionnaire developed that accounts for its effects on selected individuals' understanding of the different services over the course of PEBACC compared to those who do not receive training. It could also be useful to establish whether the six key drivers of change in relation to the ecosystem resources and services are improving or worsening within the study communities.

Although a longer-term effort and perhaps broader than the PEBACC programem, it would also be valuable to local resilience efforts to develop a framework of indicators that account for the pressures on the local environment, identified in the ESRAM as urban development, pollution, access to clean water, overharvesting and poor management practice, sand mining, and climate-related impacts.

Project sustainability

Given the wealth of information that the ESRAM scoping study has compiled for each of the communities, it is hoped that this will prove a useful knowledge base, which can be combined with local knowledge and practice in Greater Port Vila, beyond only informing the PEBACC pilot studies. As has already occurred post the field-work activity, the empowerment of local communities with new knowledge can result in self-driven resilience actions (not only promoting changes such as new waste

treatment at the hospital but also the basis for a reconciliation ceremony between one community and the Municipal Council.

In support of local agendas, key findings from this ESRAM study will also be integrated into the UN-Habitat Urban Resilience and Climate Adaptation Plan (to be published in 2017) to ensure a more cohesive and integrated approach to strengthening the resilience of communities in Greater Port Vila. There are also likely to be other synergistic opportunities – e.g. promoting the role of ecosystems in DRR planning – that will enhance the long-term sustainability of PEBACC objectives.

Appendix: Community ESRAM Reports

Blacksands

Community narrative

Blacksands is a rapidly developing informal settlement area that is at the mouth of the Tagabe River. It is under the jurisdiction of the Tanvasoko Area Council of Shefa Province and much of the land is owned by Ifira families. From the survey the median number of people in a household is five and the median length of time living in the household is relatively low at nine years. The priority ecosystem issues were considered to be: marine / coastal, firewood and materials, and fresh water.

A wide range of marine resources is collected primarily at Blacksands, Malapoa Point, Eratap, Ifira Island, and North Efate. Residents fish every day at all times so there is continuous pressure on fish stocks. Fish is for both subsistence and for sale, with a significant amount being sold (likely higher than 18%). Methods used include fishing lines, spear guns, nets, and canoes for transport. Deep-sea fishing is carried out off-shore using long lines.

The percentage of sand collected by Blacksands residents is relatively low, however, the beach is the primary location in the Port Vila region for collecting and extracting sand for making cement for new block building construction.

Water – including ground, river, and rain water – for drinking, cooking, and washing is the most important freshwater resource used. Because of the lack of water tanks, many households use creative (but ineffective) methods to collect rainwater, including iceboxes and old bathtubs. The Tagabe River and rivers at Mele, Prima and Teouma are also popular for their recreational services provided.

There are 25% of households with no garden, 45% with a home garden, and 32% with a bush garden away from the home, located in the forested areas at Blacksands, Prima and Bladinier, and further afield at Club Hippique and Teouma. Home gardens are more common, larger in size and closer to the coast where the land is owned by the household, but get smaller or non-existent in the areas further inland (e.g. Sorovango). Manioc, pawpaw and banana are cultivated in nearly every garden. The areas with bush gardens are typically also where firewood, fruit and nuts, medicine, bamboo and leaves for mats and traditional cooking are collected.

The percentage of households that collect fruit and nuts is 81%, with mango, avocado and grapefruit being the most important. Many of these trees are still recovering from TC Pam damage. Plant medicine is fairly common and is both cultivated and wild. The species used and the method of preparation, cultivation, and propagation, depend on the island of origin and family traditions. Animals are raised for subsistence food and for ceremony, with about a third of the households raising chickens and a quarter raising pigs.

Survey results

Main ecosystem resources harvested/collected/used (% of households)

Traditional wealth items (63%)	Forest (96%)	Marine/coastal (86%)	Freshwater resources (50%)	Livelihood items (40%)
Chickens (33%) Pigs (23%) Yams (18%) Mats (13%) Sugar cane (10%) Kava (7%) Sandalwood (yes)	Firewood (81%) Fruit & Nuts (51%) Medicine (31%) Bamboo (18%) Coconut (16%) Natangura (9%) Pandanus (8%) Wild nuts (4%) Timber (2%)	Fish (45%) Shellfish (24%) Sand (23%) Dead coral (4%) Crabs (3%) Trochus (1%) Octopus (yes) Scallops (yes)	Water: ground (16%), rain (15%), river (11%) Fish & prawns (7%) Eels (yes)	Mats/ baskets/ handicrafts (22%) Cash crops including 20 Vt sale (21%) Pig tusks (1%) Carving & woodwork (1%)

Main species harvested (% of households)

Garden crops (96%)	Fruits & nuts (60%)	Fish & other (45%)
Manioc, *kumala*, banana, island cabbage, taro, corn, beans	Mango, avocado, *naus*, *nakavika*, *nakatambol*, *namambe*, pawpaw, nuts, grapefruit, guava, orange, mandarin, noni	reef fish, mangro, parrotfish, rainbow fish, moustache fish (goatfish), strong skin, blue fish, black fish, sardines, octopus, lobsters, oysters, scallops

Ecosystem services identified (% of households)

Provisioning (83%)	Regulating (68%)	Supporting (79%)	Cultural (89%)
Fuel (81%) Food subsistence (61%) Medicine (31%) Raw materials (22%) Food cash crops (18%) Water (yes) Ornamental (yes)	Good soils (49%) Pest & disease regulation (33%) Water purification & treatment (21%) Climate regulation (9%) Erosion prevention, soil regulation (yes)	Biodiversity/habitat (41%) Pollination (28%) Soil fertility (17%)	Recreation/tourism (79%) Spiritual/religious values & ceremony (45%)

Workshop findings

Resource	**Pressure**
Marine / coastal	▪ Excess nutrients are causing bacterial growth, algal blooms, and increased sediment from run-off. ▪ Dead coral and bleached reefs. ▪ Overharvesting has decreased the number and size of fish. ▪ Pollution from the Tagabe River has degraded the coastal marine habitat and water quality ▪ Crab numbers have diminished because the beach habitat is being degraded and destroyed through sand mining and destruction of coastal vegetation. ▪ TC Pam hotspot, informal settlement development right down to the beach, and over-harvesting of forest materials has caused erosion and increased exposure to hazards. ▪ Concern about waste from new fish processing plant.
Firewood and materials	▪ Firewood is essential to daily activity for cooking and for ceremonies, but the amount and quality of firewood and materials like natungura and pandanus has reduced significantly due to new development. ▪ Many households now have to buy their firewood, which is an expense that can be difficult to afford.
Fresh water	▪ Pollution levels are high in the Tagabe River with plastic and human waste from upstream settlements, dumping, riverside toilets, and washing. Other sources include the Tusker factory in Tagabe and run-off from the airport. ▪ Cooking water is still collected from the river, when other options are limited. ▪ Water levels are lower and slower than before. ▪ Flooding is common during storm events and often destroys crops growing in gardens close to the rivers. ▪ Swimming used to be popular but recreational experience has deteriorated rapidly in the past couple of years.

	▪ Waste from an abattoir is going into Prima River causing pollution / health concerns.

Potential community-based adaptation responses

- Plant more trees in coastal areas (especially mangroves and pandanus).
- Awareness programme focused on climate change; also long-term repercussions of small-sized fish catch.
- Ifira chief to protect the marine area between Blacksands and Mele and declare it a no-fishing zone.
- Find new ways to cook food with less material and expense – i.e. solar cooker, deeper pits, etc.
- Replant / reforest along coast and in gardens. Good quality firewood trees include kasis and orange.
- Plant bamboo along the river to reduce flooding.
- Build proper sanitation facilities away from the river (additional WASH projects).
- Awareness programme about washing in watercourse and proper sanitation.
- Investigate ground water as increased alternate water source.
- Ensure proper waste disposal at all factories.
- Discourage migration through youth-oriented programmes on home islands or through government-sponsored relocation programmes.
- Increased accountability from government for resource management and recognition for local *tabu.*

Erakor Bridge

Community narrative

The Erakor Bridge community, located adjacent to the channel linking the Emten and Erakor Lagoons, has 50–75% customary land ownership (2009 Census). However there is also an increasing level of pressure on local resources as the rate of informal settlement increases (30% of households surveyed had moved to Erakor Bridge in the last five years). Their priority ecosystem issues were marine, pandanus / gardens, and firewood.

Erakor Bridge community relies predominantly on marine resources for their well-being. Households living adjacent to the lagoon often plant mangroves on their private land and benefit from their regulatory services, such as flood protection. As the majority of coastal areas around Emten Lagoon have been sold off to investors and are closed off, residents go outside the area for recreation, e.g. Blacksands, Mele, and Whitesands. Shells from shellfish are used as decorations around the house, as well as for other domestic purposes. There has been decreasing species diversity observed in the past decade: dugongs (sea-cows) swim up to Erakor Bridge, but there is now only about one sighting per year. However, there is an abundance of horned sea star (*Protoreaster nodosus*) and bêche-de-mer in the lagoon, which is harvested and sold to Asian markets.

Most fishing is carried out using lines (including bamboo lines), nets and diving. At the bridge, sardines are mainly caught using mosquito nets. Cockles are picked from sandbars by women and children. Crab season is the hot season (March) when crabs come out of the sand and can easily be gathered. Some of the households surveyed mentioned that there was a source of fresh ground water that directly seeps into the lagoon, creating a brackish environment where a number of shellfish thrived. Some households create local *tabu* areas to protect the lagoon adjacent to their land by putting up a *namele* leaf. Residents are aware of the provisioning, regulatory and supporting services of mangroves, and some have been replanting mangroves for generations. They also make efforts to feed endemic fish with an assortment of household leftovers including rice, bread, pawpaw leaves, and other food scraps.

Nearly half of the households use freshwater resources, including water for drinking and cooking from underground wells (31%) and by harvesting rainwater (5%) with containers and tanks. Apparently the groundwater is not safe to drink. Prawns are harvested from rivers and plant material that is collected includes watercress and water taro.

Erakor Bridge is generally a very lush area and many homes have backyards with well looked-after gardens (71% from the survey). However, housing is variable and there are a number of informal and more higher-density rental homes, which may account for the 19% of households with no garden. Sixty-two-percent of the households surveyed have bush gardens at Erakor Bridge and Erakor Half Road. Club Hippique and Teouma are also frequented for bush gardens and collection of forest resources. Despite 50% of the households having both gardens, and 97% using ecosystems for subsistence food, most residents still partly supplement their food needs by purchasing from markets.

Banana, manioc, island cabbage, taro, sugarcane and kumala are the most common crops cultivated, but corn and other non-traditional vegetable crops are also grown. There are also 7% of households who grow kava in their bush gardens, which has been troubled by the effects of the recent El Niño and diseases (also a problem for cabbage).

The land at Erakor Bridge is very low-lying and flat, and flooding has destroyed garden crops and continues to be a threat. Korman is a key nearby area for both bush gardens and firewood, but it is due to be cleared and developed into a stadium complex for the 2017 Pacific Games. Additional areas visited more specifically for firewood are Tassiriki and Montmartre.

The percentage of households that collect fruit and nuts is 59% with naus (*Spondees dulcis*), avocado, mango, navel (*Barringtonia edulis*), orange, and grapefruit being the most common. TC Pam damage to fruit trees, pandanus, natangura, coconut palms and mangroves was extensive and recovery is ongoing. All the same, there are a number of ecosystem services still providing benefits, including provision of fuel (91%), recreation (90%), biodiversity and habitat (64%), good soil fertility (57%, partly due to some knowledge of mulching and composting methods), and erosion prevention and flood protection, particularly where mangroves are still intact. A fifth of the households use, and benefit from, natural medicines, e.g. pawpaw seeds for malaria prevention. Households that own their land raise animals, including 43% of households with chicken and 33% with pigs, for subsistence

food, for ceremony and occasionally for cash sales. Other cash crops include 20 Vatu food parcels, fish, manioc, pawpaw, kumala, coconut oil, herbal medicines and nuts from navel trees.

Survey findings

Main ecosystem resources harvested/collected/used (% of households)

Traditional wealth items (66%)	Forest (100%)	Marine/coastal (95%)	Freshwater resources (48%)	Livelihood items (43%)
Chickens (43%) Pigs (33%) Yams (19%) Sugarcane (17%) Mats (12%) Kava (7%)	Firewood (90%) Fruit & Nuts (59%) Coconut (38%) Medicine (19%) Natangura (17%) Pandanus (17%) Timber (12%) Bamboo (7%)	Fish (81%) Shellfish (69%) Crabs (28%) Sand (2%) Dead coral (2%) Green snail (2%)	Water (38%) Fish/crustaceans (7%) Plant material (7%)	Mats/Baskets (29%) Cash crops (28%) Home-based manufacturing (2%)

Main species harvested (% of households)

Garden crops (81%)	Fruits & nuts (59%)	Marine Fish (81%)
Banana (36%), manioc (30%), island cabbage (25%), taro (18%), kumala (14%), yams, sugarcane, corn, pumpkin, tomato, pineapple, onion (1%)	*Naus* (22%), avocado (17%), mango (14%), pawpaw, navel, orange, grapefruit, namambe, wild nuts, *nandao*, *natapoa*, passion fruit, guava, lychee, *nakatambol*, lemon, mandarin, breadfruit, *samblong*	*Pico* (rabbitfish), mullet, *moustasfish* (goatfish), *karong*, *whitefish*, *sonnee*, sardines, *redmouth*, crabs, *kokias* (scallops)

Ecosystem services identified (% of households)

Provisioning (100%)	Regulating (66%)	Supporting (74%)	Cultural (93%)
Food subsistence (97%) Fuel (91%) Water (40%) Raw materials (31%) Food cash crops (28%) Medicine (21%)	Erosion prevention, soil regulation (33%) Climate regulation (33%) Air quality regulation (26%) Pest & disease regulation (26%) Regulation of water flows (14%) Water purification (10%) Flood protection (3%)	Biodiversity/habitat (64%) Soil fertility (57%) Nutrient cycling (22%) Soil & biomass formation (19%)	Recreation/tourism (90%) Spiritual/religious (43%) Cultural diversity/ Inspiration (7%) Aesthetic value (5%) Knowledge/education (3%)

Workshop findings

Resource	**Pressure**
Marine	▪ There has been a noted decrease in the number of fish and shellfish caught due to overharvesting, especially crabs. Use of mosquito nets results in a high level of by-catch. ▪ Fish kills due to high sea temperatures during the El Niño in February 2016. ▪ Sea-level rise has been observed over the last decade. ▪ Coastal development by foreign investors has destroyed mangroves and palm trees that were habitats for crabs. ▪ The lagoon is polluted with tins and plastic and is subject to declining water quality.

	▪ A *tabu* was declared over Erakor Bridge area by the Paramount Chief of Erakor Village, with the *tabu* zone expected to be extended to the entire Emten and Erakor lagoons for the next 5 years. Alternative livelihoods are needed for those reliant on goods from the lagoon.
Pandanus / gardens	▪ Over-harvesting and development pressures have diminished availability of wild pandanus growing on the coast. There was also a loss of this resource due to the impact of TC Pam. ▪ Leaf materials from pandanus (also natangura, coconut leaves and bamboo) are used to weave mats and handicrafts, but there is a lack of skills in weaving (although there is interest in training in pandanus management and weaving skills).
Firewood	▪ Firewood is central to family life and essential for ceremonies and special occasions and is the preferred method for cooking food. However, development pressure and private land sales have restricted access to bush land and reduced the availability of firewood materials. Many households are now purchasing it at the market. ▪ There is also concern that if firewood is not available, then live trees sometimes have to be cut down and made into charcoal. ▪ Sometimes rubbish is burned with the last of the embers after cooking because it is often composed of mixed waste (plastics, plant debris from cleaning around the gardens, etc.) and municipal waste bags are considered expensive.
Potential community-based adaptation responses	
Marine ▪ Replant mangroves and pandanus around the lagoon ▪ Raise awareness on coastal / mangrove rehabilitation ▪ Opportunity to use the shells to make ornaments Materials / pandanus ▪ Replant pandanus around the lagoon and in gardens ▪ Boost livelihood opportunities to make handicrafts, and train in weaving skills ▪ Increase awareness on coastal vegetation conservation and pandanus management Firewood: ▪ Replant, particularly the best tree species for firewood ▪ Awareness raising to conserve bush areas and manage forest to ensure adequate firewood supplies ▪ Discuss with Chiefs to find a new location for collection after Korman area is cleared ▪ Use alternative, more efficient stoves to reduce the amount of firewood material ▪ Community training on seeding, planting, and firewood lot management	

Erakor Village

Community narrative

Erakor Village residents are *man-Efate* (originally from Efate), most of whom (50–75%) claim to hold customary land tenure over the area (2009 census). Erakor Village is under the jurisdiction of Erakor Area Council of Shefa Province. Population growth in Erakor Village is not as rapid as other communities surveyed, with only 3% of households having moved into the region in the last five years. Workshop participants included 36 school children (ages approximately 13–14) and four adult teachers, so the workshop format was altered. The priority ecosystem issues were: marine / coastal, gardens, and handicrafts and raw materials.

Erakor Village has a long coastline with extensive reefs and seagrass meadows that are habitats for dugongs and sea turtles. Dugongs have been sighted near Erakor Island, at the mouth of Erakor lagoon. The majority of Erakor Village households (97%) harvest marine resources, mainly for subsistence, as well as for raw materials and ornamental purposes. Residents are skilled in fishing and undertake this activity at an early age. The majority of the children from the workshop go fishing or collect fish (100%), shellfish (81%), crabs (81%) and occasionally green snails (22%), and they have good knowledge of the different species e.g. pico, redmouth, mustache fish. There was a trial project last year to harvest sea cucumber and sell to the Chinese market. Most fishing is carried out nearby on reefs around Erakor Village, Eratap and Erakor Lagoon.

Shells are also used for decoration, necklaces, buttons, as spoons and to scale fish. Dead coral is used like gravel around the entries and courtyards of the houses, with some thick layers observed at some households (depends on the means of that household to collect the coral). Coral is collected all along the Erakor peninsula and at the south end of Erakor Island.

There are no rivers in Erakor village, and the main freshwater areas visited are Eton (North Efate), Randabau, Teouma Bridge and Mele. Workshop participants say 100% of their households go to freshwater areas for picnics and swimming, with the locations Blue Lagoon, and Mele cascades highlighted; 31% also sometimes catch prawns and eels at these locations. Socio-economic analysis of the 2009 census data suggests that up to 50% of households drink rainwater, but this was not reflected in the survey results, nor were many rainwater tanks observed during the survey.

Erakor is a garden village with almost all households surveyed having bush gardens (96%), 75% have gardens adjacent to their homes, whilst 72% have both. A quarter of those interviewed identified agriculture, gardening, subsistence farming or seasonal work in Australia and New Zealand, as the primary household livelihood and 42% of the households grow crops to sell. Local food crops (for example manioc, kumala, island cabbage) and fish are sold at the road market as '20 Vatu Food', and flowers are also grown and sold by 8% of households. Most of the bush gardens are located on Erakor peninsula near the village, but some are also at Teouma, Erakor Half-Road, Erakor Whiteground and Eratap.

Almost all Erakor Village households surveyed (91%) possess traditional items of wealth, including yams and sugarcane, which are grown in gardens. Animals (pigs – 46% of households, chickens – 36%, were represented in the survey, but workshop results suggest this may be higher) are mostly reared for food for the household, although pigs are also occasionally sold. Usually only one pig is reared at a time and they are kept in a cage so they do not eat or destroy the gardens.

Forest resources are integral to the well-being and functioning of all households surveyed: for food (many mature fruit and nut trees grow in backyards and in the bush, including cultivated species like mango, avocado, orange and grapefruit and a diversity of local species such as *naus (Spondees dulcis)*, navel (*Barringtonia edulis)*, *nakavikal samblong (Syzygium malaccense)*, *nakatambol (Dracontomelon vitiense)*, *nandau* (*Pometia pinnata)*, and *nangai* (*Canarium harvey*); for fuel (most members of the family are involved in collecting firewood, primarily from the bush, which can be more than15 minutes' walk away); for medicine (e.g. noni *Morinda citrifolia* roots – for toothache, pawpaw leaves - for cuts & boils, lemon - for flu, Banyan tree roots - are bone healers); for ornamental, ceremonial and livelihood (mats, baskets and handicrafts made from natangura, coconut and pandanus leaves); and for building materials and manufacturing (various timbers and bamboo, which is mostly wild rather than grown at home).

A few houses within the village have a few larger specimens of the highly useful and medicinal plant Morninga *Moringa oleifera*, but residents have to ask for permission to harvest it. There is someone nearby who grows and sells these seedlings.

Survey results

Main ecosystem resources harvested/collected/used (% of households interviewed)

Traditional wealth items (91%)	Forest (100%)	Marine/coastal (97%)	Freshwater resources (36%)	Livelihood items (61%)
Yams (68%) Sugarcane (47%) Pigs (46%) Chickens (36%) Mats (29%) Kava (3%)	Fruit & Nuts (99%) Firewood (89%) Coconut (88%) Natungura (63%) Medicine (55%) Bamboo (53%) Pandanus (49%) Timber (43%)	Fish (91%) Sand (76%) Dead coral (76%) Shellfish (67%) Crabs (58%) Green snail (22%) Trochus (9%) Turtles (8%)	Water (7%) Fish, crustaceans (4%) Plant material (1%) Rock & non-living material (1%)	Cash crops (42%) Mats, baskets (21%) Home-based manufacturing (5%) Cattle/Livestock (3%)

Main species harvested (% of households)

Garden crops (100%)	Fruits & nuts (99%)	Fish and other marine (91%)
Banana, manioc, island cabbage, sugarcane, taro, kumala, yams, pumpkin, corn, leaf laplap, vegetables, flowers	Orange, avocado, mango, *naus*, grapefruit, breadfruit, guava, pawpaw, *navel*, mandarin, passionfruit, starfruit, pineapple, *nakavika/ samblong, nakatambol*, lychee, *nangai, nandau*	*Mangru* (spotted scat), *pico* (rabbitfish), sardines, *mustasfish*, *glisfish*, parrotfish, reef fish, *karong*, *mallet* (mullet), *redmouth*, strongfish, biglips, bluefish, starfish, sawfish, octopus, hermit crab

Ecosystem services identified (% of households)

Provisioning (100%)	Regulating (99%)	Supporting (100%)	Cultural (97%)
Food subsistence (100%) Fuel (84%) Medicine (59%) Water (49%) Raw materials (49%) Food cash crops (42%) Ornamental (12%) Fodder (1%)	Pest & disease regulation (78%) Air quality regulation (62%) Water purification (39%) Erosion prevention, soil regulation (33%) Flood protection (26%) Climate regulation (21%) Regulation of water flows (18%)	Soil fertility (84%) Biodiversity/habitat (83%) Pollination (78%) Nutrient cycling (53%) Soil & biomass formation (26%)	Spiritual/religious (91%) Recreation/tourism (49%) Cultural diversity/ Inspiration (33%) Knowledge/education (26%) Aesthetic value (24%)

Workshop findings

Resource	**Pressure**
Marine / coastal	▪ Marine pollution is a major problem, with oil spills reported on the southern end of the Erakor peninsula, and a lot of garbage (tins and plastic) accumulating at the entrance to Erakor lagoon. ▪ Water quality in the lagoon has been further degraded by semi-treated hospital waste released into the lagoon, causing harmful algal growth. As a result, there has been a decline in sea grass, fish and other marine species.

	▪ Fish are getting smaller in size. Also, anomalously high sea temperatures during the El Niño in February 2016 caused fish kills. ▪ There is a plan to declare the entire Erakor lagoon a *tabu* area for fishing in order to allow recovery of fish stocks.
Gardens	▪ There were contrasting observations of changes in gardens since TC Pam: some report richer soils and better harvest, while others say that crops are not growing as well and that the soil is poorer. Yams have been particularly affected with poor harvests after TC Pam. Some had no harvests during the 2015/16 El Niño because it was too hot / dry. ▪ There are recurring problems with snails and disease, damaging cabbage and vegetables. ▪ Most households have substantial lawns, which they mow and burn the grass. These clippings or mulch are rarely used for holding soil moisture and nutrients in and around cultivated crop beds.
Handicrafts	▪ About 20% of the households surveyed were actively involved in making handicrafts from locally sourced materials. ▪ There was a local project that made handicrafts for sale to tourists, but this was mismanaged. There is a lack of tourism activities in the village. ▪ According to the young workshop participants, more than half are already involved in collecting timber (for building, carving and canoe making), natangura leaves (assisting with building traditional natangura thatching for homes), and coconut and pandanus leaves (for weaving mats / baskets – which is a skill they do not have but would like to learn).
Potential community-based adaptation responses	
▪ The Erakor Village Chief plans to extend the marine protected area from Erakor Bridge to the entire Erakor and Emten (Nambatu) lagoons and declare it a no-fishing zone. This presents an opportunity for a coastal rehabilitation project involving mangrove replantation and waste clean-up along the lagoon to complement these conservation efforts. ▪ Other opportunities include: an educational programme promoting climate smart agricultural techniques and best practice management of forest materials; and a project focused on alternative livelihoods through harnessing local materials to make handicrafts for tourists (revive the programme that was mismanaged).	

Etas

Community narrative

Etas is a dispersed semi-rural community in the farming valley of the Teouma catchment and is under the jurisdiction of Eratap Area Council of Shefa Province (the municipality landfill/dump site is located at the north end of Etas). There are 16 zones in Etas, populated by people from different islands who have been living there for on average nine years (the lowest in this study). The Etas community is a transient population that continues to grow with the migration of islanders to the capital city and people look for alternatives that still give them proximal access to the capital's amenities. The ecosystem issues were fresh water, firewood, and gardens.

Etas residents do not generally own the land they are on (gardens or houses), although this is dependent on the zone lived in. Whether they have bush gardens and crops to grow, and access to water sources and forested land for firewood collection, also depends on the zone the resident lives in. For example, people in Zones 1–3 do not have much space and typically have one garden (as opposed to both a bush and backyard garden). Zones 4, 6, 7, 12 and13 have more space, are more likely to own land within Etas for a bush garden and to grow kava (which needs a lot of space). According to the survey, overall, 75% of households have backyard gardens, 67% have bush gardens and 48% have both. The zone dependency also affects the use of and access to traditional items of wealth; more than half of all Etas households (62%) raise chickens or grow sugarcane (52%), and about a third possess pigs, mats and yams.

A majority (84%) of households collect fruit and nuts, either from within their gardens or on land they have permission to collect from. Despite being surrounded by bush, many residents do not have access to the resources in these ecosystems because the land has been cleared for development or is often owned by absent or expatriate private landowners (particularly near the Teouma River). Despite this, nearly 100% of households depend on ecosystems for some level of subsistence food, and more than half make some cash income from it.

The flood protection, air quality and micro-climate regulation services of the trees and forested areas is high in the zones further away from the dumpsite, but concerns about pollution (and the associated smells, flies and disease), and contamination of the soils and water sources is high for residents in Zones 9–12.

The workshop indicated that all households use freshwater resources (not the 87% that was recorded by the survey). Teouma Bridge/River is the main water source for Zones 1 – 3 (those closer to the main road) and they also have gardens near the river. For zones further up nearer to the dumpsite, Etas Springs is the main water source; this is used for cooking and drinking. Rainwater is collected, mainly in community tanks and some makeshift containers (in some places a hole is dug in the ground and covered with tarpaulin to collect rainwater). They use containers that have limited capacity and frequently run out of water. Water shortage was considered critical during the most recent El Niño. Rainwater is mainly used for cooking and drinking. River water is used for everything else including washing. Zone 12–15 households eat prawns (*naura*) from the river.

Less than 20% of residents go fishing and use resources from the sea (not the 78% that was quoted from the survey results, but more than 20% go to the coast for swimming and recreation). Fish and shellfish are purchased at the markets, but when fishing does occur, reef fish and pico are caught. Locations for fishing and recreation include: Shark Bay, Tamanu Beach, Whitesands, Banana Bay, Malapoa Point, and Ifira Point.

All of the households were accessing ecosystem services in all four categories: provisioning, such as fuel and food; supporting such as species diversity and pollination; regulating such as moderation of micro-climates; and cultural, including recreation and ceremony.

Survey results

Main ecosystem resources harvested/collected/used (% of households interviewed)

Traditional wealth items (77%)	Forest (100%)	Marine/coastal (approx 25%)	Freshwater resources (87%)	Livelihood items (50%)
Chickens (62%) Sugar cane (52%) Pigs (37%) Mats (37%) Yams (34%) Kava (18%)	Firewood (94%) Fruit & Nuts (84%) Coconut (78%) Medicine (59%) Natangura (56%) Pandanas (44%) Bamboo (38%) Timber (35%)	Fish (62% - less) Shellfish (44%) Crabs (28%) Sand (24%) Swimming (20%) Dead coral (12%) Green snail (7%) Trochus (4%)	Water (60% - higher) Swimming & washing (51%) Fish & prawns (31%) Plant material (26%) Rock & non-living material (3%)	Mats/Baskets/handi-crafts (29%) Cash crops (19%) Home-based manufacturing (5%) 20 Vt sale (3%) Carving (1%)

Main species harvested (% of households)

Garden crops (96%)	Fruits & nuts (84%)	Marine fish
Manioc, kumala, island cabbage, banana, taro, vegetable, sugarcane, yam, corn, beans, pawpaw, pineapple, cucumber, onion	Naus, pawpaw, grapefruit, mango, avocado, mandarin, orange, navel, nandau, lemon, passionfruit, *nakatambol*, *natapau*	Reef fish, pico, red mouth, redfish, *karong*, poulet, bluefish, *naura* (freshwater prawn)

Ecosystem services identified (% of households)

Provisioning (100%)	Regulating (95%)	Supporting (100%)	Cultural (96%)
Food subsistence (91%) Fuel (85%) Water (77%) Medicine (67%) Raw materials (46%) Food cash crops (38%) Ornamental (6%)	Pest & disease regulation (94%) Erosion prevention, soil regulation (45%) Flood protection (38%) Climate regulation (29%) Air quality regulation (26%) Water purification & treatment (21%) Regulation of water flows (4%)	Pollination (97%) Biodiversity/habitat (86%) Nutrient cycling (58%) Soil fertility (51%) Soil & biomass formation (14%)	Spiritual/religious values & ceremony (95%) Cultural diversity & art (14%) Aesthetic value (13%) Knowledge/education (13%) Recreation/tourism (10%)

Workshop findings

Resource	**Pressure**
Fresh water	▪ The Teouma River at Teouma Bridge and Etas Springs are the two main water sources (primarily for drinking and cooking). It is also commonly used for washing during drought. ▪ All households rely on rainwater and collect it in smaller containers or by digging holes in the ground and creating a vessel with plastic sheets. ▪ There are a limited number of community water tanks. There are no community rainwater tanks in several zones, with others having water tanks but they are not enough to supply the community and supply usually runs out 2–3 days after heavy rain. ▪ Also, due to distances involved, there is hardship in collecting water from the rivers (often done by women). The water quality at the springs is still good, but deteriorating conditions along certain parts of the river have become apparent. ▪ Run-off from the dumpsite pollutes the river, making it smell. Water colour changes and may be causing algal growth. Reports of skin rashes and other water-borne diseases. ▪ Other threats include: pollution from the dumpsite, where septic waste is also dumped; a decrease in the number of prawns due to overharvesting; falling water levels as streams

	and creeks running into the river are drying out; and increased flooding after heavy rain.
Firewood	▪ Firewood is essential to daily activity for cooking; however availability, quality, and access are limited. ▪ Many households are either purchasing wood or have to go a long way to collect it. They sometimes collect firewood illegally from private land, or from an empty plot that has not been developed yet; however there have been threats made for trespassing and 'stealing'. ▪ The best quality firewood is not always selected because of lack of availability and knowledge (however, they are amenable to getting advice). ▪ TC Pam damaged a lot of trees and there was a short-term increase in the availability of firewood but this has since run out.
Gardens	▪ The issues and threats with gardens are: they do not own land; backyard garden space is very small in some zones; water is prioritised for drinking and cooking; high amount of pest damage and disease to crops (particularly cabbage and kumala); crops are not drought-resistant; plastic and other rubbish is polluting the soils, particularly near the dumpsite. ▪ Soil fertility/quality is variable, depending on the size of plot and management practices. ▪ There are issues with soil erosion as riparian vegetation has been cut down to make gardens, extending all the way to the river. Areas next to the river flood after heavy rains. ▪ There is limited knowledge and practice of mulching, composting, rotation, etc.

Potential community-based adaptation responses

Freshwater

- Providing more residents with large rain tanks in order to harvest rain more efficiently; install more 10,000L community water tanks.
- Improve the housing – i.e. iron roofs to increased water collection.
- Plant more trees in the watershed.
- Fencing to protect water sources.
- Raise awareness within the community about washing in watercourses and proper sanitation practices.
- Develop regulations around washing in watercourses.
- Training on setting up and maintaining composting toilets.

Firewood

- Training from Department of Forestry on firewood management, types of trees, how to preserve them, etc.
- Agreement with land owners for access to firewood or a work trade.
- Community fund for firewood access arrangements or to purchase land for firewood management – perhaps a grant with an organisation.
- Replant / regeneration of trees in backyard gardens / riparian areas.

Gardens

- Awareness and training programmes in every Zone across Etas with emphasis on education and training of women and youth.
- Technical training in crop rotation management, composting, mulching, drought proofing, resting, cover crops and other natural fertility treatments.
- Materials, seeds, nursery and assistance from agricultural officers / experts.
- Plant / replant fruit and nut trees in backyard gardens and in the bush.
- Protect riparian areas from clearing for bush gardens.

Fres Wind

Community narrative

Ohlen Fres Wind is a rapidly developing semi-informal settlement area within the Malapoa-Tagabe Ward in the north of the Port Vila Municipality along the edge of Zone 1 of the Tagabe River catchment. The priority ecosystem topics are freshwater, firewood, and gardens. However a common theme for all issues is the threat from population growth and the influx of TC Pam refugees (from other parts of Efate and islands) into an already high-density ward of Port Vila.

Most of the residents collect rainwater, but do not have tanks. They use containers that have limited capacity and so they frequently run out of water. They also collect water from their main water source, the Tagabe River. However, a fence has been built around the main water pump to protect the catchment, thus restricting access. Prawns (*naura*) are harvested from the river, and watercress and water taro are cultivated in beds on the sides of the river banks and harvested for food.

While up to 63% of households say they use marine and coastal resources, a large part of their use of the ocean is for swimming (22%). Up to a third do go fishing for fish, shellfish and crabs, but the rest purchase these food sources at the market. Fishing methods include fishing line, spear gun, and diving. Most people buy sand and dead coral from companies in Port Vila and they do not go out and collect it themselves. The fishing / coastal areas used are diverse, but the primary locations for fish are Bladinier and North Efate, and for shellfish and octopus they are Malapoa, Melkoffee and Blacksands.

Gardens are an important resource for Fres Wind households (85%). A majority (62%) have a bush garden, in the Ohlen Bush primarily, and sometimes these encroach right up to the river bank where fencing has not been installed. The percentage of households with a backyard garden is 36%, and 14% have gardens in both the bush and at home. Bush gardens further away from the home are located at Teouma, Devil's Point, Manples, Erakor, Eratap, Randapoa, Club Hippique, Tamanu, and Rangorango. The airport gardens between the Sono River and west airport fence is a popular bush garden location. The soil is rich and many vegetables for markets are grown here. Although the practice of burning mulch and debris collected around cultivated crops is common, 8% of the interviewees indicated they undertook mulching and composting in their gardens.

The percentage of households that collect fruit and nuts is 64%. Pawpaw, avocado and grapefruit are very common in Fres Wind. Pandanus and banana are grown near the house, but they used to be more abundant in the Ohlen bush. Firewood is collected by 81%, mostly from Ohlen, but sources have become depleted and access restricted because of the fencing in the catchment. Nantangura is collected from Mele, N. Efate and from islands/family and, along with coconut, is not growing nearby. Bamboo is not used much in Fres Wind, but is on occasion planted in backyards. Sandalwood trees were observed in several gardens during the resources survey after the workshop. In general most forest products are being destroyed from too much cutting. Many of these trees are still recovering from the damage caused by TC Pam. Bananas and pawpaw are strong and recover well. Trees are scattered throughout and forest surrounds the north and western boundaries of Fres Wind, providing shade, good air quality and soil protection.

Animals are raised for subsistence food and for ceremony with about a third of the households raising chickens (for eggs, but mostly for meat) and 23% raising pigs.

Survey results

Main ecosystem resources harvested/collected/used (% of households interviewed)

Traditional wealth items (56%)	Forest (89%)	Marine/coastal (63%)	Freshwater resources (57%)	Livelihood items (29%)
Chickens (32%) Yams (21%) Mats (21%) Sugar cane	Firewood (69%) Fruit & Nuts (63%) Coconut (33%) Medicine (29%)	Fish (27%) Shellfish (16%) Crabs (10%) Dead coral (6%)	Water (30% - higher) Swimming (24%) Fish & prawns (8%)	Mats/Baskets/handicrafts (15%) 20 Vt sale (7%) Cash crops (3%)

(17%) Kava (10%) Pigs (9%) Birds (1%)	Natangura (17%) Pandanus (15%) Bamboo (10%) Timber (10%)	Green snail (6%) Sand (3%) Trochus (1%) Octopus (yes)	Plant material (8%) Rock & non-living material (2%)	Carving (3%) Home-based manufacturing (3%) Sandalwood (2%)

Main species harvested (% of households)

Garden crops (84%)	Fruits & nuts (64%)	Fish (up to 39%)
Banana, island cabbage, manioc, kumala, taro, garlic, pawpaw, yam, corn, fruits, pumpkin, beans, onion, vegetables	*Naus*, mango, pawpaw, nuts, orange, grapefruit, navel, mandarin, *nakatambol, nandau, namambe*, guava, avocado, *korosol, nakavika*, leichi, noni	Red fish, redmouth, pico, reef fish, mangro, parrot, rainbow fish, strong skin, blue fish, butterfly fish

Ecosystem services identified (% of households)

Provisioning (93%)	Regulating (67%)	Supporting (76%)	Cultural (76%)
Food subsistence (87%) Fuel (33% - higher) Water (26% - higher) Medicine (21%) Raw materials (15%) Food cash crops (8%) Ornamental (1%)	Pest & disease regulation (48%) Erosion prevention, soil regulation (23%) Air quality regulation (18%) Water purification & treatment (17%) Flood protection (15%) Climate regulation (10%) Regulation of water flows (6%)	Biodiversity/habitat (56%) Soil fertility (47%) Pollination (29%) Soil & biomass formation (25%) Nutrient cycling (17%)	Recreation/tourism (55%) Spiritual/religious values & ceremony (46%) Cultural diversity & art (14%) Knowledge/education (8%) Aesthetic value (1%)

Workshop findings

Resource	Pressure
Freshwater	▪ The Tagabe River is the main water source, but access has been restricted due to installation of fencing in the catchment. Relocation of residents away from river is ongoing. ▪ There is a hierarchy in living standards: some houses are connected to the UNELCO water supply with a water meter, but others are not connected and rely on river and rain water. ▪ The water quality at the river source is good but problems and deterioration of the river conditions are apparent downstream. Issues include: pollution from human waste; a decrease in the number of prawns due to over-harvesting; falling water levels and streams running into the river are drying out; and increased flooding after heavy rain. ▪ Groundwater cannot be used because it is too deep to dig to it. ▪ This water catchment area is composed of steep hills, which encourage run-off. ▪ A cattle project cleared forests in the watershed, exaggerating increased run-off. ▪ Access to water is the community's biggest problem.
Firewood	▪ Firewood is essential to daily activity for cooking and for ceremonies, but availability and access to it has changed significantly. Many households are purchasing it at the market, or now have to go a long way to collect it, or order from the plantations near Teouma. ▪ There is a 'green space' area on the north side that has been allocated as a resettlement subdivision since 2009. Prior to it being cleared, this was where many households collected much of their firewood and products from coconut. ▪ Diapers are used to start cooking fires and there is concern about the health effects of

	burning plastic. ▪ TC Pam damaged a lot of trees and there was a short-term increase in the availability of firewood, but this has now run out.
Gardens	▪ Backyard gardens are limited as space is too small, water is prioritised for drinking and cooking, chickens and dogs cause damage, pollution from plastic and other rubbish, and soils are often heavily compacted. ▪ Many residents rent their houses and are not able to garden because it depends on the relationship with the owner, as well as their income to afford supplies. ▪ Bush gardens are visited regularly, but stealing is prevalent, transport costs are expensive (for gardens out of the municipality), and not enough is produced for subsistence so food also needs to be purchased at markets. ▪ Some "guerrilla" style gardening is being undertaken, particularly in the undeveloped subdivision 'green space'. ▪ The perception is that small spaces for agriculture cannot be productive.

Potential community-based adaptation responses

Freshwater

- Providing more residents with large rain tanks in order to harvest rain more efficiently.
- Plant more trees in the watershed.
- Raise awareness within the community about washing in watercourses and proper sanitation practices.
- Training on setting up and managing a composting toilet.
- Backyard aquaculture projects (interest was high because it not only decreases their dependence on dwindling resources, it also has to potential to provide an alternative livelihood). This was suggested at the household scale rather than a community project because it was felt that there was not enough unity in the community for people to be fully responsible.

Firewood

- Replant and encourage regeneration of trees in gardens.
- Awareness raising to look after / conserve bush areas and manage trees / forest better.
- Use alternative stoves.
- Community training on seeding, planting, and firewood lot management.

Gardens

- Awareness programmes to change the perception of 'not enough space' and promote the effectiveness / importance of urban agricultural systems to food security and also encourage opportunities for livelihood from it.
- Plant / replant fruit and nut trees in both backyard gardens and in the bush.
- Protect conservation areas from clearing for bush gardens.
- Training in urban agriculture and drought-resilient gardening techniques.

Institutional

- For all the priority issues, leadership from the chiefs and greater collaboration was highlighted as beneficial.
- For forestry, encourage collaboration with the Department of Forestry and Tagabe River Catchment Management Authority.

Ifira

Community narrative

Ifira is a coastal community that has a large portion of customary and long tenured landholders (average 45.7 years). Ifira residents also own much of the land at Blacksands. The average size of the household is 6.2 people, where reliance on wage-based income is low and subsistence fishing activity is relatively high. Priority issues were: marine / coastal, pigs, and institutional concerns.

A wide range of marine resources, biological and non-biological, are collected by Ifira residents, including sea cucumber, which was identified as diminishing in populations (although it provides the important benefit of helping to control the highly invasive crown-of-thorns).

Marine resources are primarily collected at Ifira Island, Ifira Point, and other areas, including Blacksands, Mele, Teouma, Devil's Point, Rantapoa, and Malapoa. Rangorango and White Sands are visited less frequently for a combination of resources, including marine, collecting firewood, and tending to bush gardens.

Freshwater resources are low because there is no river on the island. Many households have to purchase food at the market, with nearly 20% with no garden or having the perception that garden space at home is too small. Although 65% of households have some kind of home / urban garden, 19% have a bush garden, and 9% have both gardens. Also, 91% of households indicate they collected fruit and nuts from the forest, supported by evidence during surveys, which observed numerous mature and abundant fruiting trees, such as breadfruit, natapoa, navel, and coconut.

Householders noted that the material for making traditional mats is often purchased because pandanus and natungura resources have diminished. Only 5% of households interviewed identified cash crops as a livelihood resource and provisioning service, although this is likely to be higher along the eastern shore of the island and at the peninsula, as the socio-economic analysis based on the 2009 government census work indicates that >90% grow cash crops and 25-50% fish for cash.

A large proportion of Ifira households raise animals, namely pigs, pig tusk, and chickens for food, livelihood and especially traditional ceremony, which was identified by all households. Overall, the level of cognition of the benefits of all categories of ecosystem services was extremely high in Ifira, with fuel, air quality, recreation, and biodiversity, standing out most frequently. Numerous benches and gathering areas underneath the tall trees along the edge of the beach are well-used. Comments related to the quality, condition and fertility of the soil after TC Pam were mixed.

Survey results

Main ecosystem resources harvested/collected/used (% of households interviewed)

Traditional wealth items (91%)	Forest (100%)	Marine/coastal (98%)	Freshwater resources (19%)	Livelihood items (72%)
Pigs (82%) Chickens (54%) Yams (39%) Mats (19%) Kava (7%)	Firewood (98%) Fruit & Nuts (91%) Coconut (79%) Bamboo (52%) Natangura (44%) Medicine (44%) Timber (22%) Pandanus (18%)	Fish (93%) Dead coral (86%) Sand (80%) Shellfish (72%) Crabs (61%) Green snail (22%) Trochus (15%) Octopus (5%)	Recreation (12%) Water (7%) Plant material (2%)	Mats/Baskets (54%) Home-based manufacturing (42%) Cattle/Livestock (26%) Pig tusk (21%) Cash crops (4%)

Main species harvested (% of households)

Garden crops (81%)	Fruits & nuts (91%)	Fish (93%)
Banana, island cabbage, manioc, taro, breadfruit, vegetables, corn, yam, tomato, lap lap leaf, chinese cabbage, spring onion, pumpkin, ginger, garlic, beans	Mango, navel, *naus*, avocado, breadfruit, mandarin, *natapoa*, lemon, guava, *nakatambol*, grapefruit, *korosol*, pawpaw, orange, passionfruit, *nandoa*	*Reef fish, blue fish, redfish, lose, bonito, poulet, mangro, open mouth, pico* (rabbitfish), *moustasfish* (goatfish), *strongskin,* yellowfin*, skullfish, nagorama*

Ecosystem services identified (% of households)

Provisioning (100%)	Regulating (100%)	Supporting (84%)	Cultural (100%)
Fuel (93%) Water (75%) Food subsistence (75%) Medicine (58%) Raw materials (3%) Ornamental (45%) Food cash crops (5%)	Air quality regulation (93%) Pest & disease regulation (75%) Water purification & treatment (51%) Regulation of water flows (46%) Erosion prevention, soil regulation (42%) Climate regulation (35%) Flood protection (23%)	Soil fertility (70%) Biodiversity/habitat (65%) Soil & biomass formation (58%) Nutrient cycling (53%) Pollination (51%)	Spiritual/religious values & ceremony (100%) Recreation/tourism (77%) Cultural diversity & art (54%) Aesthetic value (47%) Knowledge/education (37%)

Workshop findings

Resource	**Pressure**
Marine / coastal	▪ The most important issue for Ifira is the marine and coastal environment. Key changes have been noted and there are concerns about the impacts of pollution, waste, sea level rise, development, and population growth. ▪ Sand has been washed away by the sea and by over-collection for building purposes. Furthermore, the sand that remains is polluted and dirtier than it used to be. ▪ The coastal vegetation is creeping inland from sea-level rise and removal of pandanus and other trees for village expansion. ▪ The international port is in close proximity to Ifira and the shipping lane passes adjacent to the island. Oil leakage and waste dumping from local and international boats, ships, and freighters is considered to be a major problem affecting the reefs, fish, and crab populations surrounding Ifira. ▪ Although it is a source of income, there is concern that a nearby plane crash site used for underwater tours with tourists is negatively affecting marine-life.
Pigs	▪ Fencing practices are insufficient and many pigs roam freely, damage gardens, and pollute with their faeces. This raises concerns related to hygiene and health, particularly for children, who can get sick from the exposure.
Institutional	▪ Issues were raised about the relationship between government and civil society organisations (CSO). Concerns related to the unacknowledged role of CSOs by government and the lack of functioning partnerships and support from government. ▪ Also, although Ifira is an integral part of the Port Vila harbour, relief efforts post-TC Pam were regarded as inadequate on the part of the National Disaster Management Office (NDMO) and the government in general. ▪ Provincial and national government land management policies continue to be an ongoing issue, particularly related to the enforcement of land rights and taboos, and in the use of resources in Blacksands.
Potential community-based adaptation responses	
▪ Stop unnecessary tree damage and removal activities and replant / reforest with mangrove, pandanus and other sand stabilising tree species. ▪ Provision and propagation of pandanus and mangrove seedlings.	

- A project that improves pig fencing.
- Although not ecosystem-based, it was also suggested to build a sea wall along the coast to prevent soil erosion. Funds could be in collaboration with NGOs (Live & Learn, SPG, VANGO, VEAN) to build gabion rock baskets / walls to trap and filter oil leaks / spills from the shipping route and for coastal habitat protection.
- Related projects that would have benefits to the coastal environment, as well as socio-economic side benefits include:
    - Skills training on the importance of pandanus (planting methods and value-added items and products that could be made from pandanus material)
    - Awareness programme focused on climate change and environmental issues.

Mele

Community narratives

Mele is a peri-urban village of about 5,000, whose residents are man-Efate with over 90% customary land tenure (2009 census). Mele community previously inhabited Hideaway Island until 1950, when they relocated to the mainland. Mele is under the jurisdiction of Mele / Melemaat Area Council of Shefa Province and is one of the oldest villages in Port Vila, with over half (62%) of households surveyed having lived there for over 50 years. However it is rapidly growing, with 17% of households moving to Mele in the last decade. Their priority issues were marine and freshwater; pigs; and bamboo, natungura, firewood and coconut.

Mele village is situated at the mouth of two rivers: Teai (Teae) and Mele. Residents mainly get their freshwater supply from a reservoir at the Mele Cascades. Most private rainwater tanks were installed after TC Pam, although rainwater is still (inefficiently) harvested by other methods.

Almost all Mele households surveyed (98%) possess traditional items of wealth, including 75% that rear pigs and sell them for livelihood. Yams are abundant and common (93% of households) and grown in bush gardens for the family and as a cash crop. Mele is heavily reliant on the forest, gardens (both, 100% of households) and riparian ecosystems (95%) for provisioning services such as food, fuel and water for the household. They also make a significant income from these ecosystems and, aside from pigs, are known around Vila town for their *tuluk* (ingredients: laplap leaf, manioc, pork) and roofing thatch made with natangura and bamboo.

The majority of residents fish for subsistence (79%), with most fishing carried out on reefs around Mele and along the coast up to Devil's Point. Some deep-sea fishing is also carried out off the Mele coast. Canoes are used to access these areas, and tuna and mahi-mahi are mainly caught using long lines. The Department of Fisheries regularly seeds the protected reefs around Hideaway Island with giant clam, trochus and green snail hatchlings, and these spill over into the other fished reefs. 19% and 15% of households pick trochus and green snail for food respectively. Biodiversity on the reefs is still high, with up to five dugongs typically sighted on the south facing reefs.

Mele beach is a very popular recreational place, not just for Mele residents, but for other Port Vila communities. This is because Mele is one of the few remaining beaches with decent water quality that has not been completely closed off to locals due to coastal development.

Bamboo is the main riparian vegetation. It is not typically planted, and comes in two varieties: soft and hard. Hard bamboo is typically used for construction to make shades, posts, etc., and soft bamboo is used for handicrafts and brooms.

A majority (96%) of residents have bush gardens, 25% have home gardens and 23% have both. Most of the bush gardens are located on owned plots of land around Mele Village, sometimes close to the two rivers along the east and west borders. Rice has been introduced in a trial programme, although it is too early to ascertain the quality of the crop. If it is successful, more residents would like to grow it. Other bush garden and forest materials collection locations are accessed only if owned or if permission is granted. These include: Devil's Point, Tafu, Batlalua, Warakai, Malarae, and near the Mele golf course.

Survey results

Main ecosystem resources harvested/collected/used (% of households)

Traditional wealth items (98%)	Forest (100%)	Marine/coastal (94%)	Freshwater resources (95%)	Livelihood items (85%)
Yams (93%) Pigs (75%) Chickens (37%) Sugarcane (33%) Mats (21%) Kava (5%) Ducks (2%)	Firewood (95%) Fruit & Nuts (91%) Coconut (81%) Bamboo (78%) Natangura (71%) Medicine (50%) Timber (31%) Pandanus (27%)	Fish (79%) Sand (76%) Crabs (65%) Shellfish (45%) Dead coral (38%) Trochus (19%) Green snail (15%) Turtles (1%)	Water (58%) Fish, crustaceans (46%) Plant material (31%) Rock & non-living material (2%)	Cattle/livestock (76%) Cash crops (34%) Mats, baskets (14%) Home-based manufacturing (6%)

Main species harvested (% of households)

Garden crops (100%)	Fruits & nuts (91%)	Fish (79%)
Banana (69%), manioc, taro, yam, island cabbage, kumala, corn (7%), onion, vegetables, pumpkin, lettuce, tomato, capsicum, water taro, garlic, watermelon, beans, rice (2%), flowers, snake beans, cucumber	Grapefruit (35%), mango (31%), *navel*(25%), orange (21%), *naus*, pawpaw, avocado, mandarin, *nakavika, nakatambol*, wild nuts, *nangai, korosol*, letchi (lychee), guava, lemon, passionfruit	*Mangru*, *karong*, sardines, snapper, mahi-mahi, trevally, tuna, poulet, octopus, crabs, green snail, trochus, *naura* (freshwater prawns), lobster, coconut crab, squid, tuna

Ecosystem services identified (% of households)

Provisioning (100%)	Regulating (96%)	Supporting (97%)	Cultural (98%)
Food Subsistence (100%) Fuel (98%) Water (95%) Medicine (54%) Raw materials (46%) Food Cash crops (33%) Ornamental (25%) Fodder (1%)	Air quality regulation (73%) Pest & disease regulation (73%) Flood protection (52%) Erosion prevention, soil regulation (47%) Water purification (46%) Regulation of water flows (44%) Climate regulation (42%)	Soil fertility (89%) Pollination (77%) Biodiversity/habitat (58%) Soil & biomass formation (47%) Nutrient cycling (44%)	Spiritual/religious (98%) Recreation/tourism (76%) Cultural diversity/ Inspiration (37%) Knowledge/education (29%) Aesthetic value (17%)

Workshop findings

Resource	Pressure
Marine and freshwater	▪ Population growth has increased pressure on available resources. ▪ Fishing efforts have increased, and a number of fish species have been noted to have decreased in size, in particular *mangru*. Overfishing of freshwater prawns (*naura*) has led to their complete depletion in the Mele and Teai rivers. ▪ Coastal vegetation cut down and swamps cleared for urban development. Private residences and resorts have been built at the waterfront, limiting access to the coast and increasing vulnerability to storms and cyclones inland. ▪ Riparian vegetation is being cleared for gardens, increasing river bank erosion and flooding, reducing river water quality and increasing sediment load into the sea. ▪ Rivers are also polluted with plastic and rubbish. River water is typically turbid and occasionally has a putrid smell. ▪ The degradation of the Mele coastal area is exacerbated by sand mining, and sea-level rise is thought to have contributed to the changes observed on Mele Beach. ▪ Extensive coral bleaching has been observed, and this was prolonged during El Niño.
Pigs	▪ Residents from all over Port Vila come to Mele to buy pigs, and Mele residents cannot keep up with the demand during holiday time. ▪ Used to keep pigs in bush areas but, due to growth of the village and problems with theft, they now keep them at home. Many pigs are free to roam but there are increasing altercations with dogs and damage to gardens. Contamination from faeces is a concern. ▪ Pig diets are supplemented with kitchen scraps. It is expensive (electricity costs) to keep

	leftovers or portions of pigs so they are usually sold / eaten whole, or added to large batches of *tuluk*.
Bamboo, natangura, firewood & coconut	▪ Typically forest materials including firewood, fruits, nuts and other plants are only collected at home or on owned land. ▪ Many residents formerly went to Devil's Point for firewood, but land was sold 10–15 years ago. Some land–owner permission arrangements remain, but many have to go elsewhere to find firewood or purchase it from a plantation or farmer. ▪ Most natungura, coconut and pandanus in Mele were planted about 50 years ago, but this practice has not been continued. Pandanus trees were especially damaged after TC Pam. ▪ Mele is known for their traditional natangura thatch roofing, and people come from everywhere to purchase it. The skills are still held within the community, but as raw materials diminish, so does the ability to transfer this knowledge to a younger generation.

Potential community-based adaptation responses

Marine

- Improving the coastal environment by planting more trees on coastal and riparian areas, especially mangroves and bamboo.
- Awareness programme focused on proper sanitation practices and washing in watercourses.

Pigs

- A project that improves pig-fencing, and training in better integration of husbandry with home and gardens.
- Training and awareness in improved pig management and health.
- Promotion of curing / smoking methods and products.
- Investigate funding opportunities for a community-scale biogas project.

Bamboo, natangura, firewood & coconut

- A project to replant natangura and pandanus around Mele would help provide material for handicrafts, and improve livelihoods.
- Coconut planting should also be promoted to replace those that have not been planted for nearly a generation and the remaining that have been damaged in TC Pam.

Pango

Community narrative

Pango is a peri-urban village under the jurisdiction of Pango Area Council of Shefa Province, with customary land tenure varying from 50–90% across enumeration areas on the peninsula (2009 Census). There has been a recent influx of residents into Pango village, with 20% of households only having moved to the community in the last ten years. The priority issues were marine, freshwater, and general terrestrial including gardens, pandanus and natangura.

Pango has a very long coastline with extensive reefs and seagrass meadows that are habitats for dugongs and sea turtles. Dugongs have been sighted around Hesla-Emat, Emis, Elaknarusik and Efarfer. A majority of Pango households (97%) harvest marine resources, mainly for subsistence, as raw materials and for ornamental purposes. Most fishing is carried out on reefs around Pango, but there is no deep-sea fishing.

The main coastal vegetation in Pango includes pandanus, oak trees and sea poison tree (poisonfruit tree, *Barringtonia asiatica*). It has some of the cleanest beaches in Port Vila with very good water quality. Survey and workshop participants attribute this partly to Pango Green Force, a community group that collects garbage around the village and beaches. There is a lot of tourism in Pango, and its coastal areas are used for numerous recreational activities: diving, surfing (Hesla-Emat), and swimming.

There are no rivers in the Pango area, although groundwater used to be a major source of fresh water (1970s–1990s) until they got connected to the UNELCO water supply. A lot of these underground wells have since been covered up. Over a third (37%) of households surveyed travel around Port Vila and Efate to use freshwater resources in Mele, Prima, Randabau, Eton (North Efate), Salili and Teouma.

Gardens are used by 99% of the Pango residents surveyed, with 75% of households having a home garden (even if it is only a couple banana plants, fruit trees or a small patch of manioc) and an even larger proportion of households (85%) cultivate crops on small parcels of about one acre in size. Half of the residents have both bush and home gardens. The majority of the bush gardens are within bush plots on the Pango peninsula (i.e. Ekra, Valevale, Emakur, Honeymoon Beach, Etac, IDS, Eleo, and Angelfish), but some residents also travel to Teouma to tend to gardens where extended family own land or where they have permission to access the gardens.

Forest resources are used or collected by 94% of the households. Three-quarters of the households collect fruit and nuts, including pawpaw, a variety of citrus, mango, avocado and breadfruit (which was observed in several locations during surveys). Plant medicine is fairly common (45% of households) and it is both cultivated and wild and used according to the island of origin and family traditions. Pawpaw leaves are used by some households to repel mosquitoes. Animals are raised for subsistence food and for ceremony with around half of the households raising chickens and pigs at home. These, as well as other traditional wealth items like yams, mats and sugarcane, are beneficial to 93% of the survey respondents. Making of crafts is central to the community, and every Thursday there is a *mamas* market where baskets and mats are woven and sold.

Survey results

Main ecosystem resources harvested/collected/used (% of households)

Traditional wealth items (93%)	Forest (94%)	Marine/coastal (97%)	Freshwater resources (37%)	Livelihood items (47%)
Yams (63%) Chickens (55%) Pigs (47%) Mats (34%) Sugarcane (32%)	Fruit & Nuts (75%) Firewood (74%) Coconut (67%) Bamboo (51%) Pandanus (45%) Medicine (45%) Natangura (44%) Timber (27%)	Fish (92%) Dead coral (86%) Sand (77%) Shellfish (68%) Crabs (53%) Green snail (27%) Octopus (12%) Trochus (11%)	Recreation (27%) Water (10%) Fish, crustaceans (3%) Plant material (1%) Rock & non-living material (1%)	Mats, baskets (25%) Home-based manufacturing (18%) Cash crops (16%) Cattle/livestock (10%) Sewing & painting (15%)

Main species harvested (% of households)

Garden crops (99%)	Fruits & nuts (75%)	Fish (92%)
Banana, manioc, taro, island cabbage, kumala, yams, sugarcane, beans	Orange, avocado, mango, *naus*, grapefruit, breadfruit, pawpaw, *navel*, mandarin, passionfruit	*Mangru* (spotted scat), *los* (cod), sardines, snapper, mahi-mahi, trevally, parrotfish, wrasse, barracuda, octopus, sharks, *Papa* (cake urchin), lobsters

Ecosystem services identified (% of households)

Provisioning (100%)	Regulating (100%)	Supporting (96%)	Cultural (100%)
Food Subsistence (99%) Water (75%) Fuel (74%) Medicine (45%) Raw materials (40%) Ornamental (32%) Food Cash crops (16%) Fodder for animals (4%)	Air quality regulation (100%) Water purification (79%) Pest & disease regulation (72%) Erosion prevention, soil regulation (62%) Flood protection (34%) Climate regulation (30%) Regulation of water flows (30%)	Biodiversity/habitat (79%) Pollination (68%) Soil fertility (81%) Nutrient cycling (66%) Soil & biomass formation (66%)	Spiritual/religious (98%) Cultural diversity/ Inspiration (57%) Recreation/tourism (49%) Knowledge/education (45%) Aesthetic value (43%)

Workshop findings:

Resource	**Pressure**
Marine	▪ Population growth has increased fishing effort. While only men traditionally fished, now women and children are increasingly involved, leading to a large decrease in the number of fish / shellfish caught (over-harvesting and fishing down the food chain). Night diving is now used to catch nocturnal fish. ▪ Indiscriminate fishing practices are used (e.g. chicken wire with hooks and baskets), increasing by-catch such as turtles and sharks. Reef sharks are caught at three surfing sites using buoyed ropes (as they are regarded as a threat), with pieces distributed in the community for consumption. Approximately five sharks are caught per month. ▪ There has been extensive coral bleaching in the aftermath of TC Pam and the 2015/16 El Niño, and fish-kills were observed in mid-February (weeks after dead sea-cucumber were thrown into the sea and decomposed). A decrease in other coastal species has been observed over the past decade: seagrass, sea birds, coconut crabs, trochus, green snail etc. A crown-of-thorns starfish outbreak a few years ago destroyed portions of the reef. ▪ Workshop participants estimate that 90% of Pango coastal land has been sold to foreign investors and is being developed for resorts or private residences, resulting in limited access to the coast and exposing inland residences vulnerable to storms, cyclones, etc. ▪ Coastal erosion has increased, with Elaknarusik being the most affected area. ▪ Another side effect of the short-term gain from rapid development is that some residents either simply no longer plant gardens and trees in favour of exposed lawns or pre-empt the sale of their private land by converting the bush to grass so it 'looks good' to expatriots. Therefore, much of this land area that formerly produced food and provided other essential services is no longer functioning for the benefit of the community. ▪ Pango has strong community sentiment and organisation. The Pango chief declared a ban on fishing about two years ago, but lifted it two months later. This has given rise to

	'privatised' marine reserves that have been initiated by community members who ban fishing on the reefs adjacent to the land they own, by putting a Namele leaf on a post to signal it is a *tabu* area. As a result, the population of green snails and trochus has increased to the thousands, and this has been most noticeable in Emout. ▪ Last year (2015) youths started a community fish farm project at Vale Vale and a lobster farm at Mangaliliu (North Efate). It was constructed by filling tarpaulin with water and freshwater fish. The project collapsed once the farm dried out during the prolonged El Niño.
Freshwater	▪ Access to fresh water was identified as a main issue. However, most households in Pango have access to piped water and are connected to the UNELCO supply. Access was a problem during the El Niño drought when there was not enough water for garden crops.
General terrestrial including gardens, pandanus & natangura	▪ The focus in bush gardens is on traditional crops of manioc, taro, island cabbage and yam using traditional subsistence farming techniques (no mulching and composting). Sometimes to open up a new garden patch - and to promote production – they will burn trees in the bush, leave it for a year, then cut it down for firewood and for ceremony. ▪ Vegetables are more expensive for both seeds and management, and have high water needs and therefore do not survive in the bush because of a lack of irrigation systems. ▪ Traditional root crops are better adapted to the soils in the bush, but they suffered from the extensive damage that TC Pam did to many bush gardens, particularly those closer to the coast. Diminished crop production also resulted from the El Niño. As a consequence, some residents are trying new techniques, such as growing yams in containers and buckets. ▪ There is a desire for more seeds and seedlings of crops that grow quickly after disasters. Some of the gardens, known as 'ladies gardens' are specially planted with pandanus so the leaf material can be collected for making mats, baskets, and other handicrafts, and sometimes the fruit is used for fuel in cooking instead of charcoal or firewood. ▪ The lap lap leaf (for *tuluk* and other cooking) is much more difficult to find in the bush and the plants that remain are often affected by a fungus. Banana leaf has become the alternative now, but it is not preferred and breaks apart more easily. ▪ TC Pam also damaged many fruit and nut trees which had an immediate effect on the fruit harvest, but several residents have also noticed longer-term changes to the fruiting abundance, timing of fruiting, and the vitality and growth of the trees (which they attribute to climate change). Changes have become more acute in the last ten years, e.g. normally orange and grapefruit fruit in April, but this had not happened by the time of the ESRAM workshop. Also, one to two good citrus trees used to be enough to meet a family's needs without having to buy fruit at the market, but not any longer.
Potential community-based adaptation responses	
Marine ▪ Residents favour banning fishing on the reef for a few years to give the reefs time to recover. ▪ Two alternative livelihoods have been proposed: (1) a community deep-sea fishing project, whereby community members are trained and equipped in deep-sea fishing methods for subsistence and possibly commercial purposes; (2) Training in fish farming methods. The failed fish farm project can be revived with new skills and techniques, and this would reduce the fishing pressure on the reef. Freshwater ▪ Provide awareness and training programmes about good water management practice and improved	

techniques for urban agriculture.

- In addition, the existing underground wells can be cleaned, maintained, and the water used for domestic purposes. These areas should be fenced off to discourage people from disposing of rubbish in them.

Terrestrial:

- Replant and reforest along the coast and in gardens, getting youth involved.
- Expand the number of pandanus gardens.
- Chief council and government-supported project focused on livelihoods to improve tourism and community-based opportunities for women and youth.
- Also, given the seemingly high level of awareness around climate change and disaster risk reduction within the community, awareness programmes could be expanded to further increase their level of familiarity and willingness to find and promote solutions (there may be tourism promotion benefits if Pango becomes a signature example of an urban community 'Adapting to Climate Change' within Vanuatu).

Seaside

Community narrative:

Seaside is an urbanised, very high-density area in the Central Ward of Port Vila Municipal Council. Three main communities, Tongoa, Paama and Futuna, occupy the three city block area of Seaside to the south of the hospital grounds in three zones divided by island of origin. The number of private households according to the 2009 census is 126 for Seaside Paama (31 surveyed in this study which is 24% of the households) and 136 for Seaside Tongoa and Futuna combined (62 surveyed, 45% of households). Seaside is largely an informal settlement with temporary housing structures and shared facilities for toilets and potable water because most residents do not own their land. Priority issues were: marine, materials (for mats / baskets), and firewood / bush gardens. However, the Seaside residents' main criticism is that they are not consulted properly on decision-making processes regarding their community.

Seaside residents mainly buy food from the market, although our surveys show that 72% of households have bush gardens. Only 2% indicated they had a home garden, but observations and discussions during the workshop suggest that this is higher, with banana, papaya, and various types of citrus trees being available in a number of backyards as well as within shared community spaces. Bush gardens are located predominately at Teouma, Erakor and Etas but there is a lot of development encroaching on the gardens and problems with stealing. Seaside Tongoa households also make gardens in Bladinier. Only Paama households keep chickens. The municipality does not permit more than one chicken per household and there is a tax to be able to own a pig.

Firewood is mainly sourced from public land closer to Seaside in the urban area, along the shore and further afield at Tassiriki and the Showground. It is also collected in the areas around bush gardens at Teouma and Erakor, and building companies sometimes donate firewood to the community. After TC Pam, the availability of firewood increased due to the numerous fallen trees and debris. Sugarcane is an important traditional wealth item used for bride price and ceremony and is primarily cultivated in bush gardens.

Raw materials for making handicrafts are sourced from around Erakor lagoon. Pandanus is the preferred material but coconut leaves and natangura are also used. Many residents have abandoned making handicrafts because they lack the raw materials, especially after TC Pam.

Mangrove trees actually acted as a wind-break during the cyclone and also regulate soils and salts and help with air and water quality. Because of their shore protection function mangroves are a good location for growing crops (bananas). They are also good timber for carving traditional canoes, which is practiced by very few elders.

Hardwood is the primary timber for carving, but other reasons why more are not making a livelihood from this practice is that there are no tools (and they are expensive) and younger people view it as a lot of work for not enough gain. If good prices could be obtained and there was a reliable market, there might be more interest in this livelihood potential.

Two main fishing spots for Seaside are the shoreline at Seaside and across the lagoon on the Erakor side. The main fish caught is *Pico* (Maze Rabbitfish), which inhabit the brackish waters in the mangroves near Seaside. Stingrays are occasionally fished for consumption. Most species that currently remain in the lagoon at Seaside are detrital feeders', e.g. horned starfish, sea cucumbers and various species of snails. Green snail and trochus have been depleted from the lagoon, and residents mainly go to Randapao to harvest green snail. Other fishing areas visited include: Pango point, Banana Bay, Whitesands and North Efate (for shellfish). Most fish is caught for subsistence.

There is decreasing reliance on fishing, as areas become more inaccessible, and more households buy their fish from the markets.

Survey results

Main ecosystem resources harvested/collected/used (% of households)

Traditional wealth items (30%)	Forest (83%)	Marine/coastal (57%)	Freshwater resources (16%)	Livelihood items (38%)
Yams (16%) Chickens (12%) Sugarcane (6%) Mats (5%) Kava (4%) Pigs (1%)	Firewood (69%) Fruit & Nuts (44%) Coconut (19%) Medicine (13%) Pandanus (8%) Bamboo (4%) Timber (3%) Natangura (3%)	Fish (51%) Shellfish (27%) Crabs (4%) Dead coral (1%) Green snail (1%)	Swimming (8%) Fish/crustaceans (4%) Water (4% - higher)	Mats/Baskets (28%) Cash crops (4%) Home-based manufacturing (2%)

Main species harvested (% of households)

Garden crops (73%)	Fruits & nuts (44%)	Fish (51%)
Banana, manioc, island cabbage, taro, kumala, corn, cassava, yam, cacao, chilli	Nuts, grapefruit, mango, orange, avocado, pawpaw, guava, *naus,* , lemon, banana, *navel, nandao*	*Pico* (rabbitfish), *redfish*, *pagong*, sardines, mullet, *mangru*, sting rays, octopus, crabs, clams, lobsters, *nasese* (cockles), *cornshell* (trochus), *serwok* (Malakula shell), *strong back* (spiny chiton), scallops

Ecosystem services identified (% of households)

Provisioning (68%)	Regulating (10%)	Supporting (22%)	Cultural (47%)
Food Subsistence (60%) Food Cash crops (19%) Fuel (12%) Medicine (8%) Raw materials (3%) Water (1%)	Climate regulation (4%) Erosion prevention, soil regulation (3%) Pest & disease regulation (2%) Air quality regulation (1%) Regulation of water flows (1%) Water purification/ treatment (1%) Flood protection (1%)	Biodiversity/habitat (22%) Soil fertility (14%) Soil & biomass formation (1%)	Recreation/tourism (44%) Spiritual/religious (13%) Aesthetic value (1%) Knowledge/education (1%)

Workshop findings

Resource	**Pressure**
Marine	▪ The main threat to marine ecosystems is hospital waste effluent released into the lagoon. The waste is initially held in large 'settling' ponds at Seaside, which have negatively affected air quality in the area. The waste undergoes primary treatment and partial secondary treatment before being released into the lagoon, increasing the nutrient load, particularly nitrates / phosphates, leading to an increase in bacterial and algal growth, deterioration of the water quality, increase of waterborne diseases, and loss of recreational space. ▪ There has been an increase in mosquito-borne diseases, e.g. malaria, and increased incidences of fish poisoning. ▪ The Seaside community has poor sewage systems and residents have to pay to use sanitation facilities, thus incentivising human waste disposal into the sea.

	▪ Seaside residents have less access to the sea because coastal land has been sold off to private owners who ban access and cut down the mangroves and coastal vegetation for resort development. This has negatively affected a number of residents who used to cross the lagoon by canoe to access their gardens in Erakor. Access is now solely by road. ▪ Loss of seagrass has been observed over the past decade, as well as a reduction in dugongs sightings. ▪ There has been an increase in crown of thorns outbreaks. In mid-February 2016, anomalously high sea temperatures during the El Niño caused fish kills. ▪ During cyclone Pam, coastal vegetation was destroyed, mainly pandanus and soursop. ▪ The destruction of coastal vegetation on the steep ridges has exacerbated run-off into the lagoon.
Materials	▪ The materials group at the workshop was composed entirely of women. Materials are used to weave head dresses, bracelets, hats, fans, mats, bras for women, custom costume, and for peace ceremonies and as a bridegroom gift. ▪ The threats come from over-harvesting pressure and from development, which has restricted access to land and cleared vegetation. ▪ Pandanus in particular is not managed properly (timing and amount of harvest is depleting it) and is insufficiently re-planted. High producing pandanus plants need to be cleaned or weeded regularly, but leaves should not be removed once a week. It is propagated from stems and takes a year to be ready for use.
Firewood / bush gardens	▪ Resource pressures from population growth and land development and encroachment are the biggest threats identified in the firewood and bush gardens issue. ▪ Before the hospital wall was built (two to six years ago), Seaside Tongoa community had access to more of these resources. ▪ It now costs money and time to get to the bush gardens outside the urban boundaries. Bush gardens are often associated with land owned by family and are often tended to on Saturdays because both heads of the household are working during the week.

Potential community-based adaptation responses

- Workshop participants were unanimous that any future Seaside projects must promote unity between and within the three communities.
- A project to replant pandanus around the lagoon was favoured because it would not only improve coastal ecosystem services, but also boost livelihoods by providing raw materials to make handicrafts. Some people plant pandanus in their own backyard gardens but more could be planted in bush gardens.
- There could be benefit in raising awareness and educating on harvest management (should be once a month not every week; and coconuts need time to recover so reduce the collection of coconut leaves as well).
- There is also an interest in replanting mangroves, which also provide windbreak during storms / cyclones and improve the fish breeding habitat close to shore.
- It was suggested that a community-run body be established to monitor developments, projects and usage associated with the lagoon.
- Participants agreed on the importance of getting younger people involved in any lagoon based and planting projects.
- It was also suggested that the green space (of Millennium Park) could be better designed to improve some of these resource and ecosystem service needs.

Tagabe Bridge

Community narrative

The Tagabe Bridge community along the south side of the Tagabe River is located in Shefa Province, adjacent to the Port Vila municipal ward of Malapoa-Tagabe. According to the 2009 census there is 10–25% customary land ownership, but there is also an increasing level of pressure on local resources as the rate of informal settlement increases and their cash income is more limited than any of the other areas in this study. Priority ecosystem issues were: freshwater, firewood & materials, and marine / coastal.

Water, both river and rain water, is the most important freshwater resource used. According to the 2009 census, up to 50% of households wash in the river. Many households have their toilet block right on the banks of the Tagabe River and defecation in the watercourses is a serious problem. The rivers at Mele, Prima, and Teouma are also popular for their recreational services. Fish and prawns are also collected from the river and water taro is cultivated and collected in the river as well.

There are 31% of households with no garden, 38% with a home backyard garden, and 64% have a bush garden away from the home located in the forested areas around Tagabe, Blacksands, Bladinier and near the airport, and further afield at Teouma. 38% of households indicated they have both a home and bush garden. Banana, kumala and manioc are cultivated in nearly every garden. Only 33% indicated that the soil quality is generally good for growing crops. The recent El Niño drought has been a challenge for their gardens and island cabbage crops are afflicted with many pest problems.

The areas with bush gardens are typically also where fruit and nuts, medicine, bamboo and materials for mats, thatch and traditional cooking are collected. The percentage of households that collect fruit and nuts is 47%. Mango and naus are used by 20% of the households; but only 33% of households interviewed provided a list of species. Species such as breadfruit, passionfruit, and coconut were not listed but were commonly observed in many backyards during the survey. Whitewood was abundant along the river. Firewood includes charcoal from the north island and is usually collected at Teouma and in the bush at Tagabe and Blacksands.

Although Tagabe Bridge is a land-locked community, marine resources still play an important part of their subsistence diet, with approximately one quarter of households visiting marine and coastal sites to harvest fish and shellfish (10–25% catch fish for subsistence; 2009 census data). They fish and on occasion go swimming at Blacksands, Kawenu, North Efate, Malapoa and Erakor. They typically use bamboo lines and nets to fish.

Animals are raised for subsistence food and for ceremony, with almost 30% of the households raising pigs and a quarter raising chickens.

Survey results

Main ecosystem resources harvested/collected/used (% of households interviewed)

Traditional wealth items (62%)	Forest (80%)	Marine/coastal (33%)	Freshwater resources (73%)	Livelihood items (33%)
Pigs (29%) Chickens (24%) Sugar cane (20%) Yams (9%) Mats (7%) Sandalwood (yes)	Firewood (58%) Fruit & Nuts (47%) Medicine (36%) Bamboo (13%) Coconut (11%) Wild nuts (11%) Natangura (7%) Pandanus (7%) Timber (4%)	Fish (27%) Shellfish (16%) Swimming (4%)	Water, including river & rainwater (60%) Fish & prawns (13%) Plant material (yes - water taro)	Mats/Baskets (22%) Cash crops (11%) Home-based manufacturing (7%) Carving & woodwork (4%)

Main species harvested (% of households)

Garden crops (69%)	Fruits & nuts (47%)	Fish (up to 27%)
Banana, kumala, manioc, fruits, island cabbage, taro, vegetables, yam, corn, pawpaw, pumpkin, spring onion	Mango, naus, avocado, nuts, *nakatambol*, pawpaw, guava, *nandau*, navel, orange, *nakavika*, breadfruit, passionfruit	Shellfish, lobster, marine fish

Ecosystem services identified (% of households)

Provisioning (98%)	Regulating (71%)	Supporting (69%)	Cultural (84%)
Food subsistence (80%) Fuel (58%) Water (51% - higher) Raw materials (58%) Medicine (36%) Food cash crops (13%) Ornamental (2%)	Climate regulation (40%) Pest & disease regulation (22%) Erosion prevention, soil regulation (20%) Air quality regulation (11%) Regulation of water flows (4%) Water purification & treatment (2%) Flood protection (2%)	Biodiversity/habitat (64%) Soil fertility (49%) Nutrient cycling (20%) Soil & biomass formation (18%) Pollination (yes)	Recreation/tourism (82%) Spiritual/religious values & ceremony (40%) Cultural diversity & art (2%) Knowledge/education (2%) Aesthetic value (yes)

Workshop findings

Resource	Pressure
Freshwater	▪ According to older community members in both Blacksands and Tagabe Bridge, the Tagabe River has noticeably changed along its course and at the mouth. ▪ Washing, defecation, plastic and waste are dumped into the river at Tagabe Bridge and further upstream. The nearby Tusker factory releases waste directly into the river, although this practice may be halted, and local community organisations have been active in raising awareness around this issue. Drainage from the airport runway also apparently empties into the Tagabe River. ▪ Flooding along the river and riparian areas is common during storm events and often destroys crops growing in gardens close to the rivers. ▪ Swimming used to be more popular in the Tagabe River, but increased pollution and rapid changes to water quality and water levels in the last two to three years has deterred this activity. ▪ A Live & Learn WASH project was conducted at Blacksands, which encouraged them to build their own sanitation facilities and to become more entrepreneurial (i.e. start selling toilet parts). They also built a composting toilet at Sorovango School for the community. ▪ Tagabe Bridge residents are keen for these sorts of projects to be undertaken in their community. The Wan Smol Bag theatre group headquarters is very close and has been involved in community projects in the past.
Firewood	▪ Firewood is essential to daily activity for cooking and for ceremonies, but the amount and quality of firewood and materials like natangura and pandanus that can be collected and harvested from nearby forest areas has reduced significantly. The forest around Tagabe and Blacksands is described as being mostly small-sized trees and shrubs, and degraded due to TC Pam and from overharvest. ▪ Access to areas previously used for firewood collection, such as at Malapoa (now private property, sold by Ifira landowners) and Bladinier (residential development started in 2000)

	has also been restricted and there is ongoing encroachment from development into the forest around their bush gardens in Teouma. The population growth of Port Vila in general, rapid development around Tagabe, and the resulting additional pressure on forest resources is a huge concern. Many households now have to buy their firewood. ▪ There is recognition that over-harvest of trees and forest materials is damaging and causes other problems, such as flooding around riparian zones and erosion of the coast.
Marine	▪ The fishing sites in the coastal waters at Blacksands are no longer as healthy and abundant as they once were, particularly around the mouth of the rivers where there are turbid waters due to increased nutrients from pollution causing bacterial growth, algal blooms, and increased sediment from run-off. ▪ Overharvesting pressure has decreased the size and number of fish (particularly *Mangru*, as well as shellfish) and there has been a ten year trend in the disappearance of green snail and trochus. Mosquito nets are still used and this method has a high level of by-catch. ▪ Pollution from the Tagabe River has degraded the coastal marine habitat and water quality. ▪ Crab numbers have also diminished because the beach habitat is being degraded and destroyed through sand mining and destruction of coastal vegetation, including mangroves. Sand mining is done by professional/construction companies, e.g. MCI – forklifts are used to collect the sand and by people from all around Efate for local/residential construction. Blacksands beach has sand ideal for cement construction because of its fine particles – it is mixed with silt (mainly from the rivers) and therefore is not as coarse as white sand. Other beaches that have good sand for construction are Eratap and Shark Bay (opposite Eratap).
Potential community-based adaptation responses	
▪ Plant bamboo along the river to reduce flooding. ▪ Build proper sanitation facilities away from the river (WASH project). ▪ Awareness programmes about washing in watercourse and proper sanitation. ▪ Investigate ground water as increased alternative water source. ▪ Ensure proper waste disposal at all factories (though questions about how this is enforced and monitored?). ▪ Find new ways to cook food with less material and expense – i.e. solar cooker, a deeper pit. ▪ Replant and reforest – riparian, coast and in gardens. ▪ Plant more trees in coastal areas (especially mangroves and pandanus).	

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