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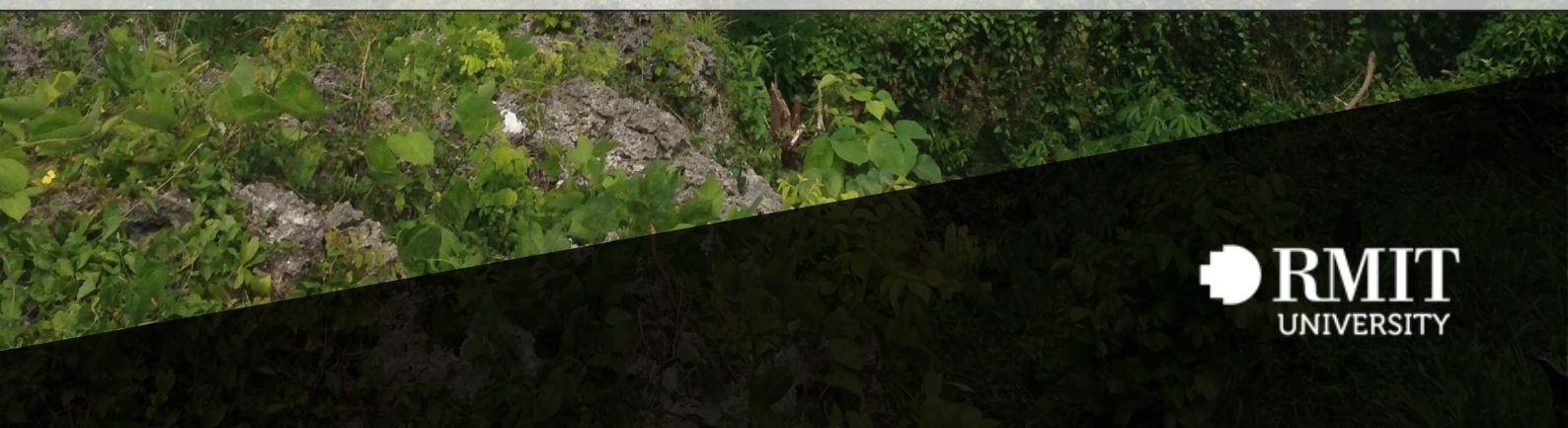
# Climate Change Vulnerability Assessment:

# Greater Port Vila

UN-HABITAT Cities and Climate Change Initiative | RMIT University Climate Change Adaptation Program

**2015**



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**Greater Port Vila Climate Vulnerability Assessment – Full Report (2015)**

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Report developed for the United Nations Human Settlements Programme *Cities and Climate Change Initiative* (Regional Office of Asia Pacific, Fukuoka).

Research conducted in partnership with Port Vila Municipal Council, Shefa Provincial Government Council, the Vanuatu Government Ministry for Climate Change (through the National Advisory Board on Climate Change and Disaster Risk Reduction), and the Vanuatu Government Ministry for Internal Affairs, as well as numerous community and non-government organisations present and operating in Port Vila.

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13th October 2015

## Foreword

As was illustrated by the devastation caused by Tropical Cyclone Pam in March 2015, Vanuatu has been historically exposed to a number of climate-related and natural hazards. Climate change will worsen a number of these climate-related risks, and introduce new hazards to Vanuatu through changes to variables such as extreme rainfall, temperatures, sea levels, and ocean temperatures and acidity.

The city of Port Vila is also changing. Increasing numbers of ni-Vanuatu are migrating to the city from rural areas, attracted by the greater level of services that are available in and around the urban area. This migration is leading to rapid rates of urbanisation, particularly in the peri-urban areas that surround the city; newer communities that are often both highly exposed and sensitive to natural hazards. As such, it is important to recognise that climate change is only one of the drivers that will affect the future vulnerability of our city.

This assessment provides a valuable baseline for understanding critical social, economic and environmental vulnerabilities, and the range of possible shocks and stresses that are likely to impact the city in the short and longer term. It was used extensively in the recovery from Cyclone Pam, and represents a critical first step moving towards the development of an urban resilience and climate adaptation action plan for the Greater Port Vila Area.

Responses that build community resilience will require collaboration and close working between many different actors. It will therefore be important to continue positive engagement processes not only between multiple levels of Government, but also between municipal and provincial authorities.

We, the undersigned, recognise the importance of this agenda for Greater Port Vila, endorse this vulnerability assessment, and declare an ongoing commitment to the development of an urban resilience and climate adaptation plan.

**Hon. Ulrich Sumptoh**
Lord Mayor, Port Vila Municipal Council

**Ms Cherol Ala**
Acting Director General, Ministry of Internal Affairs, Vanuatu Government

**Mr Jotham Napat**
Director General, Ministry of Climate Change, Vanuatu Government

National Advisory Board
on Climate Change and Disaster Risk Reduction
Government of Vanuatu

**Mr Michel Kalworai**
Secretary General, Shefa Provincial Government Council

**Acknowledgements**

The authors would like to acknowledge the input and assistance of a number of organisations and individuals who have contributed to this report.

Members of the Vanuatu National Advisory Board on Climate Change and Disaster Risk Reduction (NAB) have provided contacts, resources and feedback throughout the research process. Endorsement of this project by the NAB was a crucial step to ensure that the *Planning for Climate Change* process integrates effectively with the Government of Vanuatu's wider climate change agenda, and both RMIT University and UN Habitat Cities and Climate Change Initiative (CCCI) look forward to working with the Project Management Unit (PMU) as the project continues.

The input of Port Vila Municipal Council (PVMC), including Lord Mayor Ulrich Sumptoh and the CEO Town Clerk Ronald Sandy, has been critical to maintaining meaningful engagement within the municipal area. A number of PVMC Councillors and staff also provided extensive input at PVMC-hosted events.

Shefa Provincial Government Council has also helped facilitate the research process, with Climate Change Officer Zoe Ayong greatly assisting throughout, as well as a number of SPGC staff. Thanks also to: the Adventist Development and Relief Agency, the National Disaster Management Office, the Secretariat of the Pacific Community – German Society for International Cooperation office and intern group, and the Vanuatu National Council of Women.

Wan Smolbag Theatre Company facilitated the Blacksands Transect walk, with Michael Taurakoto and Yaxlee Nangof engaging local community leaders on behalf of the project team. Sarah Mecartney from UN Habitat provided numerous contact points and advice throughout, with staff from Oxfam, Save the Children, the Pacific Institute of Public Policy, the Vanuatu Metrological and Geo-Hazards Department, the Asian Development Bank/ World Bank Joint Mission, the Department of Local Authorities, Live and Learn, and the Department of Environmental Protection and Conservation participating in interviews and/or workshop activities.

Assistance from PacLii Director Lenore Hamilton and her staff at the University of the South Pacific (USP) was instrumental in conducting institutional analysis, with the online PacLii database providing a crucial access point for legislative documentation.

Janaka Gamage (RMIT University) conducted the preliminary analysis of census data for Greater Port Vila and developed the base maps for the GIS data in this report. Collation and provision of enumeration area census data by Vanuatu National Statistics Office staff Anna Wells and Benuel Lenge is also gratefully acknowledged.

## Executive Summary

This report constitutes the complete outputs of the climate vulnerability assessment carried out by RMIT University for Port Vila, Vanuatu throughout 2014. This activity forms part of the broader agenda for UN-Habitat's Cities and Climate Change Initiative (CCCI) in the Pacific region. The content contained in this report is based on knowledge generated through three visits to the city by both report authors, a variety of engagement activity (interviews, workshops and a transect walk), elicitation of local/traditional knowledge, collating and analysing available primary data, and a comprehensive desk-top analysis of relevant literature.

The first field trip was carried out in April 2014 with a primary aim of undertaking an actor and policy mapping exercise. Activity during this initial visit was primarily interview-based and was used to inform an initial scoping report. The second visit, in July 2014, involved a weeklong series of different engagement activities including interviews, workshops (hosted by Shefa Provincial Government and the Municipal Government), and a transect walk through the Blacksands informal settlement. A final visit to gather feedback on review of the report draft was conducted in December 2014.

Given the limited availability (or inaccessibility) of primary data to support the assessment process – more so than other CCCI cities that have already conducted vulnerability assessments – much of the initial efforts from this first phase have been necessarily focused on collating the necessary data to support steps 1 and 2 of the UN-Habitat *Planning for Climate Change* Process (Module A: what is happening?) in order to establish a more solid foundation for the assessment.

This vulnerability assessment report is in three main parts:

1) It documents the methodology and associated activity (as mapped to the CCCI planning structure) and identifies follow up actions;
2) It incorporates a first pass vulnerability assessment report that has been completed adopting the CCCI formatting used for other case studies in the Asia-Pacific region; and
3) It highlights some of the initial findings that have arisen in relation to vulnerable communities – in particular informal settlements - and some of the key issues that need to be addressed.

In addition to sea level rise and ocean acidification in the city's immediate vicinity, a key climate-related hazard identified by stakeholders was localised flooding; a consequence of both intense rainfall but also urban drainage issues. Sustaining ecosystem services under a changing climate is also seen as critical in the Port Vila context, particularly given the importance of tourism and agriculture to the Pacific Island Nation. This first phase of research also highlighted the vulnerability of informal settlements both in the urban and peri-urban areas, a consequence of their sensitivity, exposure, and lack of adaptive capacity. Addressing such issues is further complicated by complex land tenure arrangements. A full range of direct and indirect impacts is addressed in the report and will form the basis for *Planning for Climate Change*.

**List of Organisational and Project Acronyms**

**ADB-WB** – Asian Development Bank/ World Bank Joint Mission
**ADRA** – Adventist Development and Relief Agency
**CCA** – Climate Change Adaptation
**CCAP** – Climate Change Adaptation Program
**CCCI –** UN Habitat Climate Change and Cities Initiative
**CLGF –** Commonwealth Local Government Forum
**DEPC –** Department of Environmental Protection and Conservation
**DLA –** Department of Local Authorities
**DRR/M –** Disaster Risk Reduction / Management
**JICA** – Japan International Cooperation Agency
**NAB –** National Advisory Board on Climate Change and Disaster Risk Reduction
**NCC** – National Council of Chiefs
**NDMO** – National Disaster Management Office
**NHC** – National Housing Corporation
**MDRR –** Mainstreaming Disaster Risk Reduction in Vanuatu
**PIPP** – Pacific Institute of Public Policy
**PVMC** – Port Vila Municipal Council
**PVUDP** – Port Vila Urban Development Project
**PVVA –** Port Vila Vulnerability Assessment
**RMIT –** Royal Melbourne Institute of Technology
**SOPAC** – SPC Applied Geoscience and Technology Division
**SPC-GIZ** – Secretariat of the Pacific Community – German Society for International Cooperation
**USP** – University of the South Pacific
**VANGO** – Vanuatu Association of Non-Government Organisations
**VCAN** – Vanuatu Climate Adaptation Network
**VHT** – Vanuatu Humanitarian Team
**VMGD** – Vanuatu Meteorological and Geo-hazards Department
**VNCW** – Vanuatu National Council of Women
**VNSO** – Vanuatu National Statistics Office
**WSB** – Wan Smolbag Theatre

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# 1. Introduction

## 1.1 Cities and Climate Change

Small Island Developing States (SIDS) such as Vanuatu are at the forefront of climate change. Having contributed little to the greenhouse gas emissions that are increasing global temperatures they are disproportionately exposed to hazards such as sea level rise; coupled with both heightened sensitivity to and reduced adaptive capacity for dealing with climate hazards. This mean that SIDS number not only amongst the nation states most at risk from projected future climate changes; they are also some of the most vulnerable to current climatic extremes, as well as some of the early impacts of rising global temperatures that are already being observed.

Cities in SIDS act as gateways to development and the global economy, and as a consequence are drawing in rural residents at a rapid rate. This represents both a challenge and an opportunity for climate change adaptation. In the case of Port Vila, annual increases in the city's population of more than 10% over the last two decades mean that planning for the challenges presented by a changing climate is being compounded by those associated with rapid urbanisation and development more generally. Further, dependency on fragile coastal ecosystems and shallow ground-water resources for many citizens' livelihoods presents decision-makers with scenarios where a number of the ecosystem services upon which their populations and economies depend face possible collapse. The role of cities – either as sources of alternative livelihoods through employment, education and training, or as settings for more radical transformative change – will be central to planning for these medium term impacts.

Within such contexts, Climate Resilient Urban Development requires establishment of non-climate baselines and data, before the additional compounding effects of climate change can be overlayed and effectively planned for. Much of this report is therefore focused on providing Port Vila's municipal, provincial and national-level planners with a planning resource for ongoing rapid growth in a sustainable way, within the broader context of climate change.

## 1.2 UN-Habitat's Cities and Climate Change Initiative

The UN Human Settlements Programme (UN Habitat) Cities and Climate Change Initiative (CCCI) seeks to enhance the preparedness and mitigation activities of cities in developing countries. This vulnerability assessment forms part of this broader initiative, informed by the *Planning for Climate Change: A Strategic, Values-based Approach for Urban Planners* (Ingram & Hamilton 2014). This framework is being applied concurrently in multiple cities across 11 countries in the Asia-Pacific Region, with 10 urban climate change vulnerability assessments from a diverse range of developing countries currently publicly available online. CCCI aims to have 300 cities in the Asia-Pacific Region completing similar strategies by 2015. These assessments represent the conclusion of the first module of a 4-phase assessment process, with further steps identifying, prioritising, implementing and monitoring adaptation actions designed to be led by local government partners and stakeholders. This report constitutes the final output of Phase 1 for Port Vila, Vanuatu.

## 2 Overview of the City

### 2.1 City Context and Geography

Port Vila is located on the south-west coast of Efate Island, the focal point of the north-south 'Y-shaped' Vanuatu archipelago. Consisting of a varied topography and land uses ranging from plantations to quarrying, an accurate survey of the distribution of land use across the city is yet to be developed for either the municipality or the surrounding peri-urban area.

For the purpose of this report, Greater Port Vila includes the colour-shaded areas shown in Figure 1, which is consistent with the city's statistical boundaries used in the 2009 National Census (VNSO 2010). The depicted area is significantly larger than the municipal boundaries that are legislated in both the original *Municipalities Act [CAP 126]* and the more recent *Port Vila Municipality (Composition of Council and Wards) Amendment (Order No. 66 of 2013)* (Government of Vanuatu 1980; Government of Vanuatu 2013). However, as was identified in the initial scoping visit (Trundle & McEvoy 2014), as well as subsequent workshop discussions with both municipal and provincial government representatives, a broader definition better reflects the practical 'urban' extent, while allowing for more effective analysis of mutual vulnerabilities, management of cross-border issues, and joint development of knowledge and capacity-building (see also: Shorten 2002).

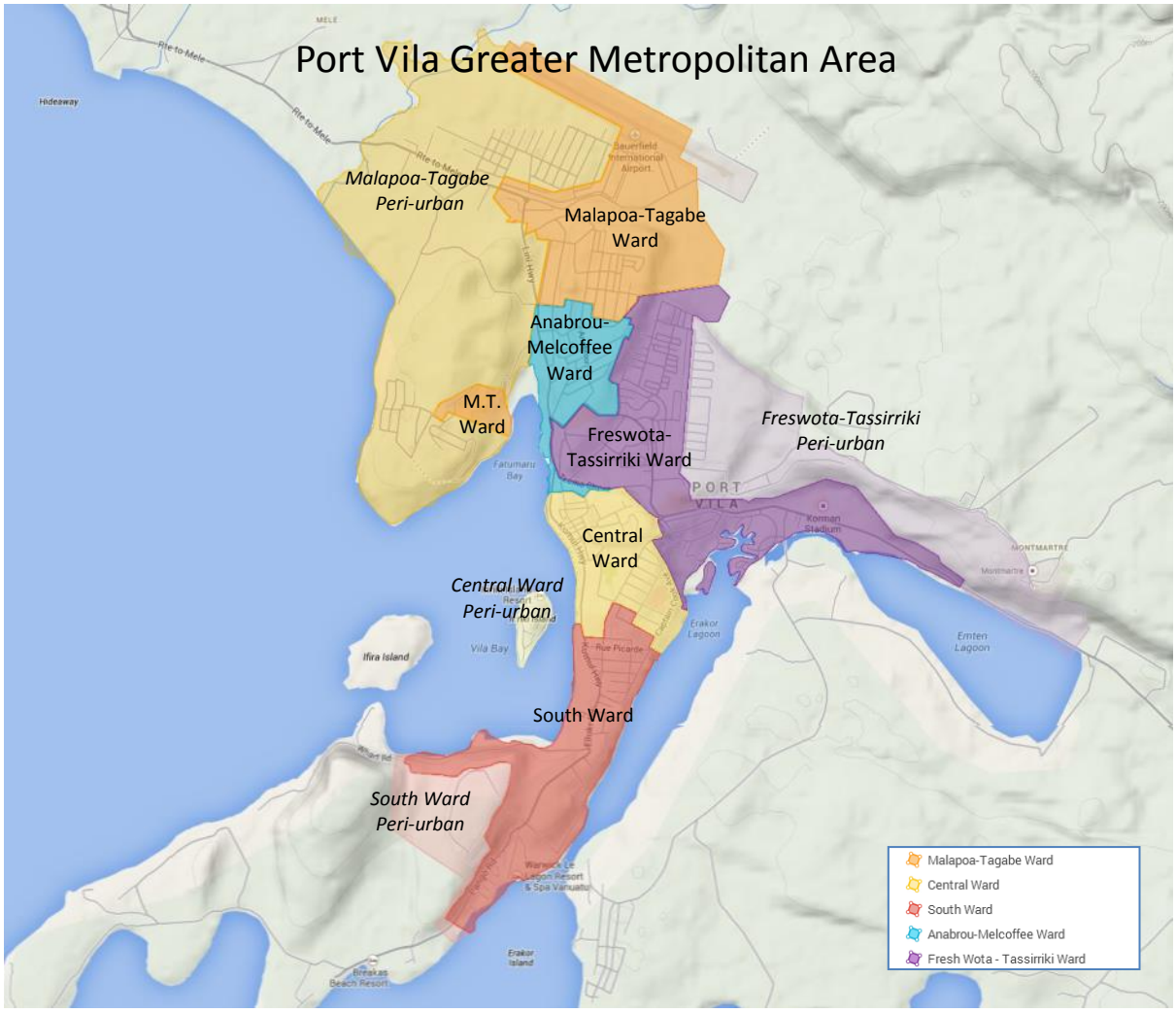


**Figure 1**: Study area delineated by ward and associated peri-urban surrounds

Greater Port Vila covers approximately 24.3km$^2$, which by area is evenly split between 'urban' (municipal) and 'peri-urban' (provincial) land. As of the 2009 national census, the population of Port Vila Municipality was 44,039 (VNSO 2010); a figure projected to have increased to more than 51,100 by 2013 (VNSO 2014). As illustrated in Figure 1, adjacent peri-urban areas have been aligned and integrated with their respective wards for statistical analysis, as well as for the purpose of enabling future adaptation and governance partnerships (discussed further in Section 3.4.3). As a result, the total population of the study area at the 2009 census was a significantly larger figure – 60,788 residents – with the projected population estimated to have reached 84,895 by 2013 (VNSO 2014).

**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 Freswin is also located at the ward's south-eastern edge. The division includes a more established, but isolated residential district centred upon Malapoa College; an isolated municipal estate geographically differentiated by the more rugged topography of Malapoa Point, of which the southern extremity remains extensively forested.

**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 Port Vila Municipal Council (PVMC). Comprising predominantly of residential housing, the westerly-sloping ward contains the informal settlement of Ohlen, as well as the suburbs of Namburu North, South and Central. The commercial, industrial and tourist-focused suburbs of Jack Fong and Tebakor Pressing lie along the western edge of the ward, along the valley corridor extending northward from Fatumaru Bay. Although the informal settlement of Simbolo falls within the ward for the statistical purposes of this study (being counted within the Namburu Central conurbation), it is located within the legislated boundary of the adjacent ward of Freswota Tassiriki.

The Greater **Freswota-Tassiriki Ward** includes the large peri-urban area of Teouma Road, which follows the escarpment along the northern edge of Emten Lagoon eastward to Montmartre. The geography of the Freswota-Tassiriki division is highly varied and heavily sloped, rising to more than 100m above sea level at its most eastern extremity, while the entire suburb of Le Meridien has an average elevation of only 10m. Non-residential land uses include agricultural at the north-eastern edge of the city, as well as forest throughout the peri-urban eastern fringe. The ward also contains the University of the South Pacific (USP) Vanuatu Campus.

**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 organisations (including the National Parliament, PVMC Headquarters and a number of schools). The area has a steep topography, with extensive critical infrastructure located along the ward's 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 leasehold arrangements, the majority of the residents do not hold direct tenure). Iririki Island, which includes Iririki Resort, has been included in this Greater Port Vila division (an enumeration area referred to by its historical name of 'Burns Philip' in statistical documentation).

**South Ward** is predominantly composed of formal residential tenure arrangements, with some industrial zones along the ward's Vila Bay coastline. The ward also includes the country's main port and only container port, which account for over 85% of Vanuatu's imports, and facilitate a significant

share of tourism income through the cruise ship terminal. The city's gas and fuel depots are also located within the ward boundary in Paray Bay, as well as the National Disaster Management Office (NDMO), the National Library and Archives Building, the Chiefs' Nakamal, the National Museum and Saralana Park. Although largely covered by forest, the peri-urban area of Nambatri West has been included in this division.

In the context of Greater Port Vila, roughly 50% of land area falls within the municipal boundary. Figure 2 demonstrates the significant differences when examined at a ward level, both in terms of total land area and peri-urban land allocation, with the Malapoa-Tagabe Ward division encompassing the largest peri-urban area (7.59km$^2$) due to the inclusion of Malapoa Point within the ward boundary. A full table of the allocation of VNSO enumeration areas by ward is provided in Annex 1 of this report.

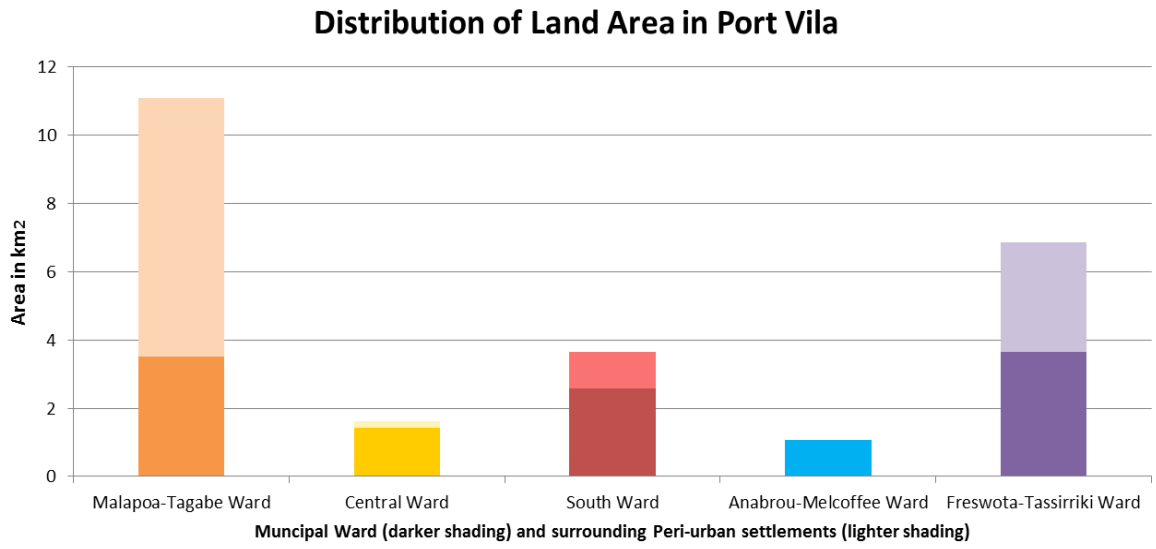


**Figure 2:** Land area by Greater Ward Area and peri-urban/urban classification

## 2.2 Climate Profile, Natural Resources and Ecosystems

Port Vila is located within the South Pacific Convergence Zone at a latitude and longitude of 17°44'S 168°19'E, within the cyclone belt and approximately 50km east of the New Hebrides Trench, an active source of tectonic events that continue to trigger major earthquakes and tsunamis (Shorten et al. 2004). Sited across a mosaic of alluvial plains, rugged volcanic topography, coral uplift and regenerative coastal processes, Port Vila's diverse geology has generated a range of exploitable natural resources, while the city's shallow coastal surrounds have provided an abundance of marine materials, food products and in-situ natural assets for the city's tourism-driven economy. Key national commercial goods (many of which are exported through Port Vila) include coconut, coffee, cocoa, as well as processed wood and fish products (ADB 2013). Relative to other Pacific nations, Vanuatu has a high share of its economic output dependent upon natural resources, with agriculture producing 23.9% of the country's GDP in 2011, in contrast to industry which produces only 10.1% (ADB 2013). Agriculture also employs 60.5% of Ni-Vanuatu[1] (ADB 2013); even within the urban area of Greater Port Vila 2.2% of households reported their primary income as being derived from the sale of fish, crops and handicrafts (VNSO 2014).

[1] Ni-Vanuatu is the Bislama descriptor for Vanuatu nationals, translating literally as "of Vanuatu"

Ecosystems within Port Vila's land boundary have been heavily modified since the area's settlement; with plantations having replacing natural scrub and forest. The city's water catchment, which lies to the east of the Bauerfield Airport land strip and extends eastward into the abutting mountain region (as well as southward to the edge of the municipal boundary), is restricted to non-intensive agricultural uses, however enforcement of this has lapsed with housing developments occurring within Zone 1 of the catchment in recent years. The eastern edge of the city lies along two lagoons (Erakor and Emten), with fragile brackish mangrove and sea grass ecosystems established within these areas (which have low levels of salinity due to the lagoon mouth lying within the intertidal zone). The coastal marine ecosystems surrounding the city provide a vital source of food, a feature for local tourism businesses and a recreational resource for residents, as well as providing the main routes for inter-island trade and transport.

Port Vila is characterised by a two season tropical climate (as shown in Figure 3), experiencing relatively mild annual average temperatures year-round, with minimal observed inter-annual variability. Long-term average Dry Season (May-October) minimum and maximum temperatures are 20.1°C and 26.8°C respectively, while Wet Season average temperatures are slightly higher; 22.7°C and 29.7°C (PACCSAP 2014).

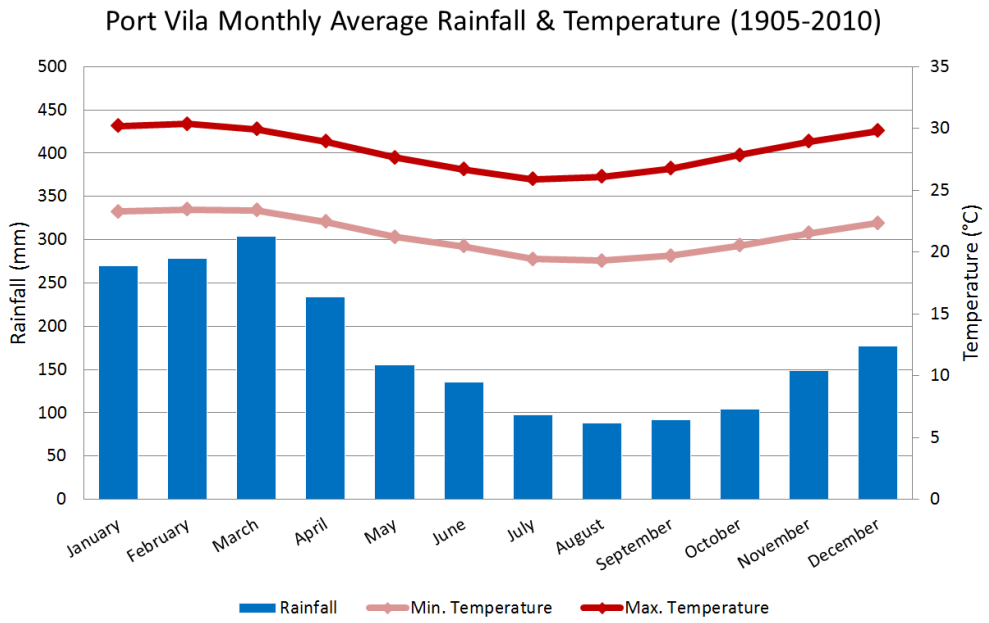


**Figure 3:** Port Vila Monthly Average Rainfall and Temperature Long-term Averages (data sourced from PACCSAP 2014)

Rainfall records are, however, much more variable, demonstrating significant inter-annual and seasonal fluctuations. Two thirds of Port Vila's 2083mm of annual rainfall has historically fallen within the Wet Season (see Figure 4), however as shown in Figure 4 significant inter-annual variations occur in both dry and wet seasons, with total annual rainfall fluctuating from as much as 4000mm down to as little as 800mm (PACCSAP 2014).

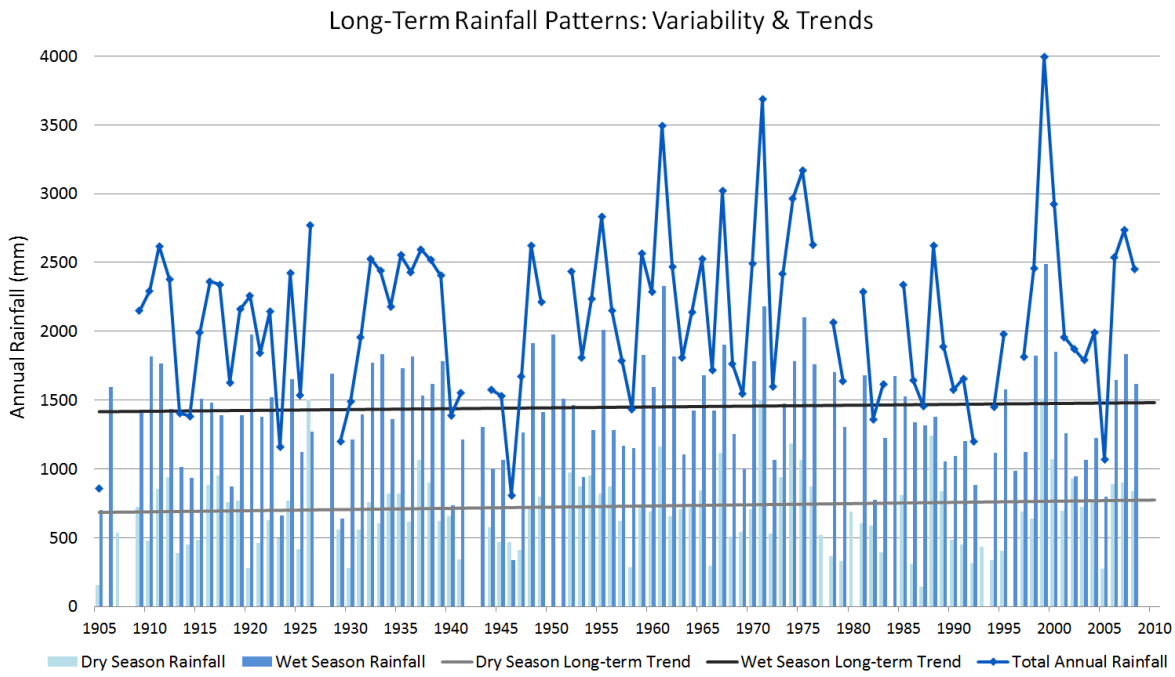


**Figure 4:** Port Vila Rainfall Variability and Trends (data sourced from PACCSAP 2014)

Observed variability correlates strongly to the El Niño Southern Oscillation (ENSO) Index, with annual average rainfall during El Niño events being 20% lower than that occurring during La Niña years (see Figure 5). Further, distinctly different patterns are evident in long-term rainfall averages when differentiated based on ENSO status, with total annual rainfall under La Nina conditions increasing significantly over the last century, in contrast with more stable El Niño averages, and a slight decrease when ENSO conditions are classified as neutral.

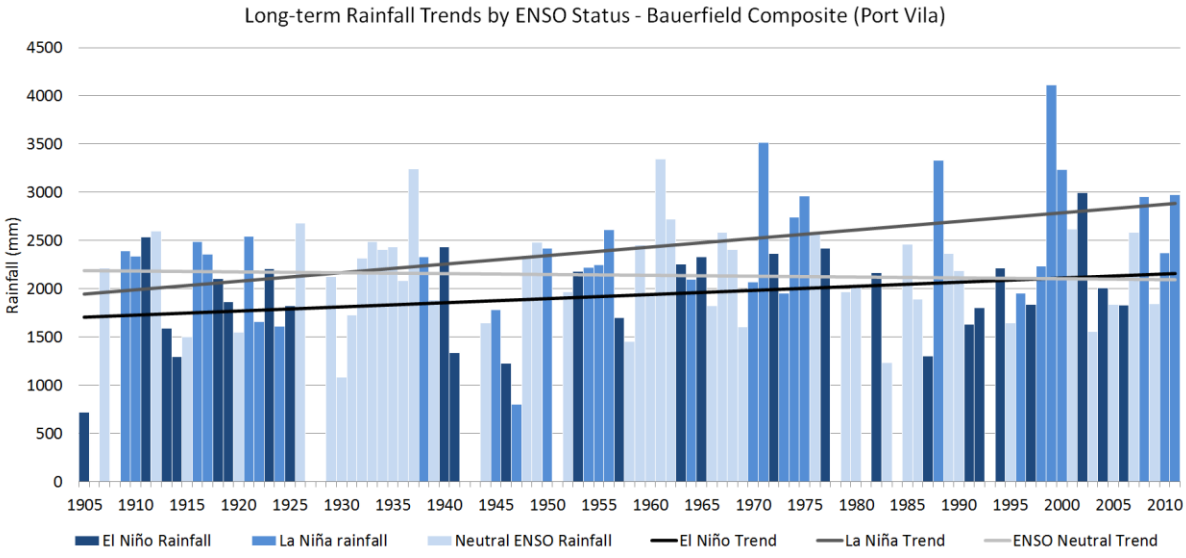


**Figure 5:** Port Vila Annual Rainfall by ENSO Status (data sourced from PACCSAP 2014)

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. Minimum daily temperatures are, however, rising at a slightly faster rate than maximums (as shown in Figure 6).

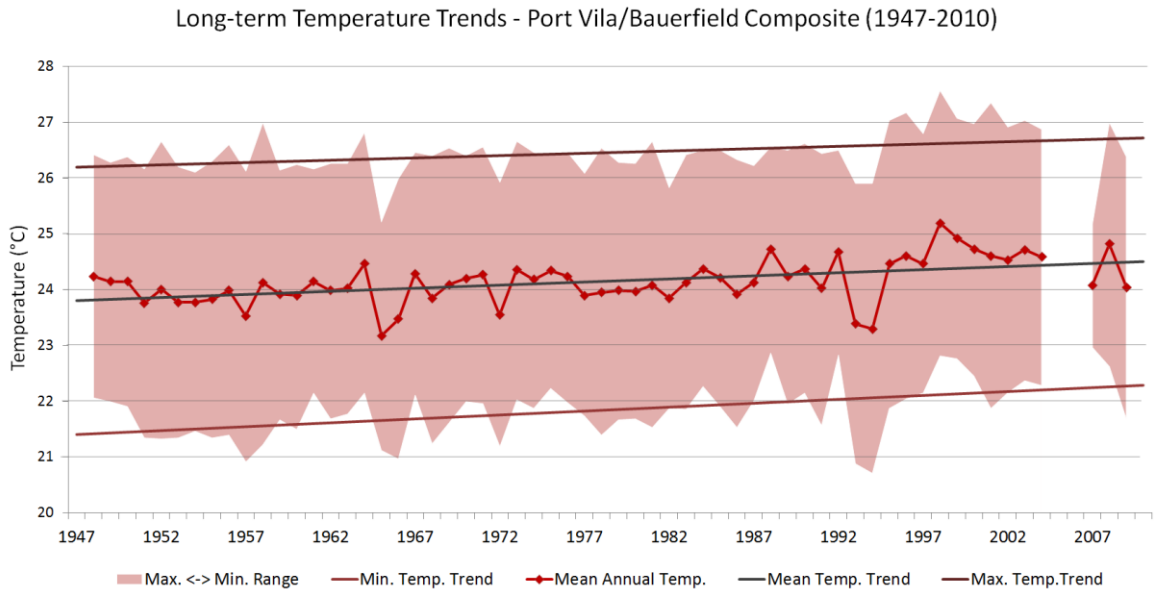


**Figure 6:** Port Vila Long-term Temperature Records (data sourced from PACCSAP 2014)

Consistent with this, trends in extreme daily air temperatures are not statistically significant, while analysis at a seasonal level shows a marginal variation from overall trends, suggesting little observable change in seasonal temperature patterns to date. There are also no discernible trends in daily rainfall extremes, however this is in large part due to the high level of annual rainfall variability (shown previously in Figure 4).

The Vanuatu Exclusive Economic Zone has experienced an average of 2.4 tropical cyclones per year for the last half century, of which 1 per year has been classified as severe. However historical records show highly inconsistent tracking of both severe and non-severe cyclones across the region on a year-by-year basis (6 in the 1991/92 cyclone season, compared with none in 2001/02) (BoM & CSIRO 2014). There is no clear trend in tropical cyclone occurrence in the vicinity of Vanuatu, and although there have been fewer cyclones impacting the islands in recent decades, trend analysis for either Port Vila or Vanuatu (which have limited data points for such observations even over a 50 year period) is not recommended. Tropical cyclones tend to impact Vanuatu between November and April (*ibid*).

## 2.3 Population and Urbanization

Port Vila Municipality has undergone rapid population growth over the last decade with projections for the four years since the 2009 census suggesting a further increase of 16.2% at an annual rate of 4%. Conservative estimates for the municipality's current population are now more than 51,000. This is double the rural rate of population growth – an average of 2% each year between 1999 and 2009 – however recorded figures would appear to suggest a slowing of the long-term rate for the city (see Table 1).

| **Average Annual Growth since previous Census** | **1979** | **1989** | **1999** | **2009** |
|---|---|---|---|---|
| Port Vila Municipality | **8.63** | **7.83** | **5.53** | **5.00** |
| Luganville Municipality | 8.51 | 3.44 | 5.42 | 2.25 |
| Rural | 3.00 | 2.21 | 2.58 | 2.06 |
| ***National Average*** | ***3.55*** | ***2.80*** | ***3.11*** | ***2.54*** |

**Table 1:** Official Rates of Annual Population Growth by Urban/Rural Classification of Residence

Much of Port Vila's recent growth, however, has occurred outside of the formal municipal boundary (see Table 2), with Greater Port Vila's population having doubled in the decade preceding 2009 at an annual growth rate of 10.7%. As such, the apparent slowing rates of municipal growth (shown in Table 1) do not necessarily reflect trends in overall urbanisation, but rather the limits to growth within the municipal boundaries of Port Vila and Luganville. Further, if Port Vila's peri-urban population is removed from 'Rural' growth calculations, national non-urban annual growth between 1999 and 2009 falls to less than 1%. These figures emphasise the importance of the urbanisation processes that are occurring in Vanuatu, further illustrated by Figure 7 below.

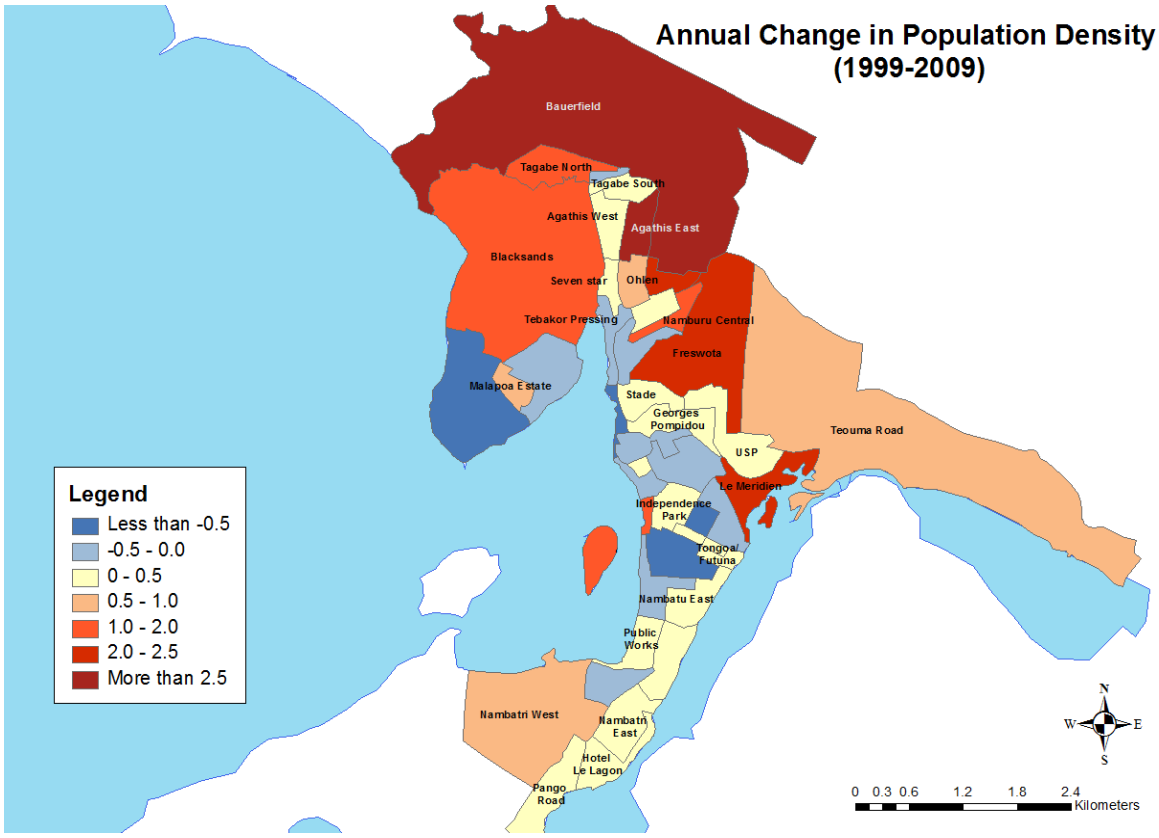


**Figure 7:** Urbanization, as demonstrated by changing density, across Greater Port Vila - 1999-2009

| Ward Division | Municipal Population | Peri-urban Population | Total |
|---|---|---|---|
| **Malapoa-Tagabe *** | 18017 | 11663 | 29680 |
| **Anabrou - Melcoffee** | 10123 | 0 | 10123 |
| **Freswota - Tassirriki** | 10895 | 1020 | 11915 |
| **Central Ward** | 4486 | 356 | 4842 |
| **South Ward** | 3020 | 1207 | 4227 |
| ***TOTAL:*** | ***46541*** | ***14246*** | ***60787*** |

** Note: a large number of enumeration areas in this ward lie across the municipal/provincial boundary*

**Table 2:** 2014 Provincially and municipally classified Urban Populations in Port Vila by Ward Division

Over half of Greater Port Vila's population resides in the northern division of Malapoa-Tagabe, the area of the city that has experienced the largest population growth over the last decade at an average annual rate of 14.6% (see Figure 8). Although much of this increase has occurred as a result of extensive subdivisions around Blandinieres Estate (largely located outside the PVMC municipal boundary), rapid population growth within the informal settlement of Blacksands (10.1% p.a.) has

also contributed to this population growth rate. Ongoing infill in Agathis East (36.1% p.a.) has also driven this northern re-distribution of the city's population.

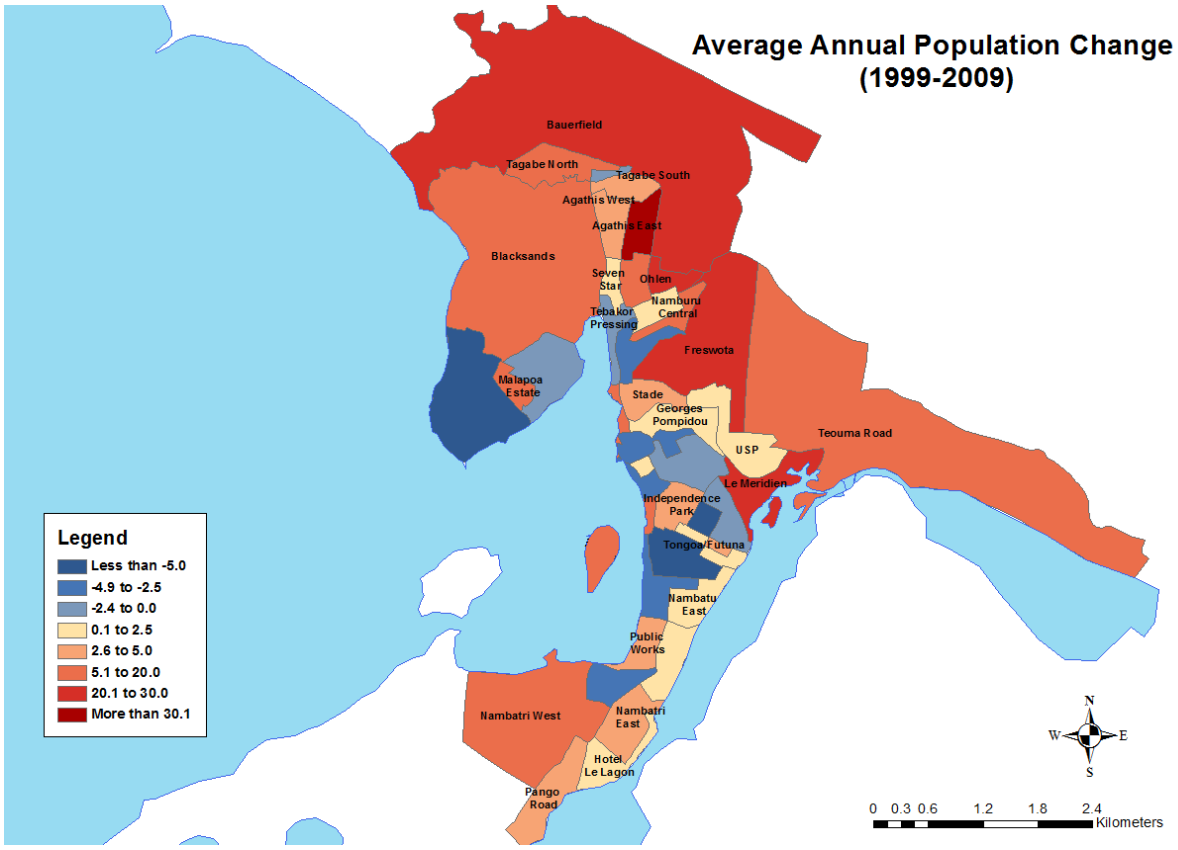


**Figure 8:** Population Growth across Greater Port Vila 1999-2009

Within Anabrou-Melcoffee population growth rates were also high, with the informal settlements of Ohlen and Namburu Central (Simbolo) growing at annual rates of 24.1% and 15.8% respectively over the last census period[2]. Freswota-Tassirikki has similarly grown at an average rate of 13.5% p.a., driven by further infill in Le Meridien and urban expansion eastward in Freswota.

The number of residents in the more established South and Central wards grew at rates below the national average (2.3% and 1.6% respectively). Overall, much of the city's urban growth is being accommodated through ongoing single-storey, detached housing expansion into peri-urban open space, with the exception of some key infill sites in the inner city (as discussed further below).

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. Tongoa/Futuna, the most intensely populated section of the city, has a current density of 410 persons per hectare (see Figure 9), equivalent to fitting the entire population of municipal Port Vila within the boundaries of Anabrou-Melcoffee Ward. The informal settlements of Simbolo and Ohlen are also extremely compact, with densities of 33,441 and 24,881 persons per square kilometre respectively, contributing to Anabrou-Melcoffee being the most densely populated of the 5 wards.

[2] Although Namburu Central/Simbolo formally lies outside of Anabrou-Melcoffee it is included within the ward's VNSO enumeration boundary

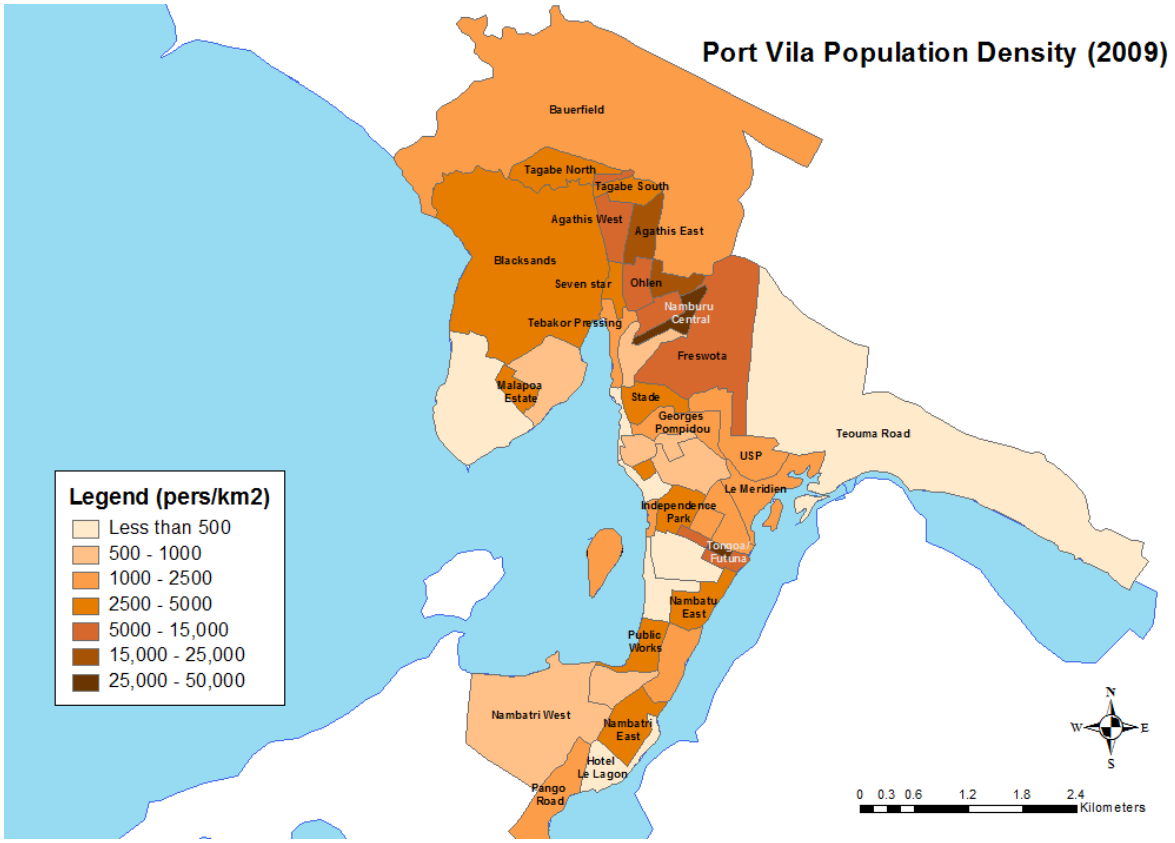


**Figure 9:** 2009 Population Densities across Greater Port Vila

Despite including extensive forested and plantation areas, Blacksands also has a population density of 3,415 persons per square kilometre, while the urban informal settlements of Ohlen and Agathis East have densities of 17,801 and 24,881 persons per square kilometre respectively.

## 2.4 Economy and Livelihoods

Analysis of sub-municipal 2009 census data (integrating peri-urban areas based on the analysis in Annex 1) shows that roughly 4 in 5 households in Port Vila rely on wage-based salaries as their primary source of income (see Table 3). This is in contrast to Vanuatu as a whole, where only one third of households rely on salaried incomes, with roughly half of the wider population dependant on the sale of fish, crops and handicrafts (VNSO 2014). The percentage of households with no primary income source is also lower across all wards than the national average of 5.5% (VNSO 2012).

| Primary Household Income by Area, Type | Wages/ Salary | Land Lease | Remit-tances | House Rent | Fish, Crops Handicrafts | Others | Self-Employed | None | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Malapoa - Tagabe Ward and Surrounds** | **3035** (80.8%) | **4** (0.1%) | **66** (1.8%) | **101** (2.7%) | **148** (3.9%) | **55** (1.5%) | **222** (5.9%) | **124** (3.3%) | **3755** |
| **Anabrou - Melcoffee Ward and Surrounds** | **1177** (86.0%) | **8** (0.6%) | **4** (0.3%) | **27** (2.0%) | **12** (0.9%) | **12** (0.9%) | **68** (5.0%) | **60** (4.4%) | **1368** |
| **Freswota - Tassirriki Ward and Surrounds** | **1909** (81.0%) | **3** (0.1%) | **16** (0.7%) | **71** (3.0%) | **29** (1.2%) | **74** (3.1%) | **148** (6.3%) | **106** (4.5%) | **2356** |
| **Central Ward and Surrounds** | **561** (85.3%) | **0** (0.0%) | **0** (0.0%) | **8** (1.2%) | **2** (0.3%) | **7** (1.1%) | **59** (9.0%) | **21** (3.2%) | **658** |
| **South Ward and Surrounds** | **745** (81.2%) | **1** (0.1%) | **6** (0.7%) | **10** (1.1%) | **11** (1.2%) | **31** (3.4%) | **93** (10.1%) | **21** (2.3%) | **918** |
| ***TOTAL*** *(Greater Port Vila)* | ***7427 (82.0%)*** | ***16 (0.2%)*** | ***92 (1.0%)*** | ***217 (2.4%)*** | ***202 (2.2%)*** | ***179 (2.0%)*** | ***590 (6.5%)*** | ***332 (3.7%)*** | ***9055*** |

**Table 3:** Primary Source of Household Income by Greater Ward Area (VNSO 2014)

Although data on poverty levels is not currently available at a ward level, the *2010 Household Income and Expenditure Survey (HIES)* provides city-wide figures for households living below the Basic Needs Poverty Line (BNPL) (VNSO 2012). This threshold has been determined through analysis of the per capita income required for meeting basic nutritional requirements and non-food essentials such as shelter, transport and healthcare, taking into account variations in expenses based on locality. The BNPL for Port Vila in 2010 was calculated as 2,866vt per person, significantly more than the national threshold of 1,761vt (VNSO 2012:33). Consequently, although more households have wage and salary based income, 1 in 7 households in Port Vila in 2010 were unable to meet basic needs (14.7%), a level well above the national average (10.7%) (VNSO 2012:34). The depth of poverty in Port Vila (measured by the Poverty Gap Index, or PGI) is also more than double that of rural areas, with those Port Vila residents falling below the BNPL requiring, on average, a real increase in income of 5.4% before their basic needs can be met; a more entrenched level than elsewhere in the country (World Bank 2014).

More specific data on the industries that form the basis of the wages and salaried incomes shown in Table 3 is not available, however statistics for Vanuatu's collective 'urban' areas, which includes both Port Vila and Luganville, shows that roughly half of the two cities' municipal populations are actively involved in the workforce. Of those residents actively engaged in the workforce one fifth are engaged in services and sales, followed by 15% engaged in craftwork and trades (see Figure 10).

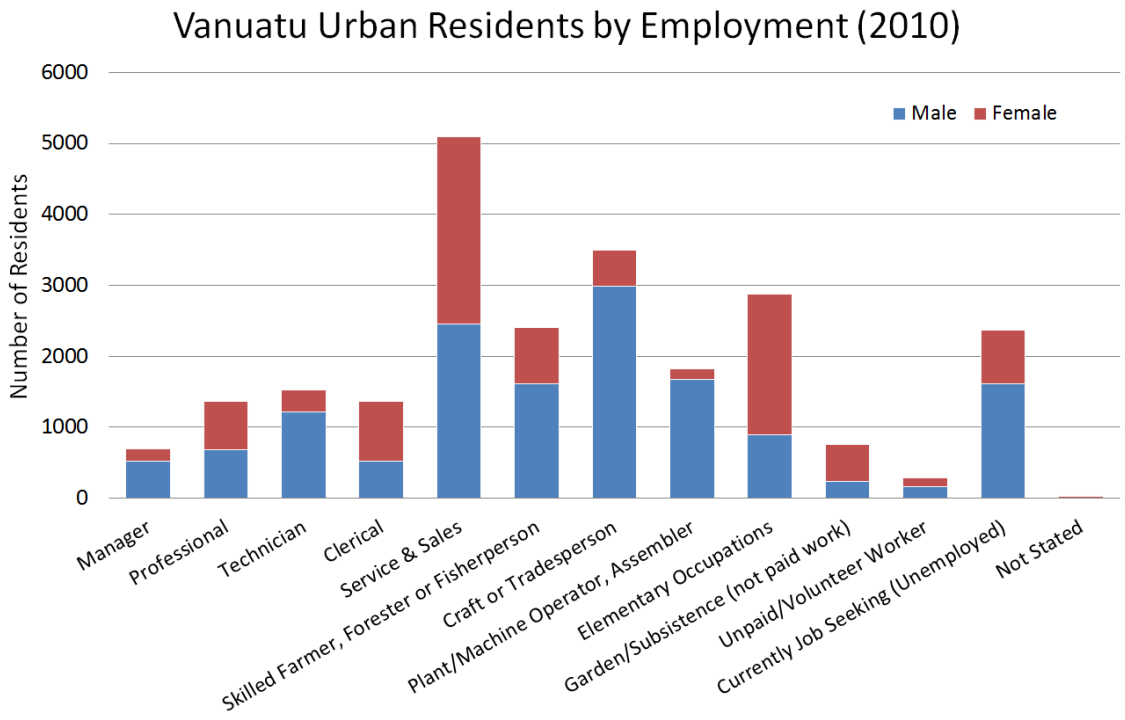


**Figure 10:** 2010 Combined Port Vila and Luganville Employment Data (extracted form VNSO 2012)

Of those urban residents not actively engaged in the workforce 39% are currently studying, with a further third occupied with household work (of whom roughly 85% are women). A full break down of self-classified reasons for not being engaged in the workforce is shown in Figure 11.

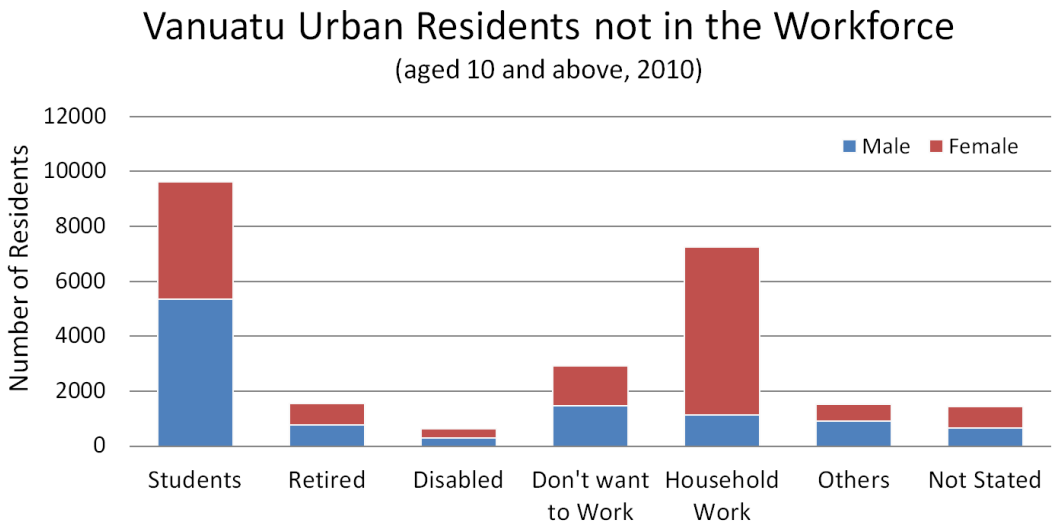


**Figure 11:** 2010 Combined Port Vila and Luganville Non-workforce Data (extracted from VNSO 2012)

The livelihoods of roughly a quarter of Port Vila households are either dependent on or supplemented by direct production of goods. In 2010 this represented a total annual value of more than 1.15 Billion Vatu (see Table 4). It is important to note that while the individual product types are further explored here in order to profile the livelihoods of Port Vila residents, specific numeric analysis beyond this should be considered with caution due to the relatively small sample size in the HIES (VNSO 2012).

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

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

**Table 4:** Household production-based income by category (VNSO 2012)

When broken down by product type, household-based income generation shows a high level of diversification in small-scale items, with the bulk of household value generation being driven in Port Vila by Kava production and processing. As shown in Figure 12, there are 36 identifiable products – predominantly food based – which each generate moderate returns for a relatively small number of households on an individual basis, but collectively contribute to the livelihoods of up to 10% of the total Port Vila population (VNSO 2012). Although of relatively small economic value, the 2010 HIES also states that all households produce Baskets and Pig Tusk products, which can be exchanged for goods and services within the cash economy as a quasi-currency. This extrapolation does however have a sampling margin of error of 53.77% (World Bank 2014). A more comprehensive survey of Port Vila household livelihoods and income is recommended to improve the margin of error evident in these samples.

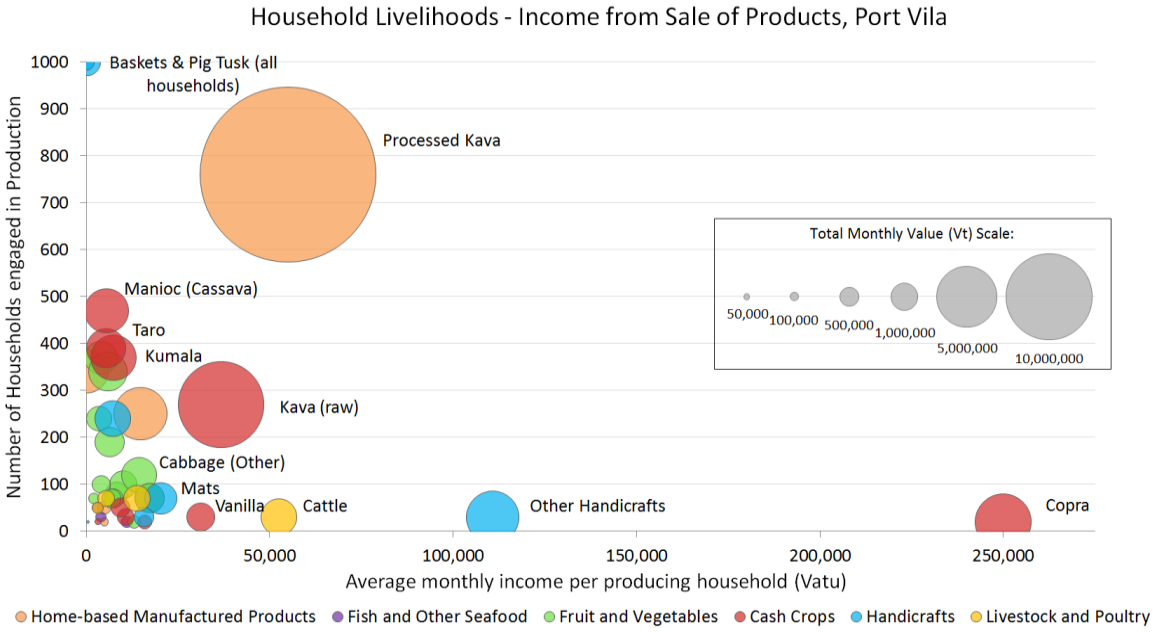


**Figure 12:** Livelihood Support by Household Production Type – Port Vila, 2010 (derived from VNSO 2012)

Kava – both processed and raw – represents the most significant household-based contributor to the Port Vila's economy, with a collective annual value of over 0.62 Billion Vatu. Copra, while of direct benefit to only a small number of Port Vila residents, was the highest value product on a per-household basis (generating a monthly income of 211,000vt), followed by miscellaneous handicrafts (110,000vt) (VNSO 2012).

In addition to market-economy based livelihoods, home consumption – or 'subsistence' – products are an integral component of many Ni-Vanuatu's livelihoods, with a total value of over 1.26 billion Vatu in 2010 (VNSO 2012). Even within the urban area of Port Vila, over 51% of households are estimated to be engaged in self-supply and consumption of livelihood products (VSNO 2012:119). The bulk of this non-market economic value is derived from household production and consumption of fruit and vegetables, worth an estimated 59,348,100vt annually. Additional food products generated for self-consumption include meat, poultry, bakery goods, beverages and other farm products such as fats and oils. Home consumption of dairy and milk production in Port Vila, while relatively small in value, accounts for 69.5% of the categories national non-market value, while clothing and footwear accounts for 85.5% (VNSO 2012).

## 2.5 Governance Structure

As shown in Figure 13, the governance structure for Greater Port Vila is complex, crossing two local government jurisdictions, with large areas of informal settlements, customary land-ownership arrangements, and a number of NGO organisations engaged in municipal service provision in different areas across the city.

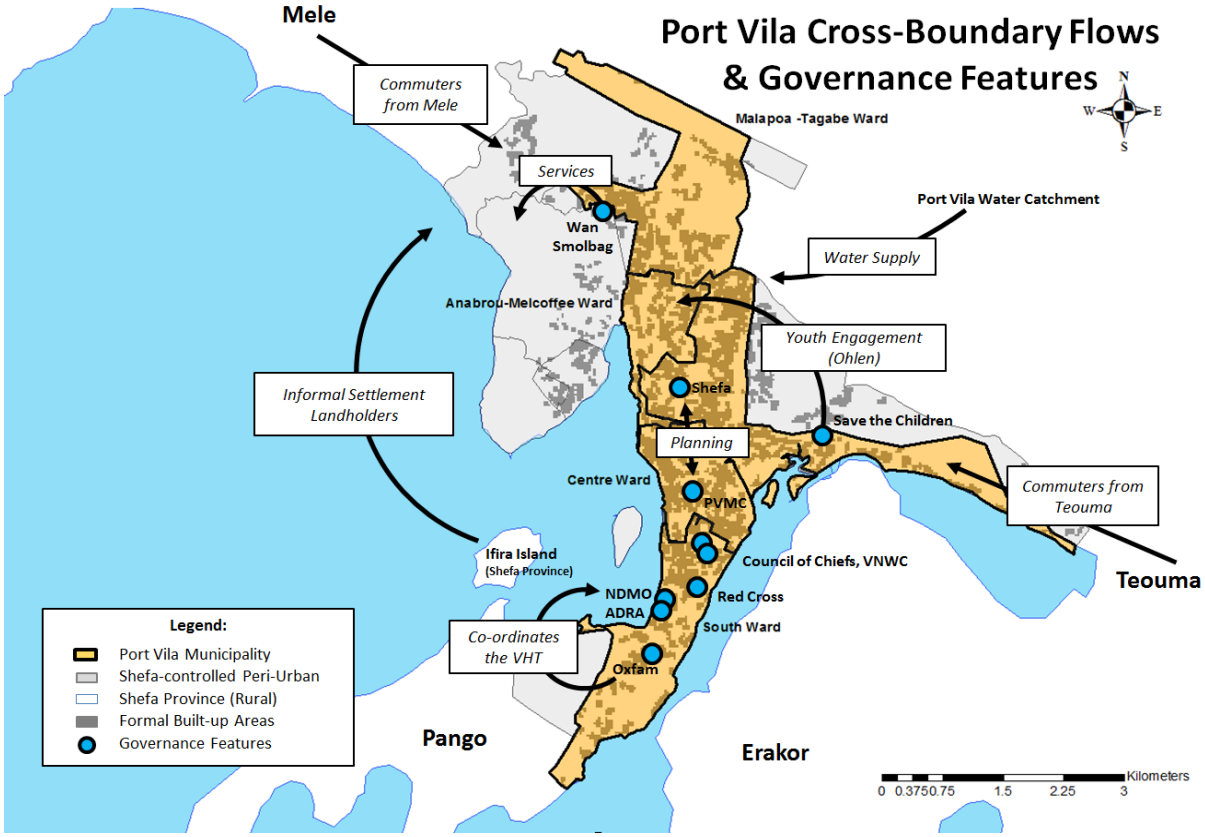


**Figure 13:** Key Cross-Border Governance Issues and Structures

**Port Vila Municipal Council** 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 the 20th of May 2013 *(Order No. 66 of 2013)*, creating an additional 5th ward within the city with only minor adjustments of the overall municipal area (specifically, exclusion of a small area of Le Plateau in South Ward). Ward councils were set up by the new Mayor in July 2014, with the aim of providing local focal points for the community, and

comprise of representatives from the Council of Chiefs, the Vanuatu National Women's Council, Church Groups, Youth Organisations and the Disabled Persons Association of Vanuatu.

**Shefa Provincial Council** governs the area of Efate Island outside of the municipality of Port Vila, including the peri-urban areas shown in Figure 13. Land outside of the PVMC (as well as Luganville) is governed under customary law by members of the Malvatumauri, or the National Council of Chiefs (NCC) (GoV 2013), 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 (particularly regarding subdivision policies).

**National Government Agencies** maintain oversight of both PVMC and Shefa Provincial Council, who both report to the Department of Local Authorities (DLA). Resources and staff expertise in areas such as urban planning, engineering, disaster risk reduction and construction is predominantly focused within these national institutions, which engage with and support the local authorities on an ad-hoc basis. These national agencies operate in partnership with large **National and Transnational Donor and Loan Bodies**, such as the World Bank, NZAID, JICA and Australian Aid on significant infrastructure and planning projects; with the latter providing funding, personnel and decision-making support.

**Local and International Non-Government Organisations** also play an important role in project implementation, data analysis and fund-sourcing at a more local scale, with some examples of these interactions shown in Figure 13. For example, the Wan Smolbag Theatre Company 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 the city. These linkages will be explored further in future stages of the *Planning for Climate Change* process.

# 3 City Vulnerability to Climate Change

## 3.1 Assessment Framework

*Planning for Climate Change: A Strategic, Values-based Approach for Urban Planners* sets out a cyclical, 4 module framework for assessing, prioritising and acting on climate change within urban environments (summarised in Table 5). The purpose of this report is to complete Steps 2 and 3 (and thereby Module A) of the *Planning for Climate Change* process, providing an operational platform for prioritising areas of vulnerability, developing adaptation options, and evaluating these options as the climate and urban development patterns continue to change.

| CCCI Toolkit Stages | Activities and Key Issues | Suggested Timeline |
|---|---|---|
| **Module A: What is Happening?** | | |
| **Step 1: Getting Started** | Desk-based review of publicly available documents, initial identification of data gaps | 2 to 3-months |
| **Step 2: Stakeholders and Participation** | Best facilitated with in-country 'champions' who can act as local contact points/co-ordinators. | An ongoing task over the course of the project, with several days of meetings at the beginning to get organized. |
| **Step 3: Vulnerability Assessment** | Integration of community viewpoints with climate and non-climate data. | A 1 or 2-day workshop followed by several months to a year of study. |
| **Module B: What Matters Most?** | | |
| **Step 4: Issues and Objectives** | Activities and community engagement will vary. | From a 1-day workshop with stakeholders, to several months or more. |
| **Module C: What Can We Do About It?** | | |
| **Step 5: Identify Options** | Depends heavily on level of engagement, expertise and funds. | Initial options can often be identified in a 1 or 2-day workshop. |
| **Step 6: Option Assessment** | More comprehensive assessment can take several months. | Options can be evaluated in a 1 or 2-day workshop with several days of advance preparation. |
| **Step 7: Implementation** | Actual implementation timelines will vary depending upon the scale and scope of the actions. | Depending on organizational capacity, development of the final *Climate Change Action Plan* can take several months. |
| **Module D: Are We Doing It?** | | |
| **Step 8: Monitor and Evaluate** | M&E processes required and need extensive mainstreaming for ongoing data collection. | Initial framework could be developed in a 1-day workshop. Development of full plan will likely take 1 or 2 months. |
| **Step 9: Adjust and Modify** | As climate impacts evolve and change adaptation actions may require modification. | Ongoing – feeds back into the next iteration of the planning cycle (Step 1 above). |

**Table 5:** UNH CCCI Planning for Climate Change Framework

As stated in the toolkit, the suggested timelines and activities only provide guidelines for application, with each urban context requiring different levels of engagement, adaptation of tools and analysis of baseline data. In the case of Port Vila, a significant proportion of the process was focused on collating and analysing socio-economic data across the urban area in order to understand the non-

climate context upon which future climate change will impact. Additionally, although city-wide hazard mapping is a notable gap, these data sets are being developed concurrently through a joint ADB-World Bank initiative. Rather than duplicate this process, this report has taken a 'bottom-up', community and stakeholder led approach to identifying hazards, with the objective of ground-truthing the more 'top-down' approach being taken through the *Mainstreaming Disaster Risk Reduction in Vanuatu* (MDRR) project (World Bank 2013). Discussions to ensure the inter-operability of these frameworks are ongoing, with the intention of integrating and streamlining the activities under forward modules of the CCCI toolkit through the NAB. This will have the additional benefit of providing a framework for more effective participatory, community engagement in the implementation of the MDRR project.

As shown in Figure 14, Climate vulnerability has been assessed as a product of exposure and sensitivity, which are counteracted by the city's adaptive capacity. This theoretical framework is commonly displayed as:

$$\textit{Vulnerability} = \frac{\textit{Exposure} \times \textit{Sensitivity}}{\textit{Adaptive Capacity}}$$

Examples of each of these components are illustrated in Figure 14.

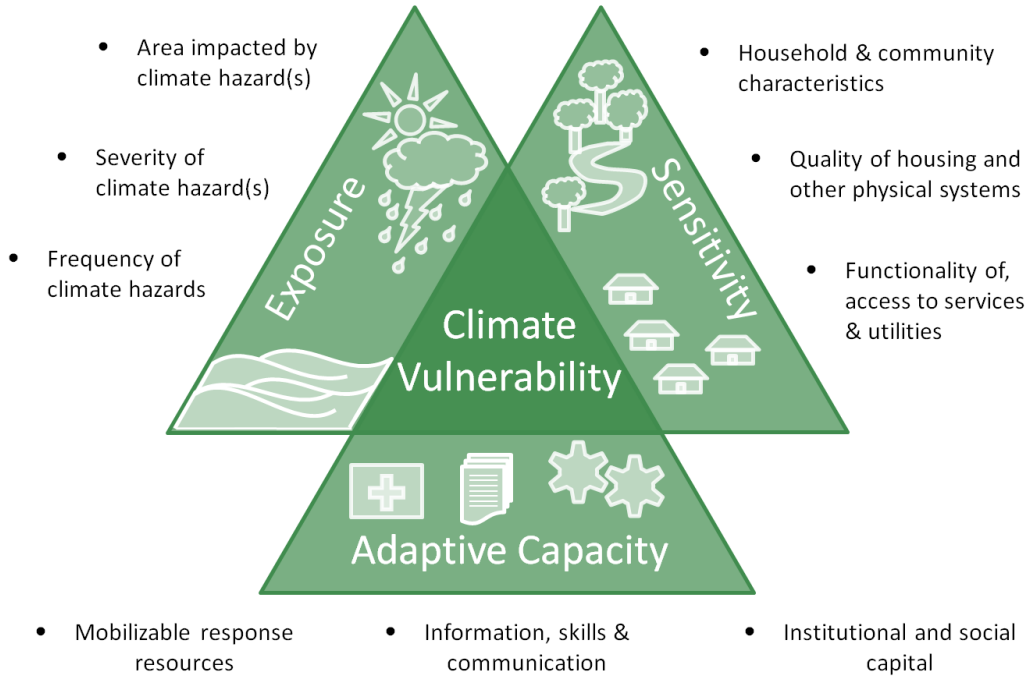


**Figure 14**: Components of Climate Vulnerability

The full process applied for collecting data across these three categories to date is set out in Annex 2 – Vulnerability Toolkit however a summary of the research methods and activities that have contributed to this report is provided below:

- **Preliminary Desktop Analysis (March-April 2014):** Desk-based review of existing literature, data and earlier UN Habitat CCCI work.

- **Scoping Interviews and Data Collection (13-17 April 2014)**: 90 stakeholders were identified through an initial scoping process. Of these, 14 representatives were interviewed (at a ratio of 3:4 women to men) over a one week period. Interviews were semi-structured, focused through key questions regarding: 1) individual roles; 2) organisational engagement in climate change related projects; 3) projects within the Port Vila municipality; 4) knowledge of other key projects and actors relating to climate change adaptation (CCA), disaster risk reduction (DRR) or Port Vila's development and/or climate vulnerability; and 5) how the Port Vila Vulnerability Assessment (PVVA) engagement process and outputs could be of best use to their organisation. See Annex 3 of this report for a summary of the analysis of these interviews.
- **Scoping Interview Analysis and Fieldwork Synthesis (April-May 2014):** Findings were summarised, with key linkages mapped and a thematic SWOT analysis developed based on findings.
- **Recruitment and Engagement of Core Stakeholder Group (May-June 2014):** An ongoing process of establishing a core group of local experts to drive the assessment process, including engagement by Professor McEvoy with the Port Vila Mayor and Town Clerk at the Commonwealth Local Government Forum in Port Moresby and contact with local community leaders arranged through Wan Smolbag and the Shefa Provincial Council Climate Change Officer.
- **Core Fieldwork: Transect Walk, Interviews and Workshops (13-18 July 2014):** 11 additional interviews were conducted engaging key participants who were not available during the initial scoping visit. Two workshops were held with stakeholders. Workshop 1 (15 Participants, 8F/7M) was held with Shefa Provincial Council applying abridged versions Tools 3D and 3F from the *Planning for Climate Change Toolkit.* Additional stakeholder-based hazard mapping (Tool 3H) was conducted using laminated satellite imagery (the basis of Figure 17). A transect walk (9 participants, 5F/4M) was conducted through Blacksands, providing photographic evidence, site observations and community narratives through Wan Smolbag and the local Chiefs, allowing 'ground-truthing' of workshop findings. A final half-day workshop (21 participants, 13M/8F) was held with PVMC councillors, NGO experts and representatives from national departments where findings were discussed, a forward working group formed, and Tools 3J & 3L applied.
- **Desktop Analysis of Findings and Non-Climate Data (July-September 2014):** Raw suburb-level data provided by the VNSO allowed preliminary application of Tool 3F*: Socio-demographic Sensitivity Assessment*. In addition legislative and institutional analysis was conducted via further desktop review with the aid of the online PacLii database, with the assistance of USP staff (an alternative approach to Tool 3-N: *Rapid Institutional Assessment Questionnaire*). The outputs of this, as well as the activities listed above were compiled and analysed, forming the basis of this report.
- **Report Feedback (December 2014):** Meetings with key stakeholders for final report input.

### 3.2 Exposure to Climate Hazards

As mentioned above, an extensive hazard risk modelling and mapping process is currently being undertaken through the World Bank and Asian Development Bank funded *Mainstreaming Disaster Risk Reduction in Vanuatu* project, which is due for completion at the end of 2015. Rather than duplicate this process, this vulnerability assessment has taken a community and stakeholder-based,

'bottom-up' approach to developing hazard profiles, in order to provide a complimentary point of reference – and in effect ground-truth – the 'top-down' World Bank analysis.

Outputs from workshops, community engagement exercises with Blacksands Communities, and interviews with local stakeholders and experts have been integrated to provide a holistic community-based understanding of Greater Port Vila's exposure to climate related hazards. Findings from the Blacksands Transect walk also formed the basis of a workshop session with key stakeholders and experts, including 8 PVMC councillors, NGO representatives and partners from Shefa Provincial Council, Vanuatu Meteorological and Geohazards Department (VMGD), Secretariat of the Pacific Community (SPC) and the Department of Local Authority (DLA).

Throughout each exercise the most consistently raised climate hazards related to issues around heavy and extreme rainfall events, as well as associated impacts through localised flooding (see Figure 15). This was highlighted during a hazard analysis exercise conducted during the workshop with Shefa Province, community and expert stakeholders, where one third of all identified hazards related to these events. Notably, water-pooling in some areas was identified as occurring even during light rainfall, while further issues around drainage were exacerbated – if not predominantly driven – by inadequate and poorly maintained drainage throughout the city.

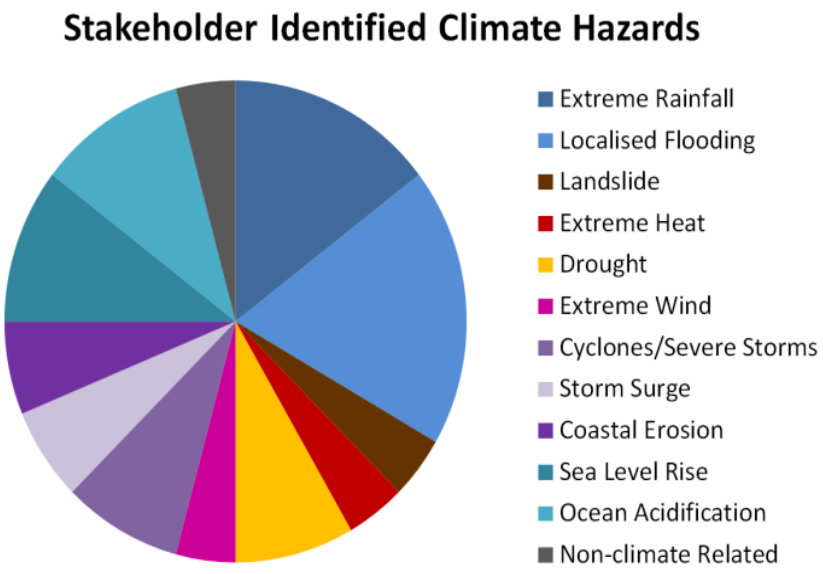


**Figure 15**: Distribution of Hazard identification by Shefa Workshop Stakeholders

Observed and likely future exposure to individual climate hazards is detailed further in the sections below, however it was noted by a number of participants that many impacts had the potential to occur concurrently, compounding the vulnerability of exposed areas. Additionally, although exposure has been assessed here through a sub-city, 'hotspot' approach (developed through the activities discussed here and depicted in Figure 16), exposure to hazards such as cyclones/severe storms, drought, and severe flash flooding was frequently described as being 'city-wide', and as such are not evident in the spatial analysis. Unless otherwise stated, future projected climate change is expressed in relation to a 20 year 'baseline' period centred around 1995, following the approach now adopted by the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (for details, see: Moss et al. 2010).

**Figure 16**: Stakeholder & Community Hazard Mapping Exercise (Shefa Provincial Govt. Council 9 July 2014)

Figure 17 provides a summary of the spatial distribution of present and past exposure to climate hazards in Port Vila, which can be causally grouped into two main climate hazards: localised flooding, and coastal/marine processes. Flooding (which is discussed in more detail in Section 3.2.1) had the most extensive area of exposure across the city, while also being observed to contribute to dengue and malaria outbreaks when surface water stagnated. Observed exposure to coastal and marine processes was more localised, with observed coastal erosion, coral bleaching and Crown of Thorns outbreaks almost exclusively centred upon Fatumaru Bay and Iririki Island.

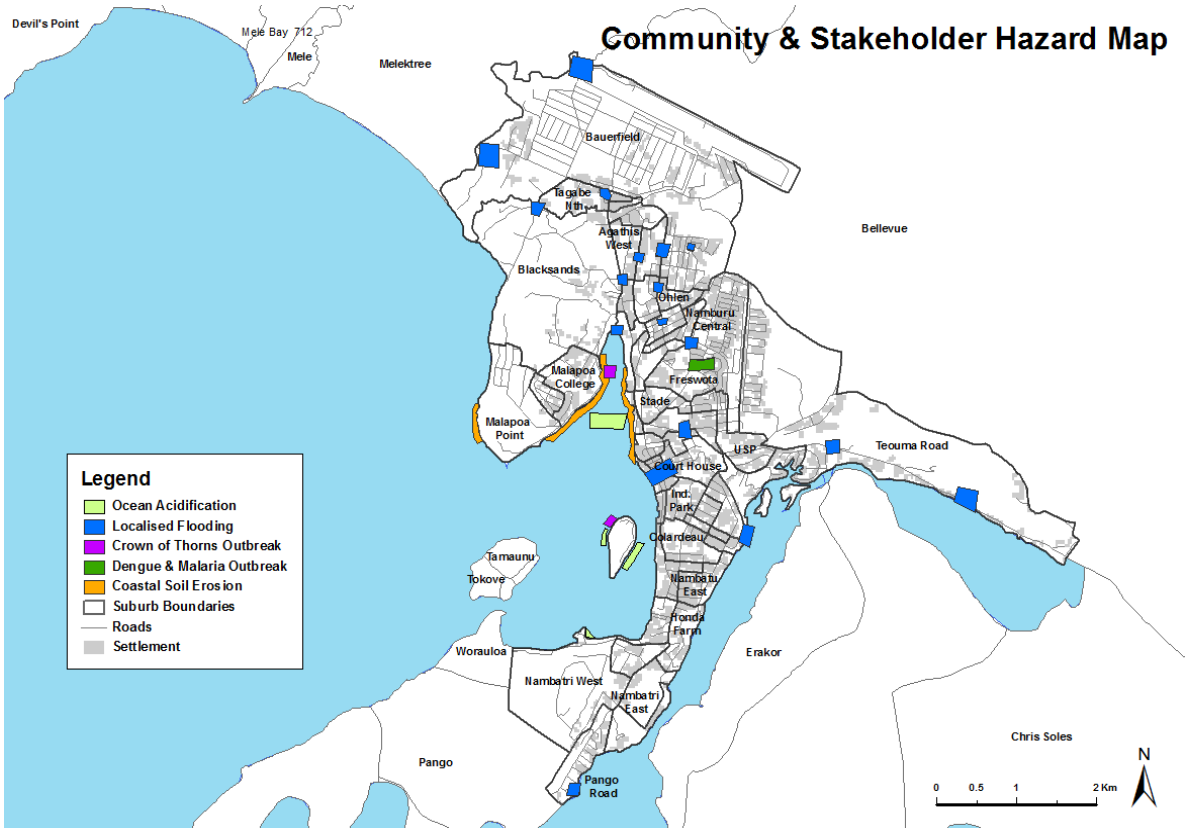


**Figure 17**: Community and Stakeholder based Hazard Map: Existing Climate Vulnerability (map data provided by the VNSO)

### *3.2.1 Flooding*

Detailed LiDAR imagery taken by Geoscience Australia has been used to develop inundation models for the Highest Astronomical Tide, as well as 1 in 10 and 1 in 100 year storm events both for current day sea levels, as well as under future climate scenarios centred upon 2030, 2044 and 2090, although the Representative Concentration Pathway (RCP) selection for these scenarios has not been specified (NAB 2014). Figure 18 illustrates current day coastal threats presented by a 1 in 100 year storm, illustrating 5 inundation hotspots across the Great Port Vila Area. **Hotspot 1** encompasses a large area of land occupied informally by Paama and Terao communities within Blacksands (Malapoa-Tagabe peri-urban area). Although **Hotspots 4 and 5** fall largely outside of the Greater Port Vila area, these residential areas (some of which are also informally settled) are dependent on the city for supplies, access and medical assistance (Pango being adjacent to south ward, and Erakor to Freswota-Tassirriki). **Hotspot 2** encompasses the largest public space in the city, a seafront that includes the city's main market (a key distribution point for local produce), as well as the terminal for inter-island ferry services. **Hotspot 3** shows inundation across the city's container terminal and seaport as well as the Paray Bay fuel depot, critical infrastructure facilities for international trade and tourism. Notably, Hotspots 2 and 3 are both the focus of large national development projects (the *Vanuatu Tourism Infrastructure Project,* funded by NZAID and the *Lapetasi International Multi-purpose Wharf Project*, funded by JICA).

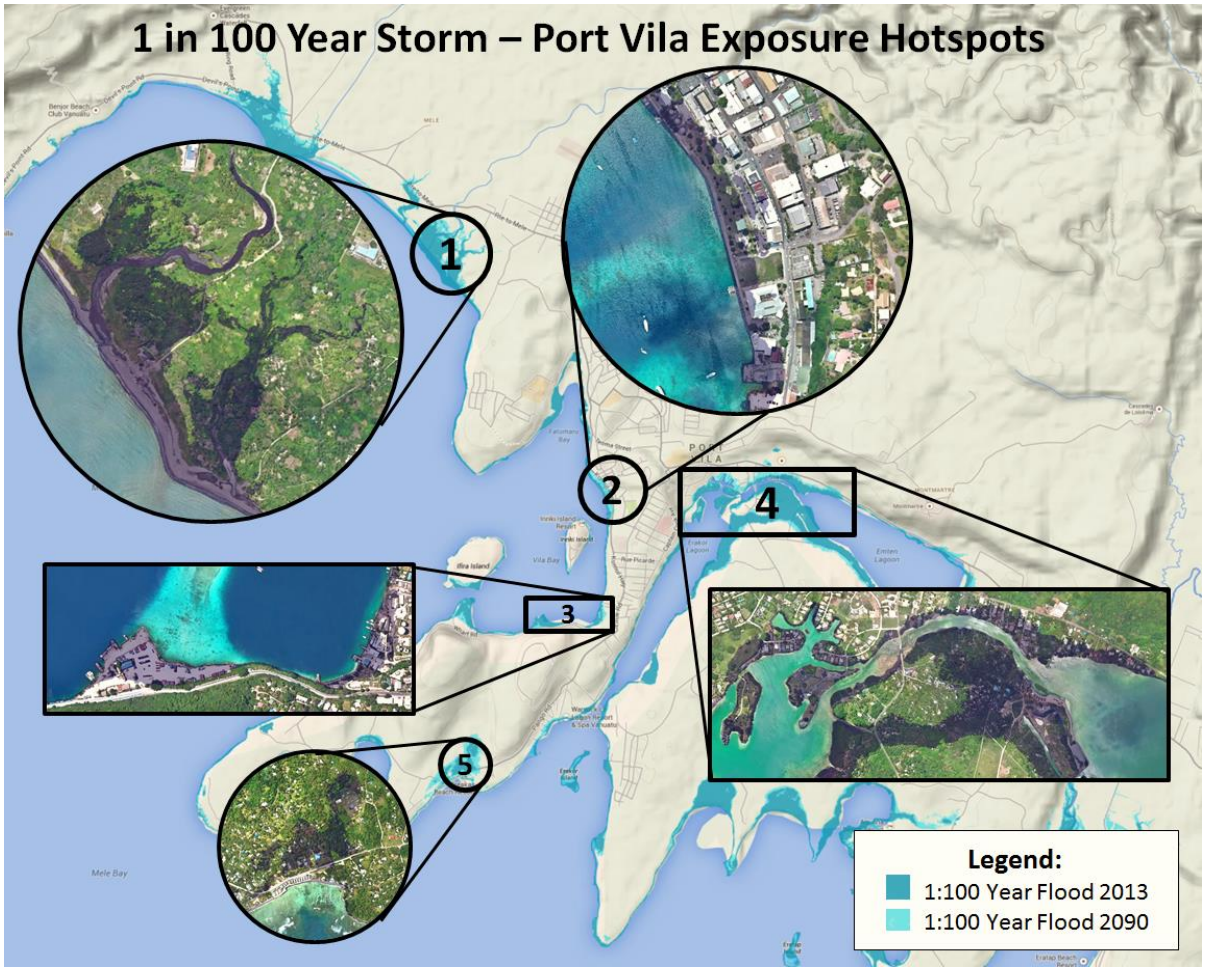


**Figure 18**: LiDAR modelling of 1:100 year coastal flooding (NAB 2014)

Although predominantly driven by a lack of effective drainage systems, work undertaken as part of the *Port Vila Urban Development Project* also identifies a number of road-based flash flooding hotspots

across the city (see Figure 19). Although not comprehensive (being based on the PVUDP team's observations, and therefore largely being identified on public land and roadsides), the 42 hotspots cover much of Anabrou-Melcofee Ward, the more established southern areas of Malapoa-Tabage Ward, and the extent of Lini/Kumul Highway, the major through-road transecting the city. Works to improve the drainage systems affecting these hotspots are currently underway as part of the PVUDP (EBI & QCL 2010a).

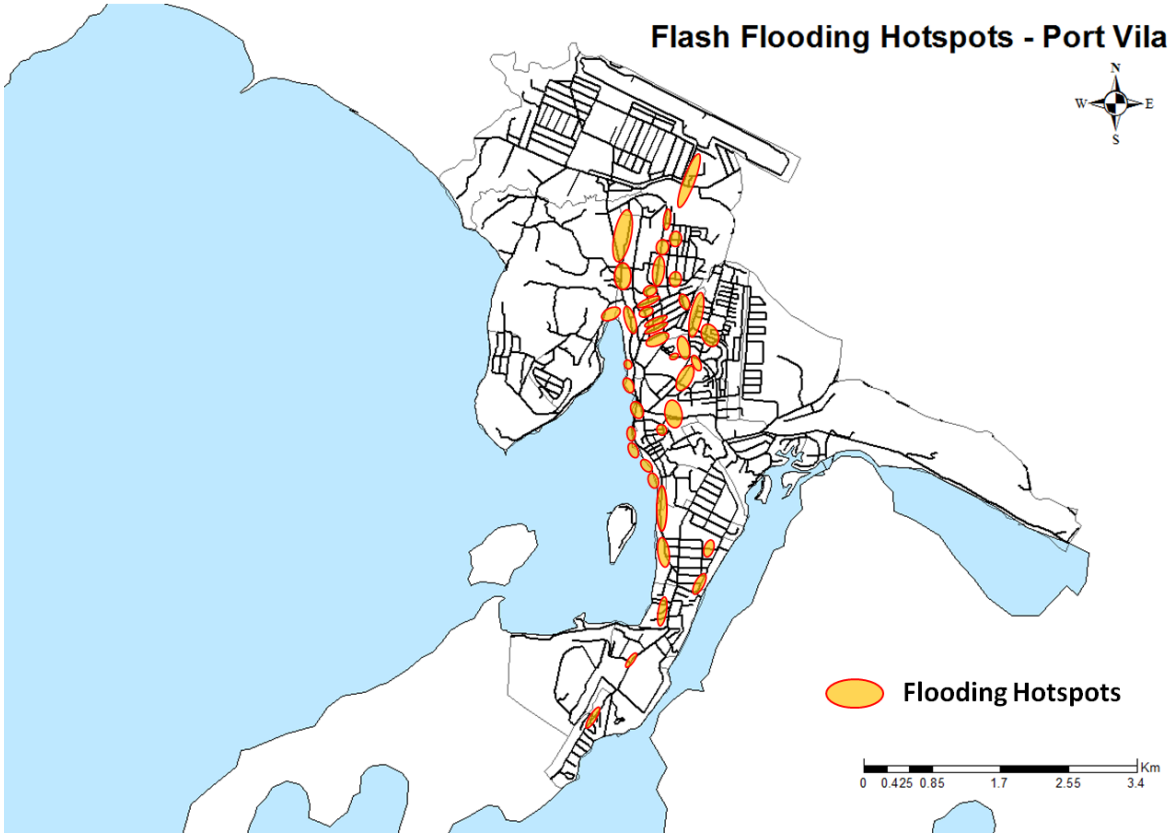


**Figure 19**: Flash Flooding Hotspots (adapted from EBI & QCL 2010a)

As noted by participants, localised flooding can occur even with average rainfall, and is not restricted to severe storm events or prolonged wet periods. However, there is high confidence that the frequency and intensity of extreme 1-in-20 year rainfall events will increase across Vanuatu. Specifically, the intensity of these extreme rainfall events is projected to increase by approximately 8-9 mm under both very low (RCP2.6) and high (RCP8.5) emissions scenarios by 2030, while by 2090 a high emissions scenario is projected to increase the intensity of heavy daily rainfall events by 40mm. The likelihood of current 1-in-20 year events occurring is also projected to increase; even under a very low emissions scenario, these are likely to increase in frequency to 1-in-13 years by 2090, whereas under a high emissions scenario, these events would occur at a rate of once every five years (BoM & CSIRO 2014:332). There is, however, low confidence in the magnitude of projected change to extreme rainfall.

Consistent with the historical observations in Section 2.2 of this report, high levels of inter-annual rainfall variability, coupled with significant disparity between climate models in the region mean that there is low confidence in both the direction and extent of future changes to annual rainfall patterns (as shown in Table 6).

| 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%) |

**Table 6:** Vanuatu National CMIP5 Projections: Rainfall (5-95% uncertainty range bracketed) (BoM & CSIRO 2014:339)

### *3.2.2 Sea Level Rise*

Global sea levels are currently increasing at an average rate of 3.2mm per year, however around Vanuatu the rate of change based on satellite observations has been significantly higher, with levels rising by an average of 6mm annually over the last two decades (PCCSP 2013:4).

Likely changes to mean sea level rise under different RCP scenarios are shown in Table 7. As with the temperature and rainfall projections listed above, there is only medium confidence in the magnitude of these changes, in the case of sea level rise because of uncertainty in the melting rates of the Antarctic Ice Sheet.

| Relative Mean Sea Level Change | 2030 | 2050 | 2070 | 2090 |
|---|---|---|---|---|
| **RCP 2.6** (very low emissions) | **+13cm** (8 to 19cm) | **+23cm** (15 to 31cm) | **+32cm** (20 to 45cm) | **+42cm** (25 to 49cm) |
| **RCP 4.5** (low emissions) | **+13cm** (8 to 18cm) | **+23cm** (15 to 32cm) | **+36cm** (23 to 49cm) | **+48cm** (30 to 67cm) |
| **RCP 6** (medium emissions) | **+13cm** (8 to 18cm) | **+23cm** (15 to 31cm) | **+35cm** (23 to 48cm) | **+50cm** (32 to 69cm) |
| **RCP 8.5** (very high emissions) | **+13cm** (8 to 18cm) | **+26cm** (17 to 35cm) | **+43cm** (29 to 59cm) | **+64cm** (42 to 89cm) |

**Table 7:** Vanuatu National CMIP5 Projections: Sea Level (5-95% uncertainty range bracketed) (BoM & CSIRO 2014:339)

Due to shifting ocean temperatures and wind patterns, Vanuatu experiences inter-annual variability in sea levels of 180mm, which complicates community-based observation of sea level change. Further, many significant impacts occur during storm surge events, which result in coastal erosion and inundation not reflected in the figures above. Projections of changes in wave height also have low certainty and have therefore not been included in this report.

In addition to climate-driven changes in sea level, the relative position of Port Vila's land mass is also changing, as the city lies over a tectonically active, subsiding area. Observations based on global positioning systems estimate that Port Vila is currently 'sinking' at a rate of 4.1mm per year (+/- 0.7mm), exacerbating climate-driven sea level rise (Kouwenhoven 2013). If this rate continues, effective sea levels will be significantly higher relative to Port Vila's existing coastal infrastructure and households, as shown in Table 8. A continuation of these vertical land movement trends would effectively double sea level rise impacts under all of the RCP scenarios out to the middle of this century.

| Vertical Land Movement | 1995 | 2030 | 2050 | 2070 | 2090 |
|---|---|---|---|---|---|
| **Additional Relative Sea Level Change** – Port Vila | **0cm** (baseline) | **+16.8cm** (14.4 - 19.3cm) | **+26.4cm** (22.6 - 30.3cm) | **+36.0cm** (30.8 - 41.3cm) | **+45.6cm** (39.0 - 52.3cm) |

**Table 8:** Possible Additional Vertical Land Movement at Port VIla (based on Kouwenhoven 2013:15)

### *3.2.3 Ocean Acidification and Warming*

Ocean acidification and warming are immediate threats to Vanuatu's marine ecosystems and coral reefs, which underpin Port Vila's tourism economy, as well as being the source of a range of traditional food and material products. Under both high (RCP8.5) and medium (RCP 4.5) emissions scenarios, coral reef health will reach marginal conditions (as measured by aragonite saturation state dropping below 3.5) at some point between 2020 and 2030. Even under a low emissions scenario (RCP 2.6), it is possible that this threshold will be reached by 2040. In addition to the threat represented by acidification, warming of the ocean increases the risk of coral bleaching events. Even under a relatively low 1°C increase in long-term mean temperatures, the average time between severe coral bleaching events will reduce to 3.1 years; less than the five year recovery period needed to prevent long-term reef damage.

### *3.2.4 Tropical Cyclones*

As discussed in Section 2.2, the large inter-annual variability in the number and strength of tropical cyclones impacting on Port Vila, coupled with their small spatial extent relative to climate model grid squares, mean that there is only medium confidence in projections relating to tropical cyclones in and around the Vanuatu Exclusive Economic Zone. However, there is growing agreement between models that the frequency of tropical cyclone genesis is likely to decrease globally with climate change. Ensemble mean projections around Port Vila indicate the possibility of a 15-35% decrease in cyclone genesis by 2090 (relative to 1990); however individual Global Climate Models are inconsistent in this part of the Pacific region (BoM & CSIRO 2014:15). However 5 out of 6 CSIRO model simulations project an increasing intensity of those cyclones that do cross the Vanuatu region, as the latitudinal areas of peak cyclone intensity shift poleward (*ibid*:13).

### *3.2.5 Seasonal Changes*

Seasonal changes in rainfall have only a low level of certainty in the magnitude of change under climate scenarios. There is moderate confidence that Wet Season rainfall will increase, however under the new CMIP5 modelling, there is less certainty regarding Dry Season change (CMIP3.5 modelling suggested a drier dry season was likely). Dynamical downscaling of climate models by the CSIRO does however suggest that the north-west side of Vanuatu's islands is likely to experience a decrease in Dry Season rainfall, consistent with IPCC 4th assessment modelling (BoM & CSIRO 2014:12). This increased seasonality of rainfall is due to an increasing intensity of the South Pacific Convergence Zone (SPCZ), which lies over Vanuatu during the Wet Season (November to April), before the Inter-Tropical Convergence Zone (ITCZ) moves north during the Dry Season (May to October). RCP-based projections of the magnitude of these changes are shown in Table 9.

| Rainfall Change | Season | 2030 | 2050 | 2070 | 2090 |
|---|---|---|---|---|---|
| **RCP 2.6** | **Wet** | **+2%** (-5 to +3%) | **+2%** (-6 to +9%) | **0%** (-9 to +14%) | **+1%** (-7 to +13%) |
| | **Dry** | **0%** (-11 to +12%) | **+1%** (-8 to +13%) | **-1%** (-17 to +9%) | **-2%** (-15 to +10%) |
| **RCP 4.5** | **Wet** | **0%** (-8 to +15%) | **+1%** (-9 to +9%) | **+2%** (-8 to +18%) | **+1%** (-13 to +13%) |
| | **Dry** | **0%** (-12 to +15%) | **-1%** (-13 to +11%) | **-2%** (-14 to +12%) | **-1%** (-25 to +14%) |
| **RCP 6** | **Wet** | **+3%** (-5 to +15%) | **+2%** (-7 to +11%) | **+3%** (-5 to +16%) | **+3%** (-11 to +22%) |
| | **Dry** | **+2%** (-6 to +13%) | **2%** (-11 to +16%) | **+2%** (-11 to +18%) | **+5%** (-9 to +21%) |
| **RCP 8.5** | **Wet** | **+1%** (-6 to +12%) | **+1%** (-9 to +13%) | **+3%** (-14 to +17%) | **+5%** (-13 to +30%) |
| | **Dry** | **-2%** (-10 to +8%) | **-1%** (-19 to +16%) | **-1%** (-21 to +17%) | **+3%** (-26 to +34%) |

**Table 9:** Vanuatu National CMIP5 Projections: Seasonal Rainfall (5-95% uncertainty range bracketed) (BoM & CSIRO 2014:339)

### *3.2.6 Other Hazards*

Climatic extremes such as heavy rainfall, unusually hot and unusually cold days, and drought are more difficult to downscale from General Circulation Models (GCMs) as short-term events have more complex probabilities and in the Pacific are influenced by a number of regional meteorological phenomena, particularly ENSO. Although the magnitude of these changes is therefore difficult to project, the general 'direction' of the change of some of these hazards can be described as follows:

- **Extreme Rainfall –** more frequent and intense (high confidence)
- **Extremely Hot Days** – more frequent and more intense (very high confidence)
- **Extremely Cold Days** – less frequent and less intense (very high confidence)

There is low confidence in the direction and magnitude of change to periods of drought across Vanuatu, as well as any other changes to these periods (such as the length or intensity of drought events). This is because drought in Vanuatu is heavily related to ENSO cycles, which are yet to be effectively modelled in relation to climate change, with drought occurring during El Niño periods. Drought is nonetheless a significant inter-annual aspect of Port Vila's climate exposure, with the population having a dependency on food produce from surrounding islands and agricultural areas. The national supply of alternative staples – particularly rice – during drought-driven food shortage periods is imported through Port Vila.

## 3.3 Sensitivity

Exposure alone does not determine the vulnerability of an area – or the population that inhabits it – to climate impacts. An important additional factor is the 'sensitivity' of infrastructure, human populations and ecosystems to the climate-related hazards that they face.

Key factors in assessing the sensitivity of Greater Port Vila relate to: housing and other physical systems (such as roads, hospitals and electricity supply); drainage, water supply and sanitation (a crucial sub-category of physical networks); and the nature of households, communities and livelihoods (including factors such as income, age and health) across the greater urban and peri-urban area.

The scale that has been assessed is largely the 'suburb' or Greater Ward level, with a transect walk having been conducted through Blacksands communities to identify issues in one of the most exposed areas in more detail. Further community level assessments, particularly in other informal communities (which are generally more sensitive to climate impacts due to their infrastructure

quality and socio-economic resources), as well as areas of high exposure, will be conducted in future stages of climate planning in Port Vila.

### *3.3.1 Housing and Physical Systems*

The quality of housing and physical systems across Greater Port Vila is both variable and difficult to assess, with building standards largely self-regulated and un-enforced. Although a National Building Code was developed in 1989 with Australian Government assistance, the Code and its associated manuals and guidelines lacked implementation. A review a decade later observed: "nine years later the National Building Codes with accompanying Home Building Manual area still not being widely used with results that houses continue to be damaged heavily during disasters" (UNDMP 1999 p. iv). The Code was updated with ADB assistance in 2000; however it continued to operate as a guideline mainly due to the absence of associated legislation. In December 2013 the Vanuatu Government passed and gazetted the *Building Code Act*, which requires further development if a functional regulatory framework is to be enforced. The Code, which was to be updated as part of the Carcasses Government 100 Day Plan (PMO 2013), is also yet to be finalised.

Self-reported housing construction materials in the 2011 census, summarised by ward in Table 10, provide some indication of the sensitivity of housing across Greater Port Vila (VNSO 2014), having been categorised by roof, floor and wall type. However, these categories do not reflect the issues discussed above, and as such have relatively homogenous outputs; for example, more than 90% of housing is categorised as having 'metal' roofing, without consideration of the reinforcement or attachment methods used to secure the roofing itself, therefore differentiating little in terms of sensitivity to impacts such as strong winds, heavy storms or tropical cyclones.

| | **Malapoa-Tagabe** | | | **Anabrou - Melcoffee** | | | **Freswota - Tassirriki** | | | **Central Ward** | | | **South Ward** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Roof** | **Floor** | **Wall** | **Roof** | **Floor** | **Wall** | **Roof** | **Floor** | **Wall** | **Roof** | **Floor** | **Wall** | **Roof** | **Floor** | **Wall** |
| **Wood** | 1% | 3% | **8%** | 0% | 2% | **7%** | 2% | 2% | 4% | 1% | 2% | 5% | 1% | 3% | **9%** |
| **Metal** | **91%** | 3% | **48%** | **94%** | 2% | **33%** | **92%** | 2% | **22%** | **95%** | 1% | **27%** | **94%** | 1% | **23%** |
| **Concrete** | 3% | **82%** | **31%** | 2% | **95%** | **52%** | **4%** | **90%** | **64%** | 3% | **95%** | **66%** | 2% | **91%** | **67%** |
| **Traditional** | 3% | **8%** | 4% | 0% | 1% | 2% | 1% | 2% | 2% | 1% | 0% | 0% | 1% | 3% | 1% |
| **Makeshift** | 3% | 1% | **8%** | 3% | 1% | 5% | 1% | 1% | **7%** | 1% | 0% | 2% | 1% | 0% | 1% |
| **Other** | 0% | 3% | 1% | 0% | 0% | 1% | 0% | 2% | 1% | 0% | 1% | 0% | 1% | 2% | 0% |

**Table 10:** Housing material by Greater Ward Area

The largest difference between material categories recorded in the census data related to wall material, with a significant proportion (48%) of housing in greater Malapoa-Tagabe being constructed with metal walling, in contrast to the other divisions. Traditional floor material use is also significantly higher in Malapoa-Tagabe, while use of makeshift wall materials is significant in both greater Malapoa-Tagabe and Freswota-Tassirriki.

The census statistics shown in Table 10 also lack detail regarding the quality of the materials and the standards to which these materials are used. For example, the two buildings shown in Figure 20, located in the Blacksands Informal Settlement, highlight both the potential structural sensitivity of housing classified as having 'concrete flooring', as well as the variability of housing strength of those that may have been classified as having 'metal roofing'.

**Figure 20**: Incomplete concrete brick building (left) and a permanent housing structure (right) in Blacksands

Earlier analysis by SOPAC (Bettencourt and Dunn 2003) identified a large proportion of Port Vila's building stock as having a high sensitivity to climate-related and geo-hazards (see Table 11), however given the rapid population growth in the subsequent decade it is difficult to correlate this data to current day conditions. Nonetheless, the small number of 'well engineered' buildings – only 5.3% of the total building stock in 2003 – further emphasises the sensitivity of Greater Port Vila's built form to climate impacts and other natural hazards.

| SOPAC Building Class & Description | | Quantity of Building Stock | Est. Value (USD) |
|---|---|---|---|
| A | Well-engineered structures (schools, hospitals, etc.) | 254 **(5.3%)** | $32.0 million |
| B | Concrete or concrete block structures – moderate quality construction | 2822 **(58.8%)** | $298.5 million |
| C | Wooden bungalows (poor wind, earthquake provisions) | 1629 **(33.9%)** | $105.1 million |
| D | Poor quality structures (shacks and sheds) | 98 **(2%)** | $3.3 million |

**Table 11:** Port Vila building stock analysis (Bettencourt and Dunn 2003)

Analysis of housing built from traditional, improvised or makeshift materials at a suburb level is shown in Figure 21 and illustrates the concentration of poorer quality housing in the northern enumeration areas of Greater Port Vila. In particular Blacksands, Bauerfield and Freswota are demonstrated to have housing that is likely to be extremely sensitive to climate extremes, containing roughly 70% of the city's improvised, makeshift or traditional housing stock.

Notably, while these more 'sensitive' housing types were located in areas with large informal settlements, housing in others such as Tongoa/Futuna and Pango road does not conform to this pattern, with site visits showing widespread use of 'permanent' corrugated iron walling and roofing that is not evident in the VNSO census datasets.

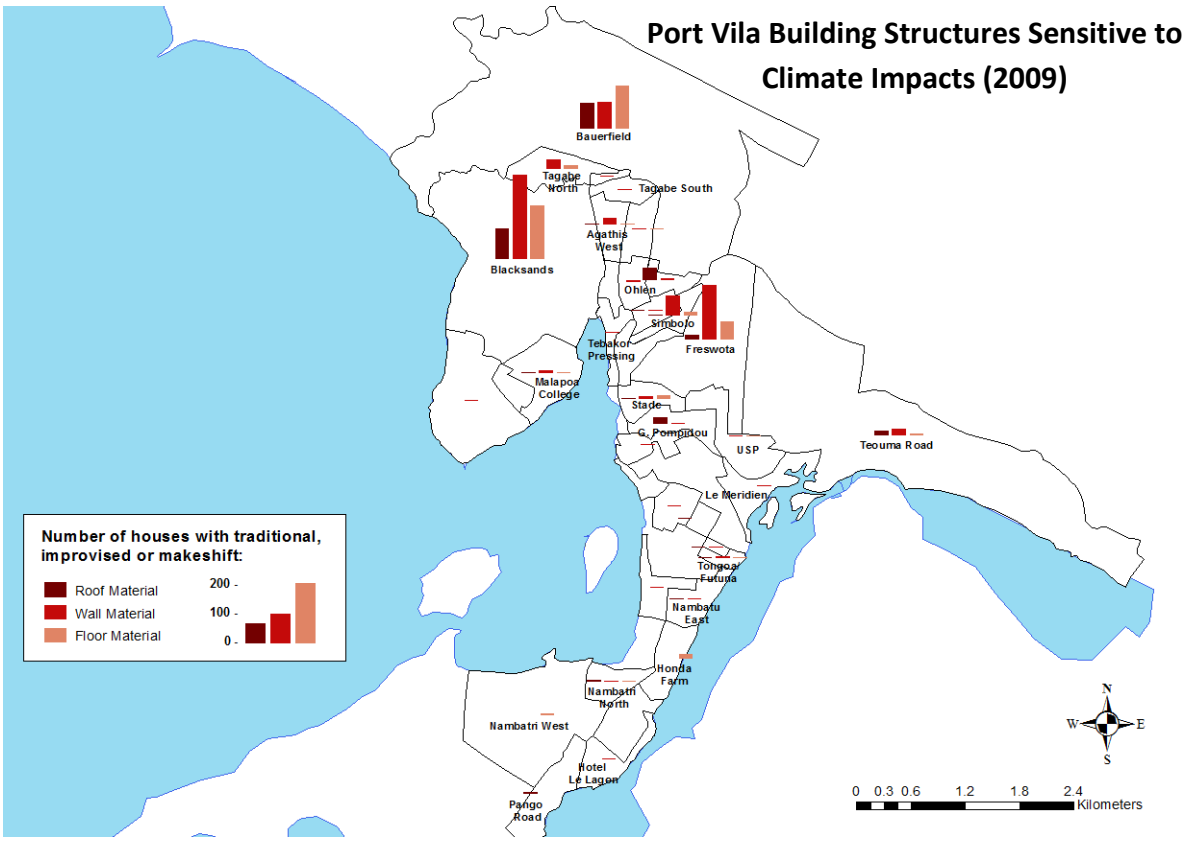


**Figure 21**: Distribution of houses made from traditional, improvised or makeshift building materials.

Data on road infrastructure was not extensively analysed for this report, in part due to ongoing quantitative analysis being conducted under the PVUDP (EBI & QCL 2010a). However, the dependency of peri-urban communities on single entry and exit routes in the event of tropical cyclones, storm surges and geo-hazards such as tsunamis was brought up during both the workshops and the Blacksands transect walk; routes which are largely unsealed, with poor maintenance resulting in extensive potholes (see Figure 22). Elsewhere in the city the impact of road-side flooding at key intersections on traffic congestion and productivity was also raised (as illustrated in Figure 17 and Figure 19), with Port Vila's main road – the Lini Highway – being one of the worst affected.

**Figure 22**: Unsealed road surfaces along the main road through the Blacksands informal settlement area

### *3.3.2 Drainage, Water Supply and Sanitation*

As discussed in Section 3.2.1, the lack of functional drainage infrastructure across the city – both through poor urban design and inadequate maintenance of existing assets – has resulted in high levels of sensitivity to even minor rain events, acting as a key disrupting factor for transport

networks; as well as presenting health risks through stagnation and provision of habitat for transmitters of vector-based disease. Those areas and social groups most sensitive to flooding therefore relate more directly to other mitigating factors, such as housing quality, surrounding municipal infrastructure (such as roads and healthcare), and ability to afford housing in areas of lower flooding exposure (see Figure 17 and Figure 19). Consequently, lower socio-economic groupings tend to be located in higher flood risk areas, with poorer quality infrastructure and ineffective drainage systems.

**Figure 23**: The 'Main Drain' below the Australian High Commission (left) and debris blocking the Tagabe River Bridge in Blacksands (right)

Across the Greater Port Vila area only 48.7% of households have either plumbed or water-sealed private sanitation facilities, with pit latrines being used by 19.3% of households across the urban area (VNSO 2014). As shown in Figure 24, access to sanitation in informal settlement areas and the northern peri-urban area of the city more generally is significantly lower, with shared pit latrines, traditional and bush toilets being heavily used by households.

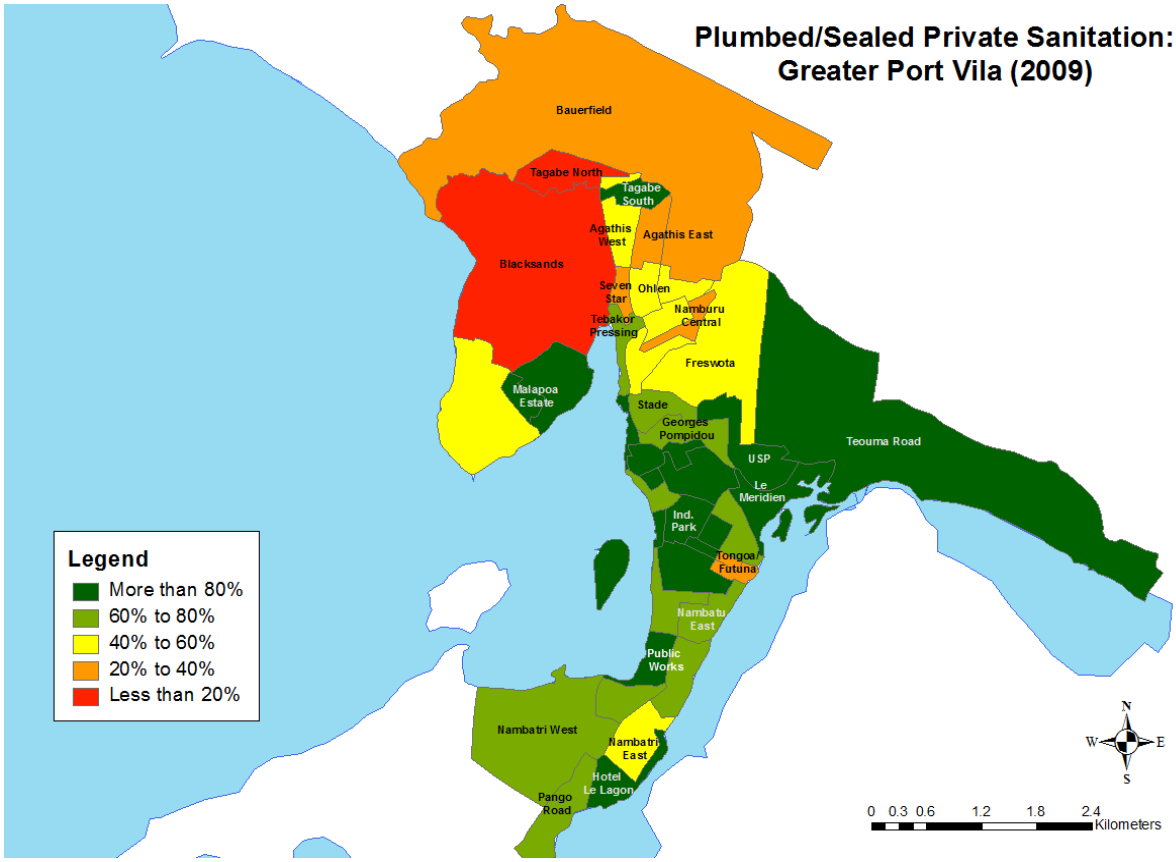


**Figure 24**: Household Access to Plumbed or Water Sealed Private Sanitation (data from the 2009 National Census)

In some areas the ratios of access to these shared facilities are highly inadequate; for example in Seaside Paama, the entire informal community of more than 600 residents is dependent on 4 shared toilets (shown in Figure 25). Notably these 'Communal Sanitation Facilities' are one of the focus areas of the Port Vila Urban Development Project's sanitation and drainage infrastructure upgrades (EBI & QCL 2010b).

**Figure 25**: Communal Sanitation Facilities (Toilet Block) adjacent to Seaside Paama

Port Vila's water supply is entirely sourced from groundwater, extracted by the privatized water utility UNELCO, as well through independent private or community-run bores. Supplementary

sources such as village and household rainwater tanks and wells provide roughly 10% of households with their primary drinking water source, and 5% of households with water for washing and non-drinking uses (VNSO 2014).

UNELCO provides an estimated 80% of Port Vila's potable water supply (a total of 10,825 cubic metres per day). This water is extracted from 6 boreholes into a shallow unconfined aquifer under the Tagabe (Matnakara) River Basin, at a rate of 11,857 $m^3$ per day (a system efficiency of 75% with an average of 8,825 $m^3$ per day reaching consumers) (EBI & QCL 2010b).

Roughly 25% (2,132 $m^3$ per day) of the water supply is used by eight commercial, industrial and institutional users: the Port Authority (and berthed ships); Lagon Hotel Resort; the Palms Resort Hotel; Iririki Island Resort; USP; Central Hospital; Vanuatu Mobile Force (Freswota; and INTV Boarding School (Freswota) (EBI & QCL 2010b).

Although an extraction capacity of 60,000 $m^3$ per day has been widely cited (EBI & QCL 2010a, Mourgues 2005), the origin of - and data behind - this figure in terms of recharge rates and groundwater flow modelling is yet to be made accessible to the authors of this report. This capacity may be an over-estimation, with borehole water pressure having been observed to fall in response to current demand peaks (EBI & QCL 2010b), and at least 2 of the 6 UNELCO boreholes showing long-term trends of decreasing groundwater levels, suggesting that further analysis of Port Vila's water supply security should be undertaken. These measurements are also consistent with community observations in Blacksands, with chiefs suggesting that the Tagabe River level had fallen significantly in the past 10-20 years; a potential symptom of extraction and surface-ground water interaction.

### *3.3.3 Livelihoods, Households and Communities*

As discussed in Section 2.4, around 14.7% of Port Vila households are classified as being unable to meet basic needs, with the city having double the level of poverty depth – measured by the Poverty Gap Index (PGI) – of rural areas in Vanuatu in 2010 (VNSO 2012). Although the spatial distribution of more sensitive livelihoods was not evident in the data available for this report, those livelihoods dependent on ecosystem services are most likely to be impacted by climate change and extreme event impacts. In particular, interviews highlighted the importance of the bush garden and local fisheries as a supplementary food source for many poorer households in times of hardship. Notably, both of these ecosystem-based livelihood sources are vulnerable to the same extreme weather impacts to which these households are directly vulnerable, compounding their sensitivity (McDonald 2013). Salaried employment in the tourism sector is also likely to be vulnerable to medium-term impacts of climate change, particularly those employed in activities based around reefs and local fisheries, which will be impacted severely by increasingly frequent bleaching events as the ocean warms, threatening fish stocks and coral organisms (ADB 2013). Tourism and agriculture make up a combined 58% of Vanuatu's GDP (ADB 2013:22).

Households and communities in informal settlement areas are not only often located in more exposed areas (World Bank 2014), they are also more sensitive to climate impacts, lacking the built, financial and institutional resourcing to manage and respond to severe climate impacts (Chung & Hill 2002). Much of this is evidenced through earlier sections of this report, with spatial distribution of the most sensitive and exposed areas correlating to the large areas of informal settlements on the city's fringe, as well as central pockets of informal housing such as Tongoa/Futuna and Simbolo (as illustrated in Figure 21 and Figure 24, which show these areas as having little sanitation and poor housing infrastructure). These areas also often have a reduced adaptive capacity – discussed further

in Section 3.4 – for example being characterised by lower rates of education completion, as shown in Figure 26. As a result, informal settlements are an explicit focus of the vulnerability assessment approach (e.g. Blacksands transect walk). Future analysis will also include other informal settlement areas.

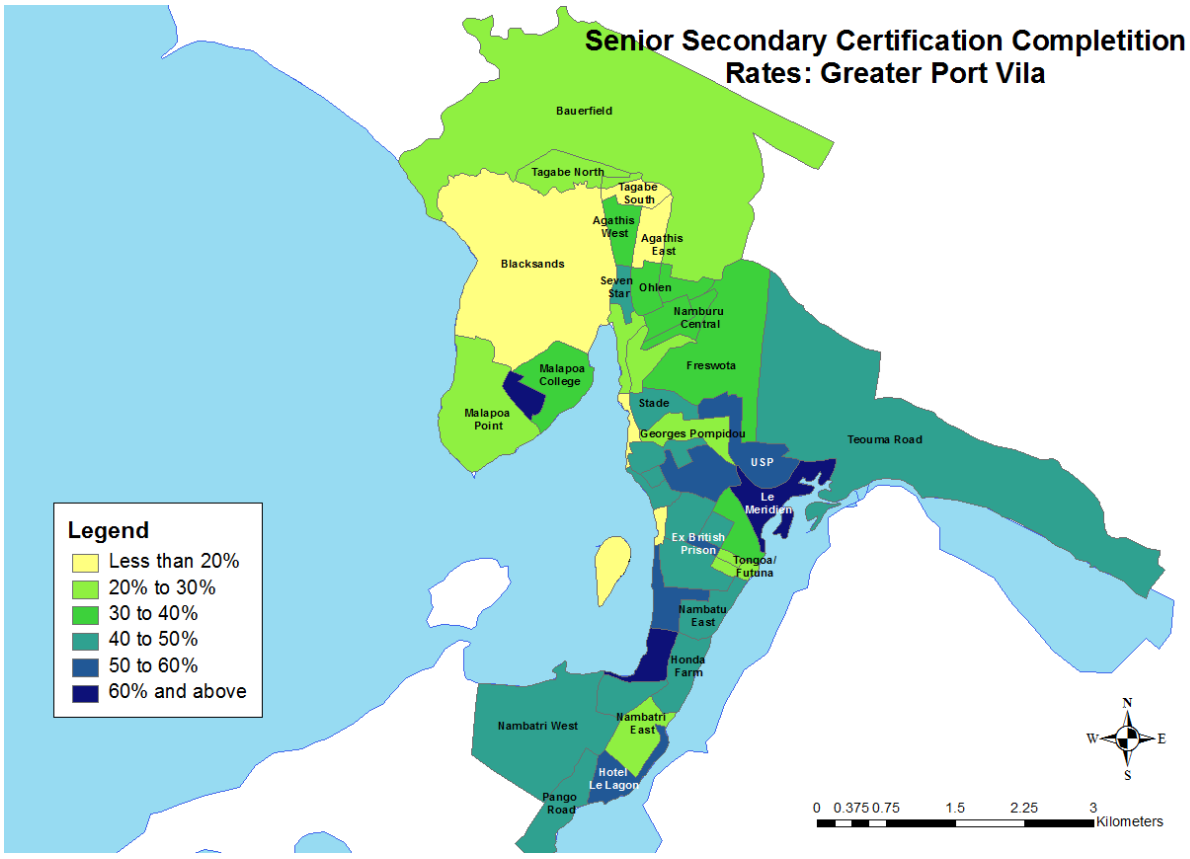


**Figure 26**: Senior Secondary Certification Completion Rates across Greater Port Vila (data from VNSO 2014)

Formal classification of informal settlements is difficult to determine, with different informal tenure and rental arrangements existing across the Greater Port Vila area, within both municipal and provincial boundaries. Census self-classification is restricted to those household respondents who identify themselves as 'owning' their housing; thus excluding households who rent, as well as those who might classify themselves as not owning the land in a formal sense from the sub-question relating to households who "occupy with informal arrangements" (see Figure 27 for an illustration of this process as per the 2009 census). As a result, 54% of households were excluded from land tenure classification statistics across Greater Port Vila, which limits the accuracy of Figure 28 (which should be used with caution).

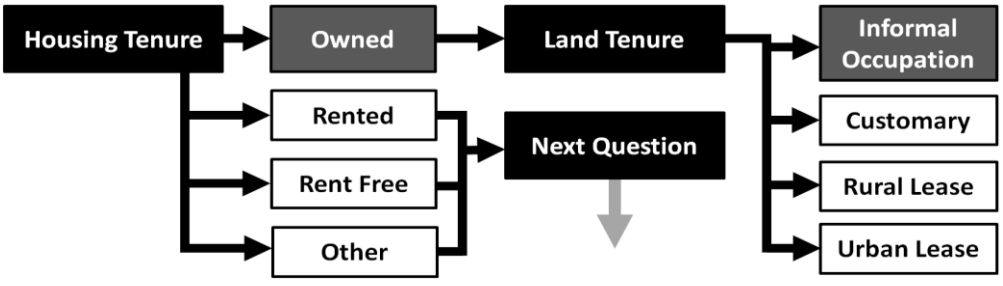


**Figure 27**: Census question structure for eliciting informal tenure arrangements (VNSO 2009)

Nonetheless, the 2009 census data is consistent with National Housing Corporation (NHC) scoping assessments, which located 14 informal settlement areas around Port Vila, of which 13 lie within the Greater Port Vila Boundary[3] (NHC 2012). As shown in Figure 28, the bulk of these households lie outside or on the fringe of the built up municipal urban area (based on 2009 census data the communities within Blacksands and Manples alone are estimated to make up 60% of the total population within informal settlements across the city). Only 20% of informally settled households lie within the municipal boundary, with an estimated total population of 2,873 (see Table 12). Although land tenure arrangements across these settlements are 'informal', many of them are long-standing, with settlements such as Blacksands established as early as the 1960's.

[3] Emten Lagoon settlement is located outside of the study area.

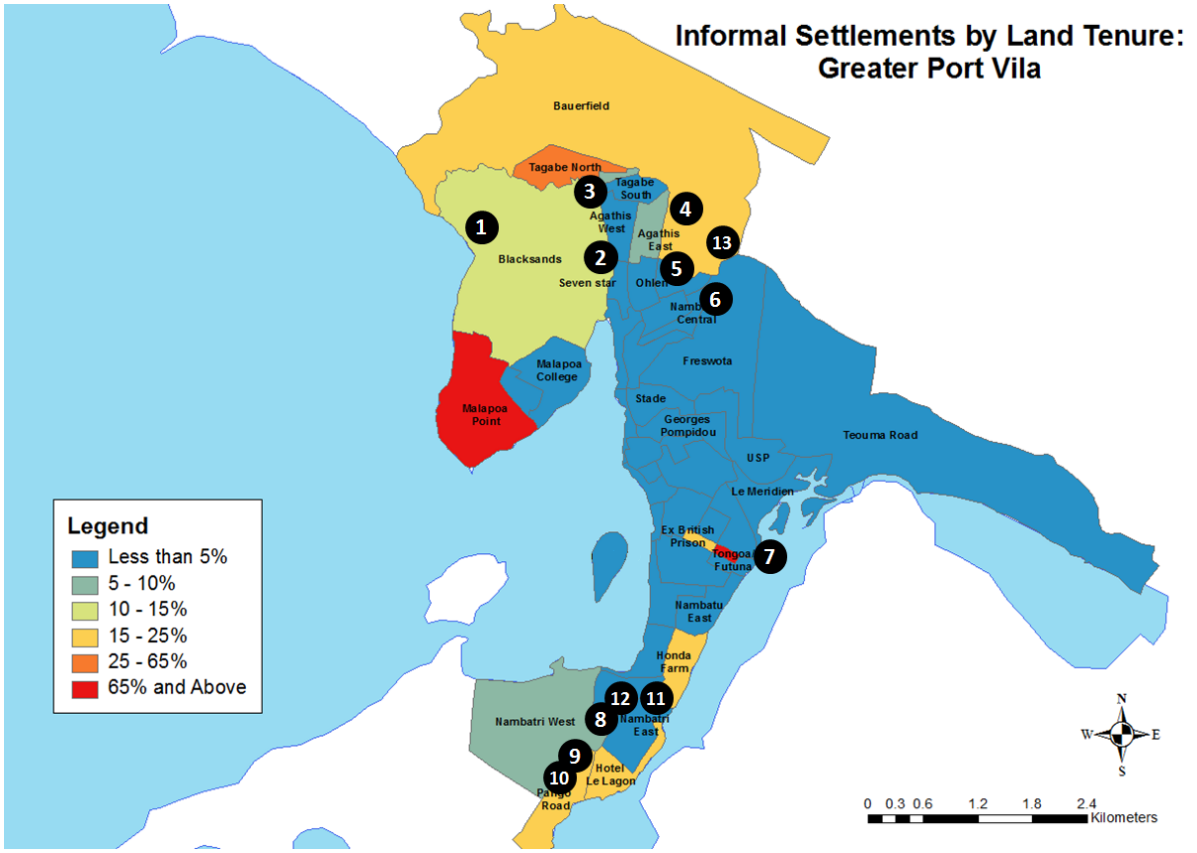


**Figure 28**: Self-classified households with informal tenure arrangements (VNSO 2014) *Note: numbers refer to Table 12*

| Settlement Name | Area | Population | H'holds | Tenure Arrangement |
|---|---|---|---|---|
| **1.** Blacksands and **2.** Manples | Malapoa-Tagabe | 7662 | 1568 | Owned by Ifira, informal resident agreements and multiple sub-rental agreements |
| **3.** Tagabe Bridge | Malapoa-Tagabe | 330 | 60 | Owned by Ifira, annual rent agreements per household |
| **4**. Ohlen Freswin | Malapoa-Tagabe | 1500 | 270 | Government owned municipal land with disputed customary ownership and corporate sub-division |
| **5**. Ohlen Mataso | Anabrou-Melcoffee | 560 | 80 | Community-government lease arrangement, no services available |
| **6.** Simbolo | Freswota-Tassirriki | 360 | 65 | Community-government lease arrangement |
| **7**. Seaside Futuna/ Tongoa/Paama | Central | 1368 | 262 | Island origin community-based sub-lease arrangement with no formal government standard requirements |
| 8. Etas – Teouma (ex-Whitewood) | South | 495 | 90 | Community-government lease, two island community-based villages |
| 9. Etas – Areman | South | 145 | 26 | Customary subdivision rent arrangement, no titles/approval |
| 10. Etas | South | 275 | 50 | No formal subdivision, landowner payed monthly rent per-plot |
| 11. Buninga/Paama Village | South | 250 | 45 | Land historically gifted to community, but held under separate corporate lease |
| 12. Nambatri | South | 90 | 16 | Households on private leasehold against owner wishes with outstanding legal fees/property taxes for respective parties |
| 13. Freswota Nth 4 | Freswota - Tassirriki | 110 | 20 | Households on private land without title/permission |

**Table 12:** Summary of Port Vila Informal Settlement Statistics (NHC 2012)

In order to better understand community-level climate vulnerability, a transect walk was undertaken through the largest informal settlement area, Blacksands, by the project team. The activity was facilitated by Wan Smolbag Theatre, a local NGO active in the area that provides a range of public services (including health and sporting facilities, education campaigns and waste collection), and included interviews with the Chiefs of five communities. The path taken for the walk was not a conventional 'transect', but instead followed key access routes throughout Blacksands, as shown in Figure 29. Elevation throughout the area is between 8 and 20 metres above sea level (with the exception of the beach section of the walk at Point 1). The RMIT research team was accompanied by representatives from a number of key stakeholder groups: Wan Smolbag, the VNCW, Shefa Provincial Council, ADRA, the NDMO and SPC-GIZ.

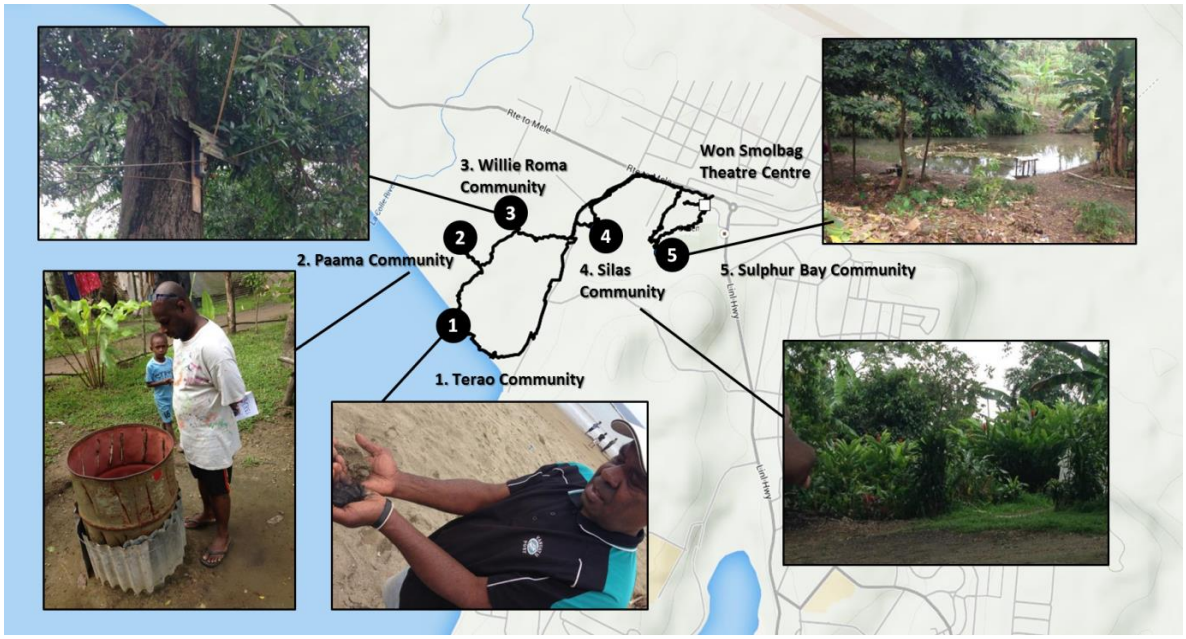


**Figure 29**: Transect walk route and key community-based climate vulnerabilities

The **Terao Community** is located at the Tagabe river mouth, and was one of the earliest to move into the Blacksands area. Chief Edward, who leads the community (shown in Figure 29 in Photo 1), described how a number of past climate events had impacted his community. One event was extensive coastal erosion following Cyclone Uma (1987), which dug out the characteristic black volcanic sand that previously covered the coastal area. It also destroyed plantations and a locally-owned nightclub. Attempts to re-forest the coastline with mangroves have been unsuccessful, with saplings not having enough time to establish root systems before being washed out by further storm surges. A member of the transect group also observed that climate change was undermining *kastom*, with traditional knowledge of fishing areas being affected by changes to reef and fishery locations (potentially compounded by overfishing). The Chief suggested that most of the community relies on fish for income. Other non-climate factors such as sand removal by construction companies were suggested to be accelerating coastal erosion processes in the area, with a number of houses along the coastline also identified as being impacted by flooding during storm events (see Figure 30).

**Figure 30**: Coastal Housing (L), Coastal Erosion (C) and Chief Edward indicating the previous plantation extent (R)

The **Paama Community** (Point 2 in Figure 29) is located 350 metres inland, upstream along the Tagabe River. Community leaders identified that most issues related to water quality and access, with children becoming sick (diarrhoea and skin disease) after cyclones, storm surges and heavy rain events hit the area; a result of swimming in the river. The community – with a population of over 130 – is wholly depending on a 1,000 litre water tank and three groundwater wells for drinking and washing water. Although the groundwater was not perceived to be saline, water quality is potentially an issue, with one well (shown in Photo 2, Figure 29) located only 9 metres above sea level. Open pit latrines are also potentially contaminating the groundwater source. During previous cyclone events, the river was observed to have risen by 5-6 metres, with the community having to temporarily move 2 kilometres inland. The community, in partnership with Wan Smolbag, has conducted extensive tree planting along the riverbank in order to reduce erosion during flooding.

The **Willie Roma Community** is located an addition 300 metres inland from the coastline, 12 metres above sea level on the south bank of the Tagabe River. The community's number one concern is improving sanitation, due to concerns that sewerage is polluting the river. The Chief noted that NDMO warning campaigns on the local television network were making the community more aware of the risks during storm events and tsunamis. Wan Smolbag is constructing compost toilets as an interim arrangement while more permanent sanitation arrangements are being negotiated between the community and Shefa Provincial Council. Additional vulnerability was evident in the informal arrangements around electricity access, with Photo 3 in Figure 29 showing the improvised nature of the community's circuit board and grid access point.

One kilometre inland and 14 metres above sea level, the **Silas Community** noted that although less directly affected by flooding, they were frequently cut-off from the rest of Port Vila during flood events due to the local bridge being the sole access point (shown in Figure 23, Figure 31). Also identified were increasingly frequent fruiting crop failures, with community leaders and the Chief explaining that they did not understand why this was occuring, and hoped that the government would be able to assist them in improving their crop yields. The Chief stated that previously the section depicted in Figure 31 would produce an annual crop of more than 100 fruit, however in recent years they were only growing 20-30. This was observed to have significantly reduced family livelihoods, with women previously earning 5000vt per tree at the markets now only earning around 1000vt. As with the previous communities, it was noted that children would develop health issues after swimming in the river, which previously used to be 5-6 metres wide, but now was often only 1 metre across.

**Figure 31**: Chief Silas and nephew Stephen at Nakamal (L) and Silas Community Crops (R)

The Chief of the **Sulphur Bay Community** explained that he had been chief for over 30 years, and had seen significant changes over the last few decades. As with the other inland communities, the reduced flow and height of the river, as well as the reduction in water quality, were the most persistent changes observed, with the chief noting that they needed more large *Nabanga* trees to hold up the riverbank, such as the one adjacent to the *nakamal* (see Figure 32). The community (1.2km inland and 17 metres above sea level) is better serviced in terms of potable water than those further from the main road, with one tap for washing, and a 6,000L tank provide by the French embassy. The community also had a number of compost toilets, built with the assistance of Wan Smolbag (see Figure 32).

**Figure 32**: Compost Toilet (L), Nakamal (C) and Nabanga Tree (R

## 3.4 Adaptive Capacity

### *3.4.1 Rapid Assessment Outcomes*

Greater Port Vila's adaptive capacity needs further detailed analysis, however a preliminary discussion was held with PVMC councillors, city stakeholders and climate experts as part of a broader workshop reviewing transect walk and mapping exercise findings. This discussion included completion of a survey by participants, based upon the UN Habitat *Planning for Climate Change Toolkit* Tool 3-L: General Capacity Assessment. The outputs from this activity, summarised in Figure 33, show both key areas of adaptive strength, as well as weaknesses across the city, with darker shading illustrating the adaptive capacity level in each category.

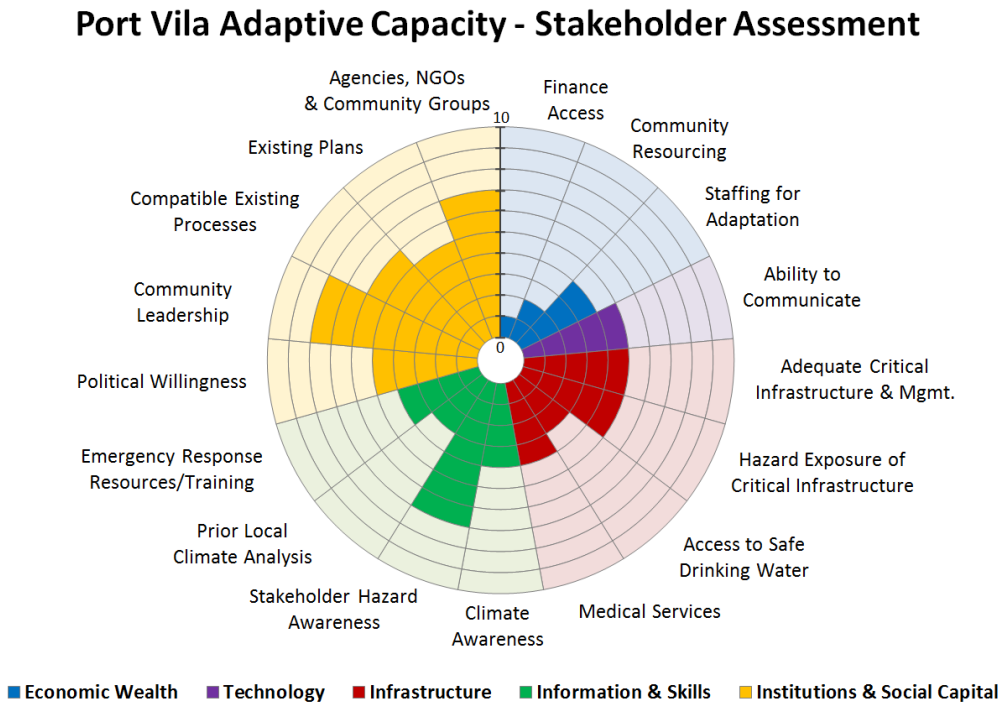


**Figure 33**: Stakeholder Assessment of Port Vila's Adaptive Capacity

Although there was consensus across the stakeholder group that Port Vila's overall adaptive capacity was low, strengths in both institutional and social capital were also evident, particularly with regard to community leadership, and the strong government agency, NGO, and community-level networks that are in place. This observation was consistent with scoping interviews, which thematically identified strong customary and culturally-based disaster response mechanisms, alongside strong national-level bureaucratic Climate Change Adaptation knowledge and capacity (Trundle & McEvoy 2014). Further, while these traditional mechanisms and national agencies were observed to be currently more actively and effectively applied rurally, they were recognised as being transferable (albeit with some modification) to the Port Vila urban context.

Community-level hazard awareness varied spatially between wards: Freswota was seen to be self-organised, with an active council of chiefs and sub-committees who had ownership of emergency response plans, engagement with the NDMO, and strong NGO support through ADRA. In contrast, Ohlen was described as *"having no-one looking after the area, even though it is 30% [of Port Vila's] population"*. The recent re-establishment of ward councils was, however, seen as a way of facilitating significant improvement in information and skills within communities.

Infrastructure across the city was similarly varied, with access to safe drinking water representing a key weakness (rated 3/10 in Figure 33). This is consistent with analysis of census data (see Figure 34), which shows some districts such as Tagabe North with as little as 54% of households having access to piped water (either shared, or plumbed directly to households), despite falling within the watershed of the city's water supply.

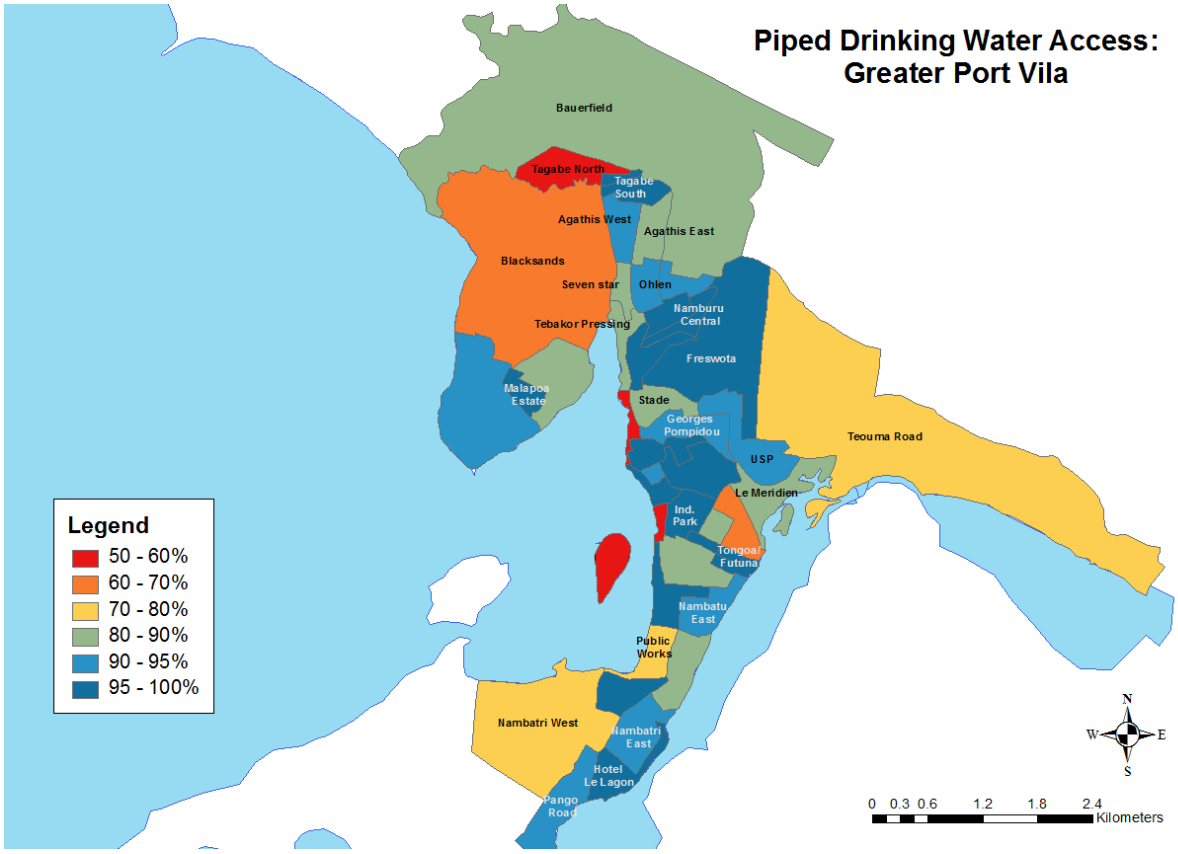


**Figure 34**: Access to safe drinking water in Port Vila by statistical district

Economic wealth was the most obvious limitation to the city's adaptive capacity, particularly in relation to access to financial assistance, with one councillor stating that at the community level the council does not know who to look to for financial support. Although staffing for adaptation was seen as a national strength, this had not yet translated to capacity within PVMC, although a Climate Change Officer position has recently been established within Shefa Provincial Council. It was suggested by the PVMC Town Clerk that the Port Vila Adaptation Plan could provide the framework for a business case for creation of a similar position within the municipality.

### *3.4.2 Institutional and Policy Frameworks*

The core institutions and organisations with roles in addressing climate vulnerability are represented in Figure 35, categorised by existing or potential roles in future climate adaptation actions. Although this framework does not include all active bodies (actions addressing water supply, for example, would have to engage UNELCO, as well as the Ministry of Lands and Natural Resources), it illustrates the functional aspects of climate change adaptation planning in Vanuatu which would need to be engaged in the development of an adaptation plan for the city.

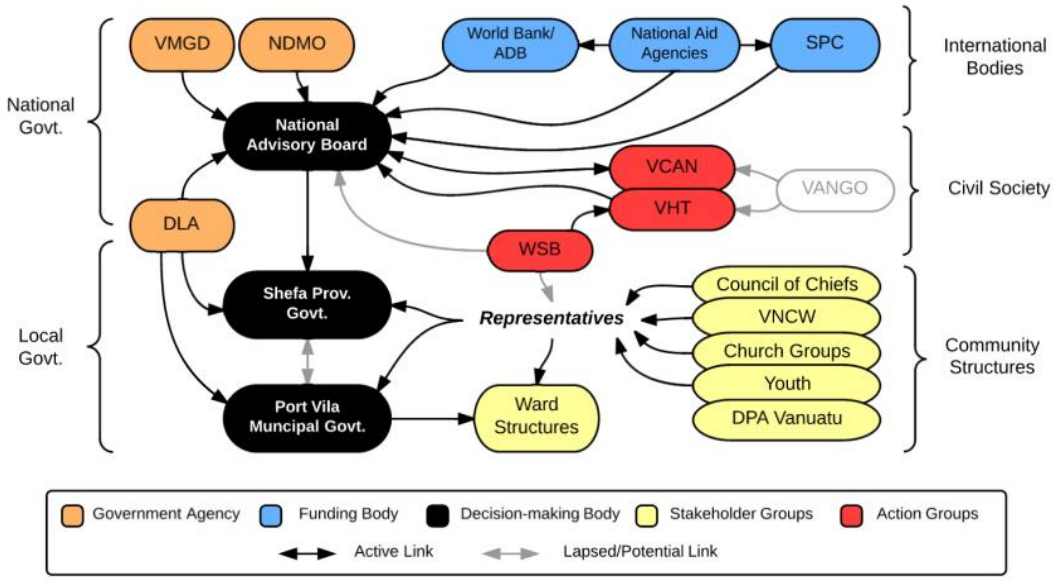


**Figure 35**: Representative Framework of Climate-Action Related Institutions

Many of the components of Greater Port Vila's institutional and policy frameworks are outlined in Section 2.5, however much of the existing capacity to manage and recover from current day climate impacts – predominantly relating to extreme weather events – resides within the national government agencies, in particular the NDMO. A second but additional core strength are those NGOs active within the Greater Port Vila area such as ADRA, Save the Children and Wan Smolbag, which provide a range of preventative roles such as educating residents of climate-related hazards and improving infrastructure within exposed communities (particularly through WASH-related initiatives).

Areas of ongoing legislative and/or policy improvement include the *National Building Code* and associated legislature, subdivision legislation (targeted at reducing development in exposed areas), and development of a *Port Vila Land Use Plan*. However, these documents have been under development for a prolonged period, with no clear timelines for their finalisation, gazetting and implementation. More broadly, implementation was a key gap, with policies and stakeholder agencies perceived as being disjointed; as put by one workshop participant, *"we have community chiefs and leaders who are well organised … but [the government] is not addressing the issue to the right people"*. Re-establishment of VANGO (shown in grey in Figure 35), strengthening of linkages between Shefa Provincial council and PVMC, and integration of locally active organisations such as Wan Smolbag into the decision-making process would help to facilitate the connection between institutional capacity and communities within the city. The lack of localised Emergency Response Plans was also a gap evident in responses (see Figure 33), which could be integrated with ward-level councils once they are established.

### *3.4.3 Multi-level Governance*

Development of an ongoing position to co-ordinate issues across municipal and provincial areas, either within DLA or – if the role is specifically focused on climate issues – within the NAB/NDMO/VMGD framework, would assist in planning for the Greater Port Vila area. As noted by the Town Clerk during the PVMC workshop, each ward will also have to engage with their respective neighbouring stakeholders both in and outside of the Greater Port Vila area: Malapoa-Tagabe with Mele and Ifira; Central and South Wards with Pango and Erakor, and Freswota-

Tassirriki with Teouma (as well as UNELCO, being the key ward area abutting the Port Vila Water Catchment area).

Although enlargement of the formal municipal area faces considerable political and social difficulty, Section 2.3 of this report highlighted the issues associated with characterising and planning for the city when most of the population growth and development that is occurring falls outside of the formal municipal boundary. A balance must be struck between customary land ownership and provision of services across municipal-provincial boundaries, which will either require mechanisms for including customary land ownership within the municipal government's jurisdiction, or formalisation of municipal-provincial partnerships for urban planning and service provision.

### *3.4.4 Community-level Structures and Traditional Knowledge*

As identified in the thematic assessment of scoping interviews, although community-level structures and traditional knowledge are not well integrated into the governance and institutional frameworks discussed above, they are considered the strongest aspect of Greater Port Vila's adaptive capacity (consistent with the 8/10 rating of community leadership and 7/10 rating of stakeholder hazard awareness in Figure 33). The link between long-standing traditional knowledge of the local climate, and how it is now changing, needs to be better established. As one councillor wrote during the PVMC workshop *"People see the changes happening but are not sure what is causing them"*. Similarly, as another respondent suggested, stakeholders are aware of current and potential climate impacts, but *"Oli no putum name blo climate change"* – they just haven't labelled it as climate change yet.

It is also important to note that if adaptive capacity is to be strengthened, resources and knowledge – such as the findings in this report – will need to be effectively communicated in ways that are understandable and accessible for the community. As shown in Figure 36, literacy rates across the city, and particularly in the more vulnerable informal settlement areas, are low, with 16% of the population self-identifying as not 'literate' in English, a level that was stated by stakeholders as being significantly higher in terms of written – rather than spoken – language. Roughly half of the urban population identified as being literate in French; however the overlap between Francophone and English-speaking residents is not identifiable through available census data (making a figure for total illiteracy difficult to calculate).

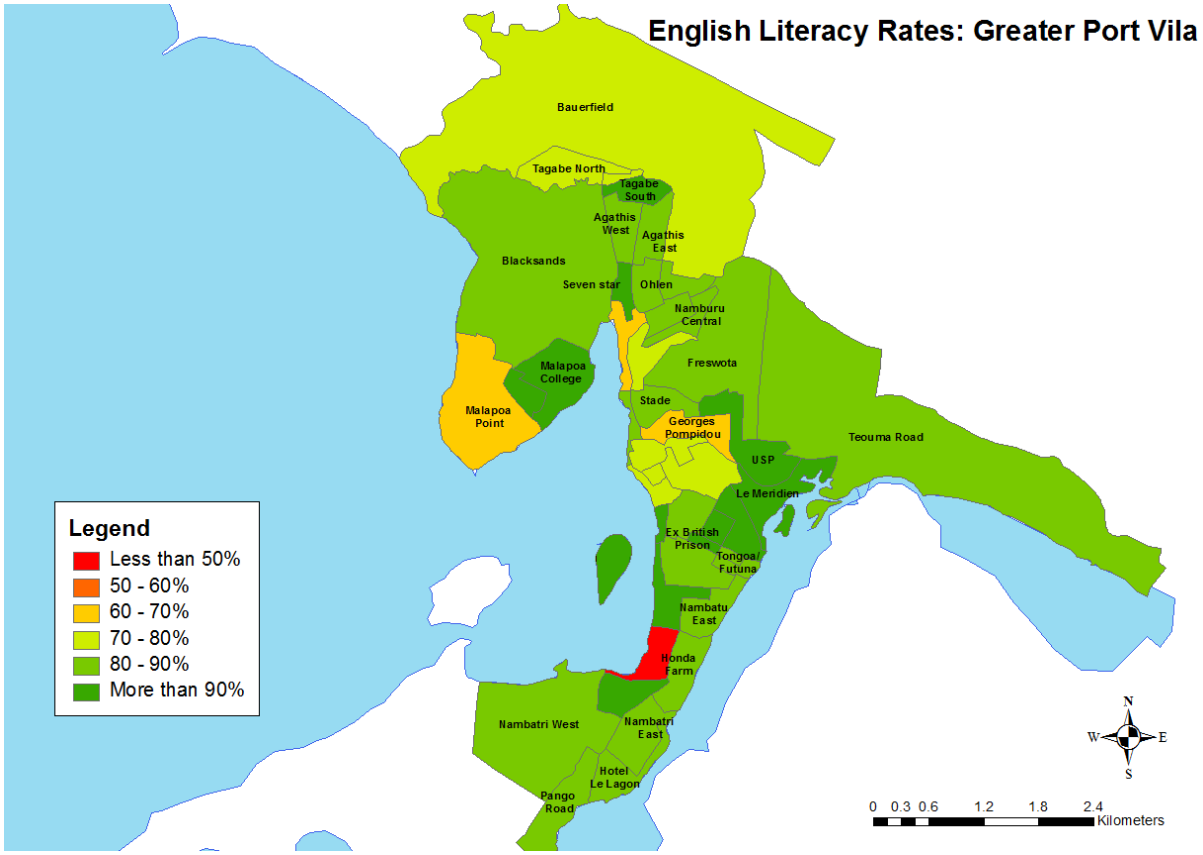


**Figure 36**: Self-reported English literacy levels across Greater Port Vila (data extracted from VNSO 2014)

Use of multimedia, particularly television and radio, to disseminate information was encouraged; although 30% of households do not own a television (VNSO 2014), many have access through social gatherings and sporting events, as evidenced in the Blacksands Transect Walk. Most households (90%) do not have fixed-line internet (see Figure 37), although connection levels are increasing. Mobile technology is however extremely prevalent, with 90% of households having one or more mobile devices (*ibid*), and a number of successful research projects have been conducted via mobile surveying techniques and information dissemination (see, for example, McDonald 2013). Use of summary reports or fact sheets in Bislama, specific to local communities or wards, would also assist in integrating knowledge of climate change into community-level structures, thus strengthening local adaptive capacity.

Engagement with Wan Smolbag as an approach for developing verbal and theatre-based communication of climate vulnerability and risks was identified as an immediate opportunity for increasing adaptive capacity in the informal settlement areas, particularly Blacksands, where the group already has extensive operations. Seed funding for an exploratory 'communication of climate risks' exercise has been provided by RMIT University, with workshops to be arranged in 2015.

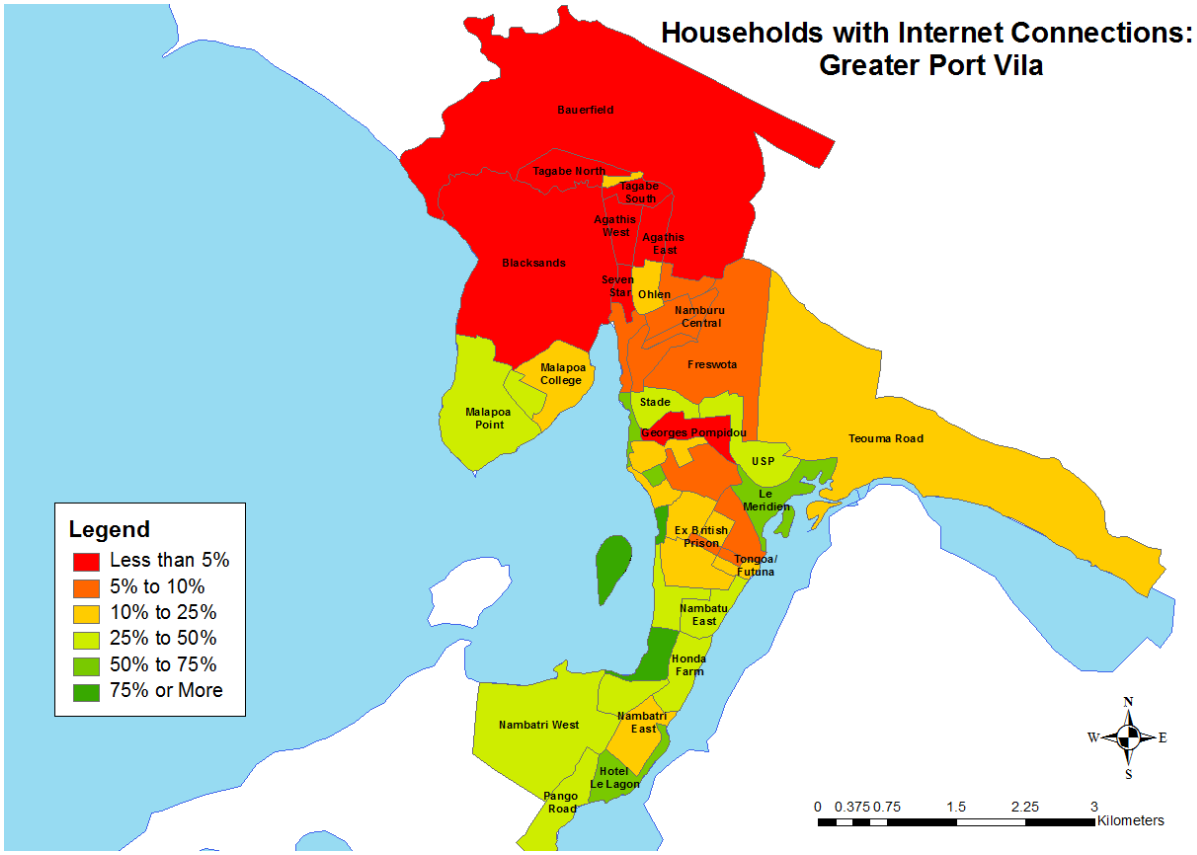


**Figure 37**: Fixed-line internet access across Greater Port Vila (data extracted from VNSO 2014)

# 4 Conclusion

## 4.1 Summary of Greater Port Vila's Vulnerability

This first pass vulnerability assessment is intended to provide an overview of Greater Port Vila's core climate-related vulnerabilities; applying the first module of the *Planning for Climate Change Toolkit* in order to profile the sensitivity, exposure and adaptive capacity of the city's infrastructure, citizens, institutions and systems.

Greater Port Vila is a rapidly growing metropolitan area, exposed to a wide array of climate-related and geophysical hazards under current climatic conditions. However much of the vulnerability of the city and its citizens can be attributed to poor quality, ill-maintained and under designed infrastructure assets; specifically, ineffective drainage systems, limited transport networks and the lack of enforced standards for buildings. The security of Port Vila's water supply in the face of a rapidly growing population is also a core issue; with current water stress reflected in reduced downstream river flows and bore pump pressure reductions during recent dry periods.

High impact extreme climatic events represent a very real and present threat, with tropical cyclones, extended periods of heavy rainfall, and drought all having caused severe damage to Greater Port Vila in the recent past. The frequency and severity of these events under all climate change scenarios is difficult to project, with climate models disagreeing in both the direction and magnitude of the change expected due to complex regional climate systems, the high variability of rainfall records, and the difficulty in predicting sub-regional, short-term weather phenomena such as low-pressure systems in Global Circulation Models.

A number of vulnerabilities relate to areas beyond Greater Port Vila's boundary that supply resources into – and/or derive income and trade from – the city. Port Vila is the sole entry point to the country for internationally imported food products, with rice increasingly a staple of urban residents' diets due to declining access to household-owned bush garden produce as the city grows. As a result, the possibility of cascading impacts from extreme events that damage port infrastructure and disrupt shipping lanes, while at the same time threatening on-shore crops, represent less obvious external climate vulnerabilities that should be planned for. The impact of droughts elsewhere in the supply chain was also raised by a number of project participants, with the affordability of imported food impacting poorer communities and households in the city, particularly in times of food scarcity and economic hardship.

In the more immediate vicinity of the city the vulnerability of marine resources to future climate impacts represents a slow-onset threat to the livelihoods of Port Vila citizens, with warming ocean temperatures projected to result in coral reef health reaching marginal conditions by between 2020 and 2030 under both high and medium emissions scenarios. Although the subsequent impacts on both tourism and fishery stock are difficult to predict, tourism and marine resources are vital to not only Port Vila's economy and its residents livelihoods but also the Vanuatu economy as a whole.

Seasonal changes are similarly difficult to quantify, however dynamical downscaling of climate models suggests that dry seasons will become drier, and wet seasons wetter. Local observations indicated that seasons are becoming less predictable, with serious consequence for the agricultural sector and community livelihoods. However the evidence of this in climate records is yet to be fully analysed.

## 4.2 Recommendations

Based on the vulnerability assessment outlined in this report, a number of recommendations for areas of immediate focus have been identified, and are outlined below:

1. **Cross-boundary engagement:** although the historical and complex socio-political difficulties in expanding or moving the municipal boundaries are acknowledged, the need to define a wider 'urban' area is self-evident in the confusion regarding changes to the city's rate of growth, as articulated in Section 2.3 of this report. Beyond statistical analysis, the practicalities of planning across municipal-provincial boundaries require management structures and formal frameworks, both at a ward/community level, and through political engagement between local governments.

2. **Institutional support for local adaptation planning:** Shefa Provincial Council's appointment of a Climate Change Officer is commendable; however there is a significant role for an equivalent position within PVMC. Tasks for such an appointment would include ward level profiling of hazards, development engagement processes to communicate these hazards to local communities, and development of climate adaptation actions (through integration with existing programs such as the PVUDP, as well as through specifically targeted initiatives). The role would also co-ordinate with their equivalent within Shefa, which would contribute to Recommendation 1. Development of a business case for such a role will be considered in the next phase of adaptation planning in the city. UN Habitat and RMIT University could provide scientific and technical support for such a position.

3. **Analysis of additional vulnerability 'hotspots':** Informal settlements in Greater Port Vila are diverse in terms of the communities within them, their physical infrastructure, and the climate hazards that they face. Further transect-walk studies should be conducted in these other areas, particularly Seaside Futuna/Tongoa/Paama and Ohlen, which face high levels of climate exposure, high sentivity, and lack adaptive capacity. Development of a rapid vulnerability assessment process and training of local people are possible actions.

4. **Communication Strategies:** Many participants expressed an interest in getting a clearer understanding of climate change and the climate hazards that they faced. As suggested elsewhere in this report, techniques for dissemination will need to be diverse, using multimedia, short-form multilingual fact sheets specific to local communities, and through development of creative programs with local actors such as Wan Smolbag. There is also a need for Bislama translation to assist with broader reach of education on climate change matters if local communities are to be fully engaged. Mobile technology is also a platform that could be further explored for further research, information dissemination, and extreme event warning systems.

5. **Integrating traditional knowledge into decision-making processes:** Traditional knowledge has been both disrupted and largely excluded from the institutionalisation and modernisation of disaster risk reduction processes, as well as the broader development agenda in Vanuatu. However, having already been exposed to a wide range of climate and geo-hazards, existing traditional knowledge and community structures should be leveraged by, rather than excluded from adaptation actions. Within Greater Port Vila, re-connecting these mechanisms will require meaningful participatory input, building on connections with local Chiefs, stakeholder groups (such as the VNWC, church groups and youth organisations), as well as the recently re-formed ward councils.

6. **Further engagement with VNSO:** Census data has to date been under-utilised within the Greater Port Vila area, and is a vital resource for PVMC planning, beyond addressing climate risks. Development of further detailed mapping, beyond those included in this report, would be of great use to the Council, and engagement with the National Statistician will be a key

component of further *Planning for Climate Change* work in the city. Revision of census descriptions of 'urban' and 'rural' areas should form part of these discussions, as well as improvement of processes for defining households in 'informal tenure' arrangements.

7. **Enhanced legislative transparency**: The dependency on *PacLii* – a program of the University of the South Pacific which is wholly funded by the Australian Government's Department of Foreign Affairs and Trade – for access to legislative documentation is a significant limitation on the implementation, understanding and integrative capacity of urban planning agendas. Additionally, charging fees for access to national legislation from the current 12 month period (resulting in a delay in PacLii availability of legislation) is highly problematic, preventing community and stakeholder understanding of the law. This was linked to confused interpretations of the status and content of a number of policies and their related regulatory instruments– including the Building Code Act, Urban Land Use Policy and the formal title of the Minister for Climate Change – which further inhibited implementation of climate change planning in Port Vila and across Vanuatu more broadly.

8. **Analysis of water vulnerability:** In addition to the drainage works being carried out under the ADB-World Bank funded PVUDP, and management planning for the Port Vila Watershed Catchment Area (Matnakara) coordinated by the Ministry of Lands and Natural Resources through the Department of Geology, Mines and Water Resources, a detailed investigation into the security of Port Vila's water supply should be undertaken in partnership with UNELCO and the Public Works Department within the Ministry of Infrastructure and Public Utilities. In particular, such a study should focus on thresholds of rainfall availability (in the context of variability under a changing climate) and ongoing rapid population growth in the city's peri-urban surrounds. Groundwater will be a critical issue for the city under a changing climate and development pressures.

## 4.3 Next Steps

As set out in the *Planning for Climate Change Toolkit*, this assessment report forms this basis for identification, prioritisation and implementation of climate adaptation actions, as shown in Figure 38. Modules B and C, which follow on from the Vulnerability Assessment, involve further engagement activities with community, NGO and government stakeholders, whereby the vulnerabilities to climate change and existing climate hazards are related to the city's overall goals and priorities (Module B). Options for adapting the city's infrastructure, institutions and communities to these impacts are then identified, prioritised and implemented, in partnership with stakeholders, through Module C.


**Figure 38**: Planning for Climate Change Toolkit Process Diagram (Ingram & Hamilton 2014)

These follow-on activities began in late 2014, with the aim of informing an adaptation plan for the city through 2015. Additionally, community and ward-level vulnerability assessments will be expanded to enhance both data quality and public participation level in the planning process, with the aim of addressing some of the immediate issues set out in Section 4.2, reflecting the cyclical nature of the *Planning for Climate Change* process as set out in Figure 38.

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# 6 Annexes

## 6.1 Annex 1 - Enumeration allocation by greater ward grouping

| Name | VNSO Code | Peri-urban | Urban | 2009 Pop. | % Growth 99-09 | Area (km2) |
|---|---|---|---|---|---|---|
| **Malapoa-Tagabe Ward** | | | | **29680** | **146.23** | **11.09** |
| Malapoa College | 806 | * | x | 433 | -12.53 | 0.43 |
| Malapoa Estate | 847 | x | | 550 | 56.70 | 0.12 |
| Malapoa Point | 846 | x | | 9 | -70.00 | 0.91 |
| Blacksands | 835 | x | | 9683 | 100.98 | 2.84 |
| Agathis West | 807 | * | x | 1499 | 48.12 | 0.20 |
| Tagabe South | 805 | | x | 452 | 26.97 | 0.15 |
| Agathis East | 804 | | x | 3585 | 361.39 | 0.20 |
| Tagabe North | 803 | x | * | 1421 | 137.63 | 0.31 |
| Tagabe Central | 802 | | x | 349 | -7.67 | 0.04 |
| Bauerfield | 801 | * | x | 11699 | 261.19 | 5.57 |
| **Anabrou - Melcoffee Ward** | | | | **10123** | **102.99** | **1.07** |
| Tebakor Pressing | 808 | | x | 454 | 21.39 | 0.09 |
| Namburu North | 809 | | x | 891 | 0.22 | 0.13 |
| Namburu South | 810 | | x | 147 | -35.24 | 0.19 |
| Melcofe | 811 | | x | 2 | -83.33 | 0.06 |
| Seven Star | 836 | | x | 908 | 59.02 | 0.16 |
| Namburu Central | 838 | | x | 4282 | 158.11 | 0.13 |
| Ohlen | 837 | | x | 3194 | 241.24 | 0.13 |
| Jack Fong | 839 | | x | 245 | -23.20 | 0.14 |
| **Freswota - Tassirriki Ward** | | | | **11915** | **135.33** | **6.86** |
| Stade | 812 | | x | 769 | 31.01 | 0.20 |
| Georges Pompidou | 813 | | x | 519 | 14.82 | 0.26 |
| Freswota | 840 | | x | 8384 | 208.80 | 1.20 |
| USP | 841 | | x | 502 | 18.40 | 0.39 |
| Le Meridien | 842 | | x | 721 | 201.67 | 0.37 |
| Teouma Road | 843 | x | | 1020 | 57.89 | 4.24 |
| **Central Ward** | | | | **4842** | **16.03** | **1.61** |
| Bouganville North | 814 | | x | 118 | -49.57 | 0.17 |
| Post Office | 815 | | x | 668 | 34.68 | 0.18 |
| Bouganville South | 816 | | x | 91 | 5.81 | 0.03 |
| Court House | 817 | | x | 220 | -17.29 | 0.31 |
| Independence Park | 819 | | x | 699 | 44.42 | 0.19 |
| Vila East | 820 | | x | 90 | -51.35 | 0.08 |
| Ex British Prison | 821 | | x | 501 | 13.86 | 0.04 |
| Vila Central Hospital | 822 | | x | 259 | -23.15 | 0.21 |
| Tongoa/Futuna | 823 | | x | 1195 | 32.34 | 0.03 |
| Seaside Paama | 824 | | x | 645 | 6.09 | 0.07 |
| Burns Philp (Iririki) | 818 | x | | 356 | 165.67 | 0.22 |

| Name | VNSO Code | Peri-urban | Urban | 2009 Pop. | % Growth 99-09 | Area (km2) |
|---|---|---|---|---|---|---|
| **South Ward** | | | | **4227** | **22.52** | **3.64** |
| Colardeau | 825 | | x | 74 | -53.16 | 0.29 |
| Nambatu West | 826 | | x | 88 | -46.67 | 0.20 |
| Nambatu East | 827 | | x | 882 | 21.15 | 0.23 |
| Nambatri West | 829 | x | * | 1207 | 70.96 | 1.41 |
| Honda Farm | 830 | | x | 421 | 1.94 | 0.26 |
| Public Works | 828 | | x | 9 | -47.06 | 0.09 |
| Nambatri East | 831 | | x | 880 | 33.33 | 0.31 |
| Hotel Le Lagon | 832 | | x | 59 | 20.41 | 0.24 |
| Pango Road | 844 | | x | 473 | 41.19 | 0.37 |
| Nambatri North | 845 | | x | 134 | -38.81 | 0.20 |
| ** VNSO area crosses PVMC/Shefa boundary* | | | ***Total:*** | ***44039*** | ***48.14*** | ***24.27*** |

## 6.2 Annex 2 – Vulnerability Toolkit Inception Status Report

| Task (Module A only) | Toolkit Methods | Status at RMIT Inception | Current Status (August 2014) |
|---|---|---|---|
| Step 2: Stakeholders and Participation | | | |
| **Task 2.1: Identify stakeholders** | Tool 2A – Stakeholder ID Worksheet | 7 stakeholders interviewed: 3 from local government, 4 NGO development community members. | Key stakeholder organisations mapped. 25 additional stakeholders interviewed, including representatives from NDMO, VMGD, World Bank, WSB (NGO), SPC-GIZ, VNWC, Save the Children.<br><br>Workshops held (total of 30 stakeholders participating), including the Lord Mayor, Director of DEPC and 8 PVMC councillors. |
| **Task 2.2: Establish the Stakeholder advisory group** | Tool 2B – Stakeholder Analysis Matrix (and checklist) | Not evident, will need to be compiled. | A core group of 'Champions' has been established, crossing Provincial Govt., National Govt. Departments and the NGO community |
| **Task 2.3: Establish stakeholder advisory group procedures** | Tool 2C – Stakeholder 'Terms of Reference' Worksheet | Advisory Group formation (and ToR) for such a short project timeline may be in-effective. | Local structures not sufficiently established for forming a ToR. Project is to be submitted to the National Advisory Board for their approval in September, which can act as a proxy review group. |
| **Task 2.4: Determine level of broader community engagement** | No tool provided | Not evident. | Engagement with 6 community chiefs throughout the Blacksands Informal Settlement. Seed funding submitted at RMIT for developing a non-written dissemination approach in partnership with Wan Smolbag, a local NGO. Wider dissemination will build on established stakeholder 'champion' group, and their networks. |
| Step 3: Vulnerability Assessment | | | |
| **Task 3.1: Exposure Analysis** | Tool 3A – Weather and Climate Change Summary Table<br>Tool 3B – Climate Change Local Observation Template<br>Tool 3C – Influence Diagram<br>Tool 3D – Overview: Exposed people, places, institutions and sectors<br>Tool 3E – Hazard (exposure) mapping | Reference to CSIRO/PCCSP summary of historical trends for Port Vila, Tropical Cyclones, recent SLR. Projections for ocean acidification to 2100 included. | Work to date has focused on community level, 'bottom-up' data and tools to avoid duplicating World Bank hazard mapping (preliminary discussions held on integrating the two approaches with World Bank country lead Anna Wells).<br><br>Access to LIDAR-based storm-surge and SLR mapping granted by the NAB (GIS layers accessible for next field visit).<br><br>Base layer access is progressing slowly – basic land use maps are not yet available, and digital versions may not be forthcoming.<br><br>Outputs of workshop mapping excerises (hybrids of Tools 3D, E and G) have been digitised. Sufficient data for tools 3B, C and D have been collated through interviews, which are in the process of being coded. Access to raw metrological data is being |

| Task (Module A only) | Toolkit Methods | Status at RMIT Inception | Current Status (August 2014) |
|---|---|---|---|
| | | | negotiated with the VMGD. |
| **Task 3.2: Sensitivity Analysis** | Tool 3F – Socio-demographic Sensitivity Assessment<br>Tool 3G – Sensitive Places Mapping<br>Tool 3H – Community-based Sensitivity Mapping<br>Tool 3I – Sensitivity Threshold Identification<br>Tool 3J – Priority Threat Assessment<br>Tool 3K – Climate Threat Plotting | Socio-economic trends, current demographics and sectoral descriptions included in prior report, as well as policy exploration. | Sub-city data is not publicly available, however a list of relevant variables was requested from VNSO regarding the 2009 census, and they have recently been supplied to the research team in raw form. Processing and mapping of these variables is progressing.<br><br>Analysis of the outputs of the transect walk exercise through Blacksands (geo-coded photo data, notes and interview contents) is progressing, and will provide more detailed 'sub-city' analysis of a peri-urban growth area and informal settlement sensitivities.<br><br>Key thresholds regarding water supply, drainage, vector-borne diseases and storm events have been identified for further exploration in additional fieldwork. |
| **Task 3.3: Adaptive Capacity Analysis** | Tool 3L Adaptive Capacity Assessment<br>Tool 3M – Rapid Institutional Adaptive Capacity Assessment | Adaptive capacity considered at an institutional level but Tool 3M not completed. **In-depth community consultations and further in-depth interviews will be undertaken under 3L.** | High-level stakeholder application of Tool 3L undertaken with PVMC and key experts (National government and NGO community).<br><br>Further work to be conducted as part of the development of an Adaptation Plan. |
| **Task 3.4: Summary Vulnerability Assessment** | Tool 3N – Summary Vulnerability Rating Matrix<br>Tool 3O – Summary Vulnerable Populations Rating Matrix | Matrices not evident. **To be completed through a workshop process and cross-examined through key stakeholders** and/or the proposed review group. | Tool 3N applied during the Shefa Provincial Council workshop.<br><br>Further work to be conducted as part of the development of an Adaptation Plan. |
| **Task 3.5: Preliminary Adaptation Options Identification** | Tool 3P – Vulnerability Assessment Report Outline | Report completed, however **this stage will have to be re-completed with new data integrated from the above.** | Some discussion during workshops at PVMC and Shefa.<br><br>Further work to be conducted as part of the development of an Adaptation Plan. |

## 6.3 Annex 3 – Scoping Interview Outputs: Key Themes

| Theme | Description | Weight | Notes |
|---|---|---|---|
| **Current focus on rural areas for both CCA/DRR** | Activities | **5** | |
| **PVMC as a potential champion, capacity limited** | Actors | **5** | *use as a seedbed, build capacity* |
| **Won Smolbag as the key grassroots actor** | Capacity | **2** | |
| **Strong National-level bureaucratic CCA knowledge/capacity** | Capacity | **2** | |
| **Strong customary/culturally-based disaster response mechanisms** | Capacity | **2** | *Potential to be disrupted if not integrated* |
| **Role of Women in Households** | Capacity | **2** | |
| **Issues of implementation at multiple levels** | Capacity | **4** | |
| **Climate data limitations/lacking to date** | Capacity | **3** | *CSIRO vs. CMIP5 SimClim* |
| **Broad-based education as NGO strength** | Capacity | **3** | *Lacking standardisation currently* |
| **Culture/Traditions modified in urban environ.** | Institutions | **5** | |
| **Church groups as a key engagement area locally** | Institutions | **2** | *Vanuatu Christian Council* |
| **A need for standards/legislation** | Institutions | **5** | *Building, subdivision codes* |
| **Urban Linkages - beyond the physical boundary** | Vulnerability | **2** | |
| **Lack of effective urban land use arrangements/planning** | Vulnerability | **4** | |
| **Heavy rainfall vulnerability/lack of drainage/sewerage/water access** | Vulnerability | **5** | *untreated water supply, drainage lacking* |
| **Food security - the hidden issue** | Vulnerability | **5** | *Complacency in urban areas* |
| **Food and goods shift from subsistence/local to global/monetary: new exposures** | Vulnerability | **3** | *Urban centres as catalyst for this* |
| **Waste Management** | Activities | **2** | *Not clear re. CC link though* |
| No more workshops | Activities | 1 | *Focus groups or field visits* |
| Rapid personnel 'churn' | Capacity | 1 | |
| Issues around healthcare response resources | Capacity | 1 | *JICA involved in hospital build* |
| Adaptation as economic empowerment | Capacity | 1 | |
| Downscaling makes limited difference to PV | Data | 1 | *Complexity not worth it* |
| Well-funded high-level CCA nationally but sustainability over time not clear | Institutions | 1 | |
| Lack of ongoing maintenance - short-term initiatives only | Institutions | 1 | |
| Diverse cultural/ethnic groupings driving politics/settlement | Institutions | 1 | |
| Development agency 'top-down', NGO 'bottom-up' divide | Institutions | 1 | Lack of clarity over roles & local govt. as an 'in between' |
| Co-ordinated Civil Society | Institutions | 1 | VHT as a key grouping body |
| Blurred Municipal/Provincial divide of responsibility | Institutions | 1 | |
| Importance of non-written communication | Methodology | 1 | |
| Community/stakeholder ownership/longevity and sustainability of action needed | Outputs | 1 | |
| Urban Greenspace lacking, vital for women | Vulnerability | 1 | Potential PVMC action |

*NB: Weighting scale derived from a ranking of theme frequency in stakeholder interviews (1-5, with 5 as most frequent).*