Cities and Climate Change Initiative

ABRIDGED REPORT

Lami Town
Fiji

Climate Change
Vulnerability Assessment

UNEP

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Lami Town, Fiji – Climate Change Vulnerability Assessment

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Introduction

1.1 Cities and Climate Change

Climate change is already affecting millions of people worldwide. In urban areas, which are typically characterized by significantly higher population density, climate change will exacerbate and compound existing climate vulnerabilities, especially for the urban poor. As a result of climate change, it is expected that storm frequency and intensity will increase, flooding will become more serious and droughts will affect food production in rural areas, which will have damaging effects in cities. Coastal areas are particularly threatened by inundation from storm surges and sea-level rise. Existing urban development challenges, such as poor health and inadequate housing, is substantially exacerbated by the effects of climate change. At the same time, cities are the main drivers of increasing greenhouse gas emissions. This means that cities must be at the centre of efforts to both mitigate the causes of climate change, and to adapt to their anticipated effects.

In Fiji, as in many areas in the Pacific, urban populations are located in highly hazard-prone areas in the coastal zone. Storm surges and sea-level rise can affect settlements, food production and infrastructure. A lack of basic services such as clean water supply and solid waste management can exacerbate the negative effects of climate change. Amid all this, the poorest are almost always the most vulnerable, as they have less access to infrastructure, basic services and social safety nets in the event of a disaster.

1.2 UN-Habitat's Cities and Climate Change Initiative

Cities and local authorities have the potential to mitigate the causes of climate change, and protect themselves from the effects. The Cities and Climate Change Initiative (CCCI) promotes the mitigation of, and adaptation to, climate change in developing countries. More specifically, it supports the development of pro-poor innovative approaches to climate change policies and strategies, building on UN-Habitat's rich experience of sustainable urban development (through the Environmental Planning and Management approach of the Sustainable Cities and Agenda 21 Programmes) as well as on well-recognized capacity building tools. CCCI develops, adapts and disseminates methodologies that put city managers and practitioners in a better position to support adaptation to climate change. It also promotes collaboration among local authorities and their associations in global, regional and national networks, with the rationale of:

1) enhancing policy dialogue so that climate change is firmly established on the agenda;
2) supporting local authorities' efforts to bring about these changes; and
3) enhancing awareness, education and capacity-building in support of climate change strategies.

A major outcome of the initiative will be the development of a set of tools for mitigation and adaptation.

02

Overview of the City

2.1 Fiji: Overview

Fiji is located in the South Pacific, around 2,000 km North of New Zealand, at a latitude of between 15° and 22° South and 175° and 178° East. There are 322 islands in the Fijian archipelago, of which 110 are inhabited. Of a total land mass of 18,270 km² Viti Levu (10,544 km²) and Vanua Levu (5,538 km²) are the two largest islands and account for most of the country's population and economic activities. Of its population of 837,271, as of 2007, approximately 51 per cent live in urban areas. Suva is the capital and is one of two cities, along with Lautoka. There are 11 declared towns, including Lami. The Fijian economy has shown relatively slow growth in recent years, with its annual GDP improving from a period of slight contraction in 2009 and 2010 to a 2 per cent increase in 2011[1] the main economic sectors are tourism and cash crops, particularly sugar.

2.2 Geographical Location

Lami Town is adjacent to Suva City on the southeast coast of Viti Levu. It is a coastal town in the north-western part of the greater Suva area, which is the most densely populated region in Fiji, with 62.1 per cent of the country's total urban population. The total land area of Lami is 680 hectares and the population is approximately 20,000.

Figure 1: Lami Town within the Greater Suva area

Source: Fiji, Department of Lands

[1] World Bank (2009-2011). World Development Indicators.

2.3 Governance Structure

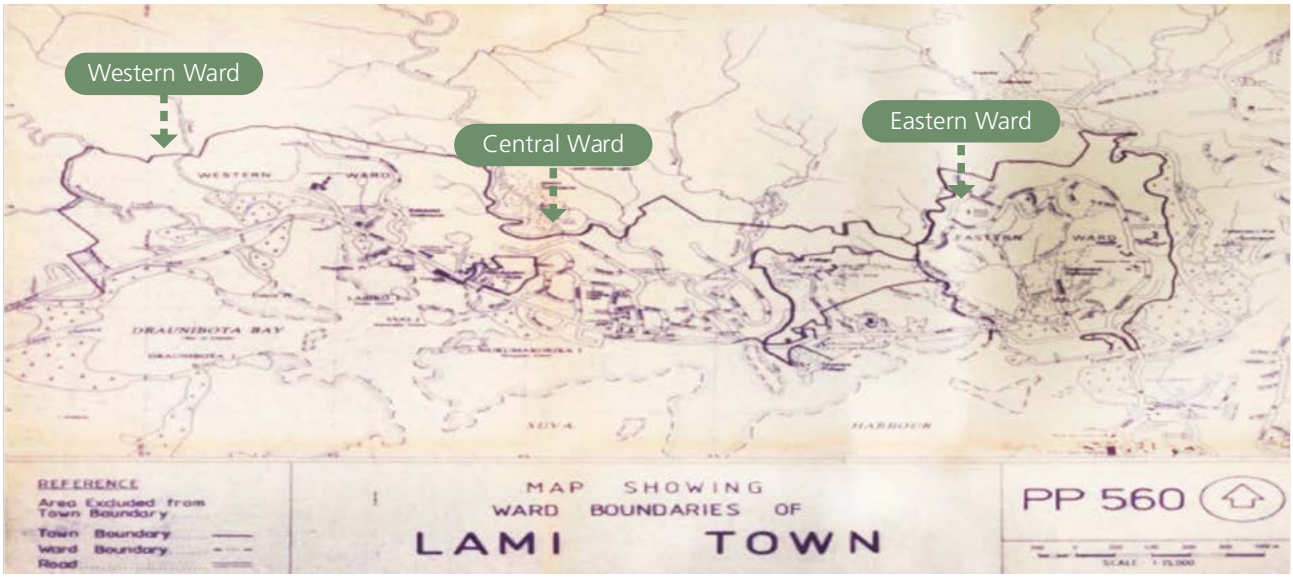
Lami was established as a town by ministerial declaration through the Local Government Act in 1977. The town is split into three wards: Western, Central – the main commercial and industrial area – and Eastern. Lami's land tenure consists of three categories of land which make up Fiji's land division system: native/native reserve land (51 per cent), state land (21 per cent) and freehold land (28 per cent).

Lami Town Council is responsible for certain basic services, such as public works, drainage, waste management, health promotion and welfare, with some law-making powers on issues such as garbage collection, building permits and local tax payments. The Council reports to the Ministry of Local Government, Urban Development, Housing and Environment. The Council is headed by the Special Administrator, who takes responsibility for strategic direction, and a Chief Executive Officer, who is responsible for implementation of policies.

Lami has a comprehensive strategic plan, covering the period 2010-2014, shown in Figure 3. The plan covers infrastructural development, improving land availability and upgrading sea and flood defences. This vulnerability assessment is designed to complement the strategic plan and allow Lami Town Council to prioritize activities within it. The Council comprises five departments, each tasked with implementing the Strategic Plan:

1) Town Planning and Building Services;
2) Health and Environment Services;
3) Public Works and Services;
4) Enforcement and Parking Meters; and
5) Finance and Administration.

Figure 2: Map showing Lami Town boundaries



Source: Fiji, Department of Town and Country Planning, 2004

Figure 3: Lami Town's Strategic Plan Governance Structure

Source: UN-Habitat

2.4 Demographic and Urbanization Trends

Lami's population comprises 10,752 people in the urban area and 9,777 in the peri-urban area. There are large areas of native reserve land in the peri-urban areas, which are home to large i-Taukei settlements. Demographic data for Lami Town is not available, but in Rewa Province, which includes both Suva and Lami, 25.6 per cent of the population is less than 15 years old, and 7.3 per cent are over 60.

Fijian society is becoming increasingly urbanized, with over 50 per cent of people living in urban areas, which generate over 60 per cent of the country's GDP. Accordingly, the Fijian economy has grown increasingly reliant on industrial and service sectors, and is moving away from agriculture. Growing urban populations have been accompanied by increasing pressure to deliver improved services, while protecting ecosystems. Urban population growth in Fiji has now steadied to around 2.0 per cent per annum, a decline from the period 1986-1996 when the peri-urban population grew on average 3.7 per cent per year. Lami's urban population growth has been slower than the national urban figure: 0.2 per cent per year in the main town and 1.4 per cent in the peri-urban areas. However, it is important to highlight the importance of rural-urban linkages. While the urban population has been growing slowly, many people in peri-urban areas depend on the urban economy for their livelihood, and therefore growth in population does not necessarily correlate with growth in economic activity.

2.5 Physical Features, Land Use and Tenure

Lami is an industrial centre which is characterized by both low-elevation coastal areas and hilly terrain. There are two indigenous villages and several informal settlements within the town boundary. Lami's commercial centre is a small area which makes up approximately 4 per cent of total land use. The commercial centre is bordered by a two-lane highway –

the Queen's Road – which links Central, Eastern and Western wards. The commercial and industrial centre is a low-elevation coastal area.

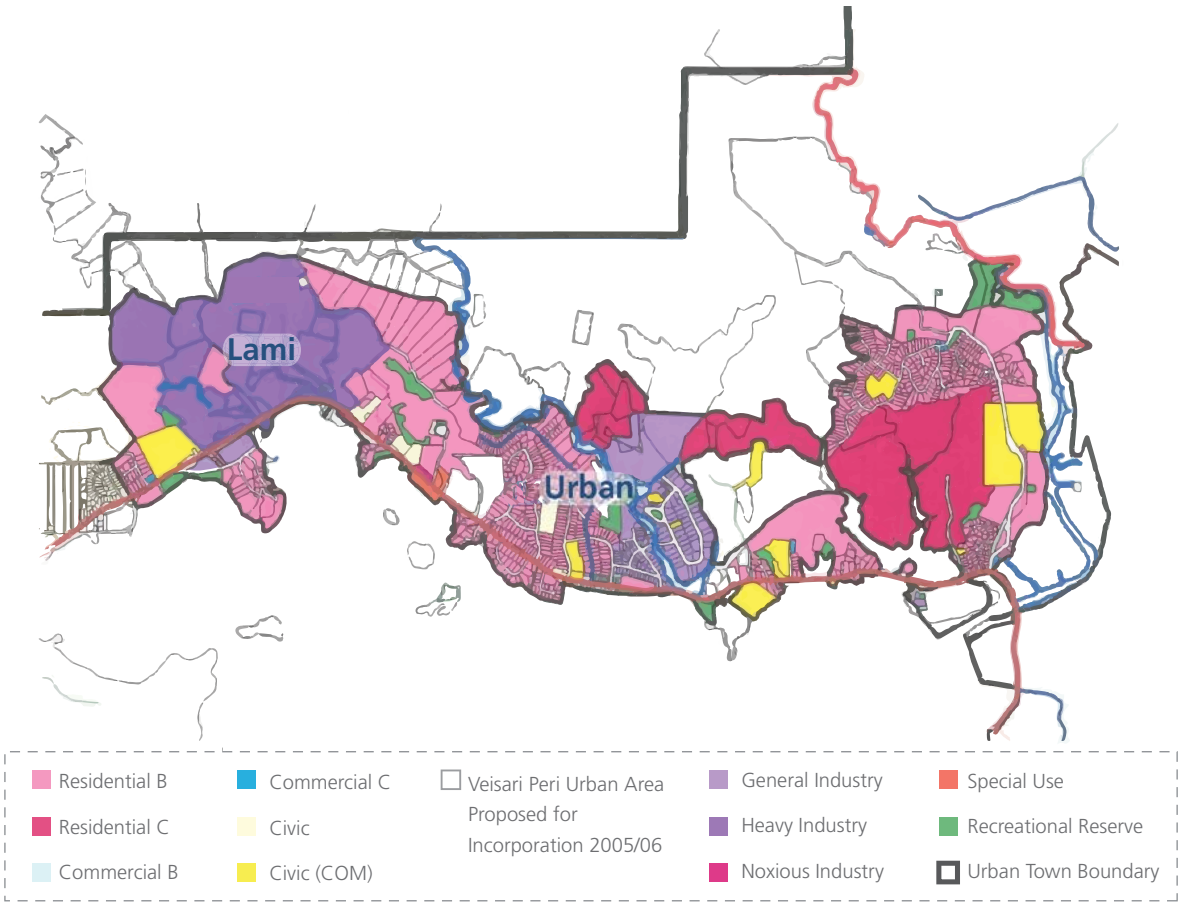
The town's industrial area makes up 16 per cent of land use, and is primarily located in the Eastern Ward. There is a mix between light industries such as food processing and manufacture, and heavy industries such as paint manufacture and chemical processing. There is still land earmarked for industrial development which remains undeveloped. Much of Lami's industrial area, Wailada, is located on reclaimed mangrove swamps and is therefore in a low-lying, flood prone area.

Seventy-four per cent of Lami's land area is currently used as residential space, including informal settlements. Many of the formal settlement areas are located in upland areas above the town, and as such face problems of landslides and erosion. The informal settlements in the town tend to be in low-lying areas and suffer from flooding, as well as a lack of basic service provision. Special use zones, such as hotels, community services and parks comprise approximately six per cent of Lami's land use.

Under Lami's land tenure system, the Town Council works in collaboration with the i-Taukei Land Trust Board in order to lease native land. All shoreline areas, mangroves and rivers are classified as state land and therefore the management of these is controlled by the Director of Lands and Surveys under the Ministry of Lands and Mineral Resources.

The town's Eastern Ward consists of rolling hills up to 75 metres above sea level and flat land along the flood-prone Tamavua-i-wai River. The Central Ward is also characterized by rolling hills about 75 metres above sea level in the Matata area, while the Lami and Wailada River areas in the Central Ward are also vulnerable to flooding. The Western Ward consists of steep and sloping terrain inland, and a largely flat coastal area comprising mangroves and grasslands.

Figure 4: Land use map of Lami Town



Source: Lami Town Planning Scheme, 2004

03

City-Wide Vulnerability – Scoping Exposure, Sensitivity and Adaptive Capacity

3.1 Assessment Framework

In line with the Intergovernmental Panel on Climate Change Fourth Assessment Report[2], in this assessment exposure is defined as the degree of climate stress and is characterized as a change in climate conditions or variability, including the magnitude and frequency of extreme events. Sensitivity is defined by the extent to which a system is affected, either positively or negatively, by climate stimuli. Adaptive capacity relates to the ability of a system to alter itself to adapt to actual or predicted climate stresses, or the ability to cope with the consequences. Vulnerability is therefore a function of exposure + sensitivity - adaptive capacity.

Figure 5: Assessment framework

Source: UN-Habitat

3.2 Exposure

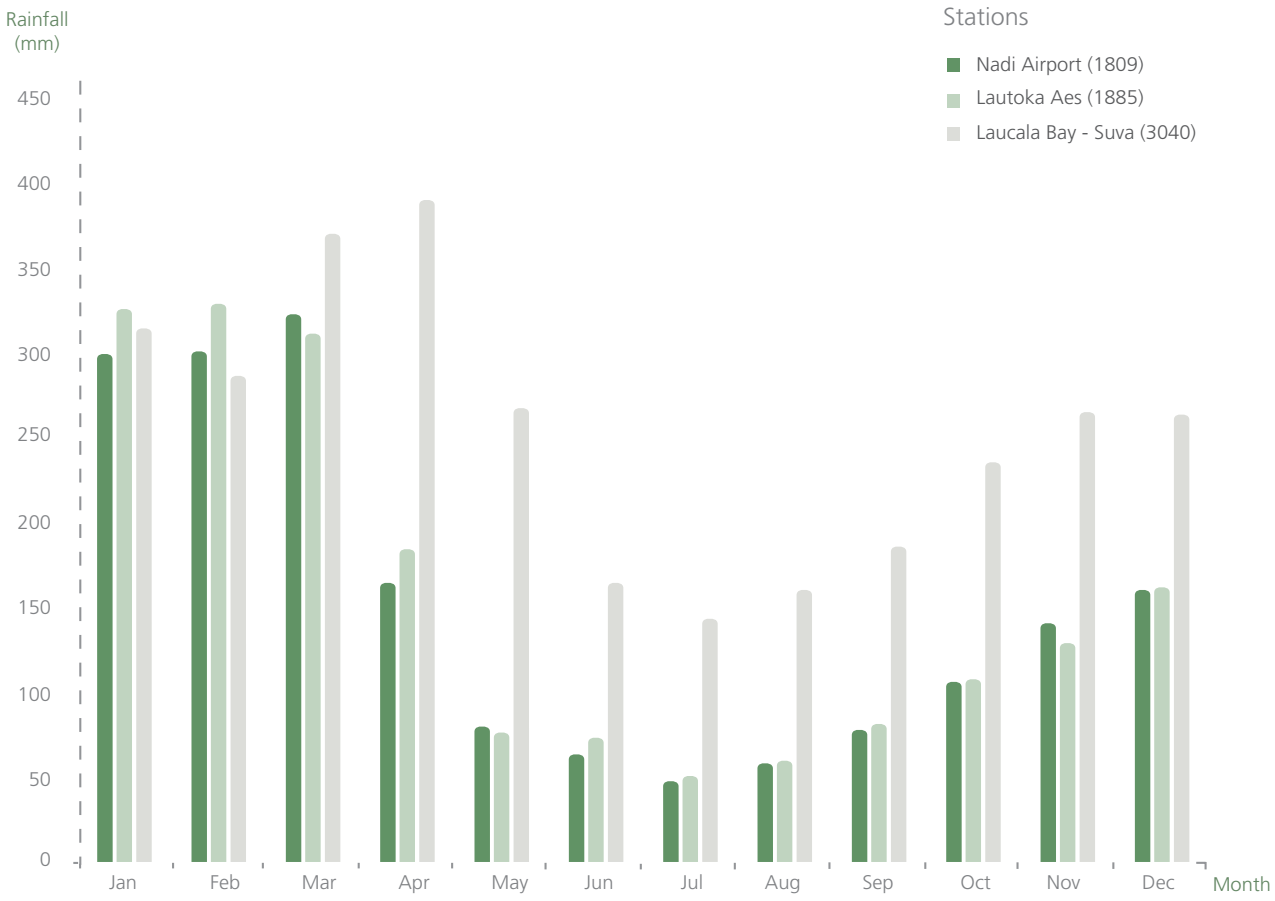
3.2.1 Rainfall

Fiji's wet season is generally from November to April, with the dry season running from May to October. Suva and Lami, on the eastern side of Viti Levu close to Laucala Bay, receive considerably higher rainfall than the western side of the island, as shown in Figure 6. The annual average rainfall is 3,041 mm. Wet season rainfall fluctuates between 264 and 390 mm per month, which is sufficient to cause flash flooding in some cases. Monthly average rainfall in the dry season is between 142 and 267 mm. In the rainy season especially, cyclones can occur and bring continuous downpours. High levels of rain during the wet season enhance impacts on water levels in Lami Harbour, coastal river systems, storm water drains and runoff from the land.

Changes in rainfall as a result of climate change are

[2] Pachauri, Rajendra K. and Andy Reisinger (eds.) (2007). Climate Change 2007: Synthesis Report (Geneva, United Nations Intergovernmental Panel on Climate Change).

Figure 6: Monthly average rainfall in Viti Levu, 1961-1990



Source: Fiji (2005).Climate Change: The Fiji Islands Response.

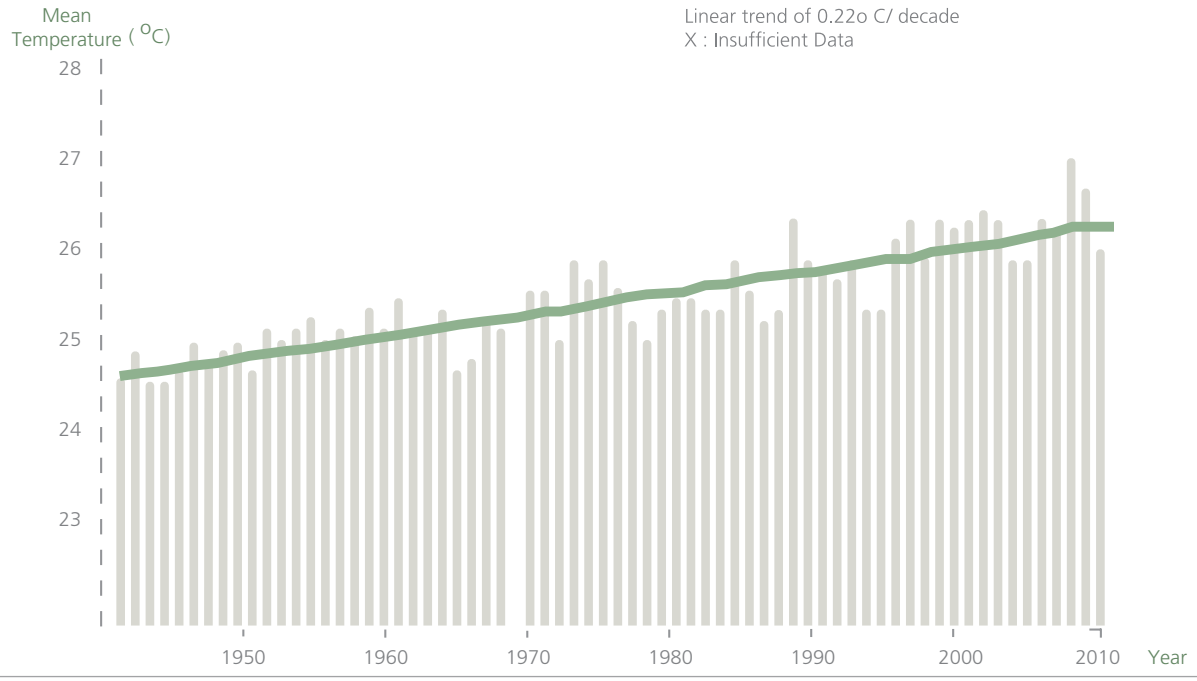
expected in future. The South Pacific Convergence Zone has a significant impact on Fiji's weather. Climate models are currently unclear on whether this will cause an increase or decrease in rainfall. General circulation models tend to show increased rainfall of around 3.3 per cent by 2025 and 9.7 per cent by 2100 with present emission levels, or up to 3.7 per cent by 2025 and 20.4 per cent by 2100 in a high emissions scenario. Given the already high levels of rainfall experienced by Lami, any increases will substantially heighten vulnerability to flooding if adaptation measures are not taken, especially if increased rainfall occurs over short periods of time.

Flooding occurs regularly in Lami, with most years seeing local flooding. Most floods occur as a result of intense rainfall associated with severe weather such as cyclones and tropical depressions. Many of the rivers and streams on Viti Levu, originating in mountainous areas, are small and not able to cope with high intensity rainfall which occurs as a result of storms. Water levels can rise very quickly as a consequence: flash flooding is common, especially in the rainy season, and the period between heavy rainfall and flooding can be as little as three hours. Flash flooding also has serious effects on river discharge systems. The Veisari, Wailekutu, Wailada, Tamavua-i-wai and Navesi Rivers all discharge into Suva Harbour. The plains around these rivers, especially the Wailekutu and the Wailada Rivers, are flat and very prone to flooding.

3.2.2 Temperature

Fiji has a warm tropical climate with daily temperatures between 26°C and 31°C. The coolest months are July

Figure 7: Annual mean temperature for Laucala Bay, Suva, 1940-2010



Source: Kellogg Brown and Root (2011). Strengthening the Capacity of Developing Member Countries to Respond to Climate Change.

and August, while the warmest are January and February. Coastal areas see greater temperature variation, as low as 18°C at night and 32°C during the day. Fiji Meteorological services have used data from 1971 to 2000 to provide a baseline for the Greater Suva area's 'normal climate', with a monthly average of 253mm of rain and an average maximum temperature of 28.7°C. As shown in Figure 7, there has been an observable change in annual mean temperature, from around 24.8°C in 1950 to around 26.2°C in 2010.

According to a study conducted for the World Bank, using midrange emissions scenarios, an increase in temperature of 0.5°C by 2025 is predicted, and a 1.6°C increase by 2100. A high emissions scenario shows projected temperature increases of 0.6°C by 2025 and 3.3°C by 2100[3] . This could have a knock-on effect by, for example, increasing demand for energy, negatively affecting food supply and impacting on human health.

Climate Change and El Niño

El Niño and La Niña are terms to describe the periodic warming and cooling, respectively, of the tropical Pacific Ocean and the consequent disruption of the atmospheric circulation bringing extreme weather and climate to many low-latitude areas, including Fiji. It is thought that climate change is causing more frequent and more severe El Niño events.

An El Niño event usually results in drier, hotter conditions during the rainy season, and drier, cooler conditions during the dry season. La Niña brings heavier rainfall in the rainy season and more rain in the dry season.

3.2.3 Storms and Wind

Winds are generally low, even in the rainy season, though wind direction is often changeable. High winds can develop as a result of tropical cyclones, which are most common in the rainy season, especially in January and February. Cyclones combine strong winds, elevated sea-levels and very heavy rainfall, causing coastal and river inundation, coastal erosion, and damage to coral reefs. Cyclones occur in Fiji at a rate of around 10-15 per decade, with two to four of these being strong enough to cause severe damage. The frequency and intensity of cyclones are determined by sea surface temperature, suggesting that the El Niño Southern Oscillation can affect tropical cyclones, and are also thought to be correlated with climate change.

Flooding of rivers and storm water drains, and increased runoff from land, are also issues which occur as a result of cyclones. Fiji's Initial National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) notes that flooding and landslips caused by cyclones have significant impacts

[3] Feresi, Jone, Gavin Kenny, Neil de Wet, Leone Limalevu, Jagat Bhusan and Inoke Ratukalou, (eds.) (2000). Climate Change Vulnerability and Adaptation Assessment for Fiji (Hamilton, The International Global Change Institute).

on Fiji's economy and infrastructure, as well as negative effects on the local population. These include, besides damage to properties, increased health risks as a result of contaminated water sources and infiltration of waste water from old and ineffective septic tank systems, raising exposure to waterborne diseases[4] .

According to joint research by the University of the South Pacific and the Secretariat of the Pacific Community's Applied Geoscience and Technology Division, there is insufficient data on floods and their effects in the Lami area, and in Fiji more generally. However, the National Disaster Management Office has recorded loss of life, affected populations and the cost of damages resulting from major disasters in the last ten years. An excerpt of these findings is presented below in Table 1. While there has been no specific recording of damage caused in Lami as a result of cyclones, the national trend shows that Fiji is frequently affected, with loss of life and extensive damage to housing, services and infrastructure.

Table 1: Major disasters in Fiji, 2003-2010

Year	Disaster Name	Description	Deaths	Affected Population	Total Damage (USD, millions)
2003	Tropical Cyclone Ami	Flooding and landslide affecting the Northern Division	19		18
2008	Tropical Cyclone Gene	Northern and Eastern parts of Fiji, including Lami, affected	8	Unknown	5
2009	Flash Flood		11	146,000	113
2009	Tropical Cyclone Mick		3	149,000	31
2010	Tropical Cyclone Thomas	Northern and Eastern parts of Fiji, including Lami, affected	2	Unknown	59

Source: UN-Habitat

3.2.4 Storm Surge and Sea-level Rise

Storm surges are defined as increases or decreases in shoreline water levels caused by factors other than tides or seasonal water level changes. Storm surges are normally caused by changes in atmospheric pressure, winds and waves, flooding from rivers and cyclones. It has been noted that storm surges are already affecting coastal areas across Fiji, including Lami. An analysis of 12 storm surges in the greater Suva area showed that the largest surge peaked at 0.43 metres above local mean sea level. The greatest surge took place during a falling tide, however, which decreased

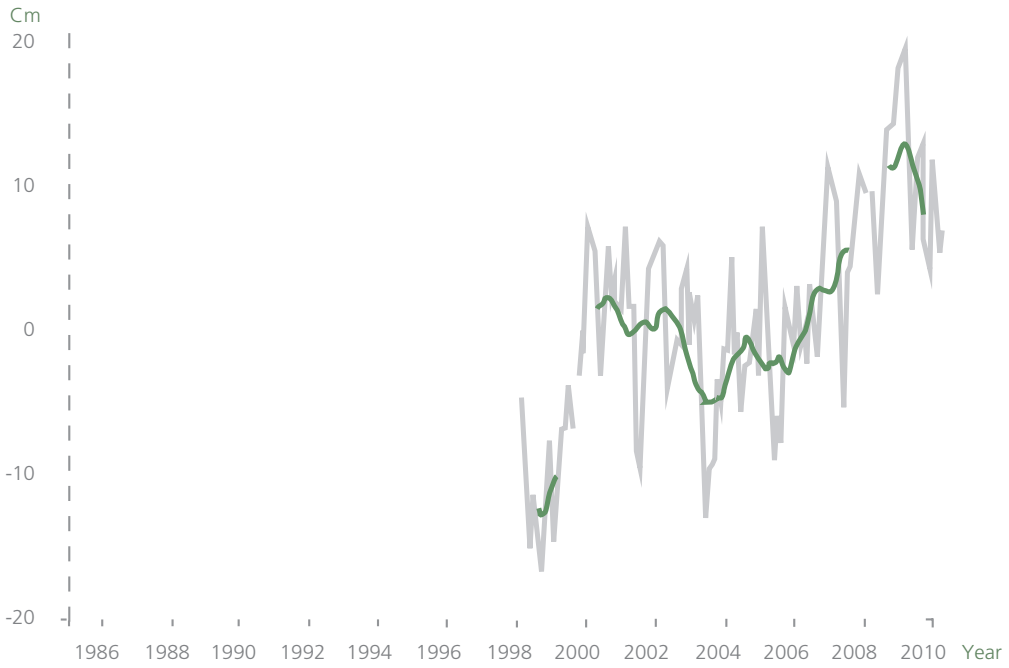
Storm surge in Lami, March 2011
Photo © Lami Town Council

[4] Fiji (2005). Climate Change: The Fiji Islands Response: Fiji's First National Communication under the Framework Convention on Climate Change (Suva, Department of the Environment).

the severity of the storm surge. It is possible that natural factors in the Greater Suva area, including the extensive reef in Suva Harbour, decrease the severity of storm surges. Nevertheless, in March 2011 the southern and south-eastern coasts of Viti Levu were inundated by storm surges which swept several metres inland. These storm surges broke the sea-wall in Lami, inundating property, including some belonging to Lami Town Council.

Local mean sea level is defined as the height of the sea relative to a fixed point of local land averaged out over a given period of time, normally a month or a year. Reliable measurement of sea-level rise in the Suva Harbour, and in Fiji more generally, is difficult because there are gaps in the data provided by the water level recorder which has been operational in Suva Harbour since 1972. As shown in Figure 8, the water level in Suva Harbour has fluctuated greatly since this dataset began recording in 1998, with an overall rise of about 10 cm. There are significant seasonal deviations of about +/-10-15 cm from the mean average, and inter-annual changes of up to +/-25 cm. The inter-annual changes may be a result of the El Niño Southern Oscillation. Significant changes in the average sea-levels observed through seasonal and inter-annual fluctuations mean that relative sea-levels, such as high-tides and water height during storm surges, will also be higher. The projections for sea-level rise through general circulation models are also alarming: 10.5 cm by 2025 and 50 cm by 2100, according to mid-range emissions scenarios, and double this under high emissions scenarios[5] .

Figure 8: Sea-level in Suva Harbour, 1998-2010



Source: Kellogg Brown and Root (2011). Strengthening the Capacity of Developing Member Countries to Respond to Climate Change.

3.2.5 Non-climate Disasters – Earthquakes and Tsunamis

While earthquakes and tsunamis are not climate related, these geo-hazards have affected Lami in the past, and are therefore considered here. While Fiji is located within the Pacific 'Ring of Fire', a highly active seismic zone, Viti Levu is situated on the Fiji tectonic platform and so itself is not in a seismically active zone. However, it is surrounded by such zones where the Fiji Platform joins other tectonic plates. The Greater Suva area has been affected by earthquakes, though none in recent years that have caused loss of life or substantial damage. Fiji, including the Greater Suva area, is also at risk from tsunamis because of its location. The last serious earthquake and tsunami to affect Lami was in 1953, when a magnitude 6.7 earthquake triggered a tsunami that breached sea walls in Suva harbour.

[5]Kellogg Brown and Root (2011). Strengthening the Capacity of Developing Member Countries to Respond to Climate Change: Inception/First Progress Report, p.18 (Asian Development Bank).

3.3 Sensitivy

3.3.1 Ecosystems

Lami has diverse ecosystems which have the potential to be both negatively affected by the impacts of climate change and provide positive adaptation benefits, as analyzed below. Lami has 88 hectares of intact mangrove forest, and there is approximately 1,387 hectares of coral reef in the entrance to Suva Harbour. The town also has 330 hectares of offshore mudflats, which provide a barrier to storm surges, and large areas of intact upland forest.

Ecosystem services are important to the health, livelihoods and quality of life of the people of Lami. Table 2 shows the different uses of ecosystem services provided by rivers and foreshore areas in Lami, and the changes which have been observed by residents of the four settlement areas in the town.

Table 2. Community uses of river and foreshore ecosystems in Lami and changes in their use.

Activity	Samoan Settlement (%)	Kalekana Settlement (%)	Naisogowaluvu Settlement (%)	Matata (%)
Fishing	35	40	-	59
Catching crabs and shellfish	24	38	11	18
Washing and water for personal use [6]	35	14	22	5
Change in conditions of waterways and foreshore areas				
Reduced fish numbers	47	47	-	32
Water has become shallower	35	-	22	5
Increase in solid waste	35	11	22	14
Erosion	12	15	11	23
Sea-level rise	12	11	25	14

Source: UN-Habitat

Table 2 indicates that community members have noticed significant declines in the 'quality' of ecosystems, as a result of human factors such as an increase in solid waste, possible climate factors such as sea-level rise, and outcomes which may be down to a combination of factors, such as reduced fish availability. This would indicate that ecosystems are sensitive as a result of climate change and other human factors, and that they will provide fewer services for local communities in the future unless action is taken to preserve them.

[6] This occurs during water supply cuts.

3.3.2 Physical Systems

None of the settlement areas in Lami have access to sewerage infrastructure. Around 80 per cent of households (though the proportion is as low as 59 per cent in Kalekana settlement) use septic tanks to store sewerage, with the remainder using pits for disposal. Most households with septic tanks reported that they do not currently face issues with them. However, a minority of this group, as well as those households who use pits rather than septic tanks, reported that spillage does occur during flooding. More frequent or more severe flooding as a result of climate change in the future could cause spillage from septic tanks and pits, which would have adverse impacts on health.

The Water Authority of Fiji supplies piped water to all areas of Lami. However, residents across Lami report that cuts in water supply are frequent. As a result, around 38 per cent of residents store rainwater as a back-up when water supplies are cut. Households on high ground have noted that water pressure is often very low, especially after cuts, and that water is sometimes not potable. This would suggest that Lami's water supply is sensitive to numerous climate stresses, especially extension of the dry season, and flooding may also contaminate the alternative water sources used by households during water cuts.
Electricity in Fiji is supplied by the Fiji Electricity Authority, with the bulk of supply coming from hydropower generation. Approximately 81 per cent of households in Lami have access to electricity supply. The remaining households rely on candles and kerosene lamps to provide lighting. While the electrification rate is high, the 19 per cent without access to electricity are largely households in informal settlement areas. Cuts in electricity supply are increasingly common, as a result of growing demand. Households and small businesses are forced to use generators during prolonged outages, which contribute towards increased emissions.

Until recently, of the 47 roads in Lami, 17 were managed by Lami Town Council and 30 were managed by the Department of National Roads under the national government. After the formation of the Fiji Roads Authority by government gazette in early 2012, all roads are now under the jurisdiction of the Fiji Roads Authority. Six of the roads within Lami are constructed of gravel and are therefore more vulnerable than tar-sealed roads: they often lack drainage, and their loose surface can be washed away in flash floods. However, these gravel roads are vital for access to poor settlement areas in Lami, so it is important that they remain functional. There are several bridges within the town that are vulnerable either due to erosion of the materials and foundations of the bridge, or because the bridge was not designed for the type and density of traffic they currently support. The Queens road, Viti Levu's main transit route, passes through Lami and is the solitary thoroughfare between the Eastern and Western division. The increasing vulnerability of the four bridges in Lami will prevent overland travel. It is vital to the island's economy that Suva (and the greater Suva area) remains connected to Nadi, the main economic hub and location of Fiji's main international airport. Access is compromised during floods, and damage to bridges in Lami would cause widespread damage to the Fijian economy as a whole.

The urban poor are especially vulnerable to climate change because their homes are frequently located in hazardous areas
Photo © UN-Habitat / Bernhard Barth

3.3.3 Economic Systems and Livelihoods

Unemployment is high in Lami: the 2007 census showed that only 29.5 per cent of the city population was in employment. The remainder were classified as 'economically inactive'[7] . Taking the Kalekana settlement as an example, in 2009 most of the residents worked as fishermen, in private security or other work with the nearby Fiji Fish Company. There was also a high incidence of self-employment in the area, with typical income sources being food selling and transport. The average income in the Kalekana settlement was calculated to be FJD 166 per week – marginally above the national poverty line of FJD 147 per week. A similar study was conducted in the Matata settlement area in 2009 by Fiji National University, which found that the average household income was below the national poverty line.

[7] Fiji (2009). 2007 Census of Population and Housing (Samoa, Fiji Islands Bureau of Statistics.

The high rate of economically inactive people and dependence on industries such as fishing suggests that many of Lami's residents work in the informal economy. While this provides valuable cash incomes to poor households, it also means that these households are less likely to be within reach of social safety net systems. In the event of a disaster such as a flood or cyclone, households deriving their income from the informal sector are at greater risk of losing their livelihood and are less likely to receive protection from company or government social security systems. Fishing is also a climate vulnerable livelihood, as fishermen rely on favourable weather conditions and consistent fish populations.

3.3.4 Social Systems

Settlement areas in Lami are made up of temporary and permanent structures which normally occupy state or native land, though the Samoan settlement occupies freehold land. Settlements are based on communal living arrangements with no formal tenure security, but a communal arrangement between landowners. In some cases, land is occupied illegally. Using data from the four urban poor settlements analyzed here - Kalekana, Matata, Naisogowaluvu and the Samoan Settlement - approximately 67 per cent of homes are single room, but the vast majority house families of at least four, and often up to ten people. High occupancy rates of households, insecurity of tenure and a reliance on building materials such as corrugated iron and timber, especially in informal settlements, suggest strongly that housing and urban poor areas are very sensitive to negative climate change impacts. Housing in formal settlement areas is usually constructed of cement, and has valid building certificates issued by Lami Town Council.

The urban poor and their homes
Photo © UN-Habitat / Bernhard Barth

Lami has three health centres, two privately operated and one provided by the government. Each centre is thought to be sensitive to the impacts of climate change. The two private centres are located in the low-elevation coastal zone and are vulnerable both to storm surges and sea level rise. The government health centre, on the other hand, is located on high ground above the main town. For most residents, it is only accessible via the Suva-Nadi highway and by crossing several bridges, which can be affected by flooding.

3.4 Adaptive Capacity

3.4.1 Autonomous Adaptation at the Community Level

Autonomous adaptation initiatives are undertaken by individuals, households or communities without formal support from the government or NGOs. These actions are usually spontaneous and in response to one or more climate related threats. As in the sensitivity section, this community level adaptation analysis is based on fieldwork in the four communities.

Recognition of climate change and the need to undertake adaptation actions is relatively high in the four communities analyzed, with an average of 77 per cent of respondents saying that they are already carrying out adaptation actions to respond to climate change. Among these actions were better management of solid waste disposal: 58 per cent of respondents are doing this in Kalekana Settlement, for example. A smaller percentage also reported that they had voluntarily relocated from areas which are very vulnerable to climate change impacts. Many residents also suggested that they are trying to reduce their electricity consumption, showing some willingness at community level to reduce greenhouse gas emissions.

There is no evacuation strategy for Lami as a whole, or for the individual communities affected by climate change. However, some communities, especially those in low-lying areas that are more likely to be impacted by tropical cyclones, storm surges and tsunamis, have autonomously developed evacuation strategies. For example, in the Matata settlement, 41 per cent of respondents in the community told the assessment team that they gather in the community hall during warnings of natural disasters, while 23 per cent of residents gather in the local church. A further 9 per cent of res-

idents assemble in the neighbouring Valenicina community hall. Similarly, in the Samoan settlement, 53 per cent of residents moved to higher ground when warned of severe weather: of these, 41 per cent gathered at the private residence of a community member who lives on higher ground. In all settlements, community members who live on higher ground further away from the coast remain in their homes when there are warnings about natural disasters.

3.4.2 Adaptation at the Institutional Level

Unlike many other developing countries, Fiji does not have a National Adaptation Programme of Action on climate change. It does, however, have an Initial National Communication to the UNFCCC. This provides background information but does not represent the official policy of the Fijian government. In March 2012, the National Climate Change Policy was approved. The National Climate Change Policy is an implementation tool of the People's Charter for Peace, Change and Progress, which represents Fiji's umbrella framework for development. Under the People's Charter is the Roadmap for Democracy and Sustainable Socioeconomic Development. The Roadmap recognises the negative impacts of climate change and how these can be exacerbated by human factors, such as poor solid waste management[8] .

The National Climate Change Policy is comprehensive, and has the following objectives:

- **Mainstreaming:** Integrate climate change issues into all sector and planning processes.
- **Data collection, storage and sharing:** Collect, manage and use accurate, scientifically sound climate change related data and information.
- **Awareness raising:** Increase awareness and understanding of climate change across all sectors and at all levels in Fiji.
- **Education and training:** Integrate climate change in school curricula, tertiary courses and vocational, non-formal education and training programmes.
- **Adaptation:** Reduce the vulnerability and enhance the resilience of Fiji's communities to the impacts of climate change and disasters.
- **Mitigation:** Reduce Fiji's greenhouse gas emissions and implement initiatives to increase the sequestration and storage of greenhouse gases.
- **Financing:** Ensure sustainable financing for climate change efforts.
- **International and Pacific region adaptation:** Effectively participate in and contribute to international and Pacific region climate change negotiations, discussions, commitments and outcomes.

Under its sector analysis, the National Climate Change Policy makes specific provisions for urban areas, including locating buildings away from foreshore and flood prone areas, utilization of cyclone proof construction methods, flood control through improved water resource and river basin management, and catchment management through reforestation, protection of wetlands and soil conservation. The policy also covers other sectors which overlap and relate to urban development, such as health and energy. The National Climate Change Policy is also to be supported by the National Climate Change Adaptation Strategy for the land-based sector, which primarily focuses on agriculture and livestock, though ecosystem based adaptation will also be considered. The Strategy was due for completion in February 2012.

At the national level, climate change is managed by the Climate Change Unit, which has one permanent staff member and five project staff. The Unit was established in 2009 under the Department of Environment at the Ministry of Local Government, Urban Development, Housing and Environment, but in 2011 moved to the Ministry of Foreign Affairs and Cooperation, in a strategic move to enhance visibility of climate change. The unit is overseen by the National Climate Change Country Team, which provides a platform for information sharing and project progress reporting 'direction and guidance'[9] . These structures demonstrate the commitment of the Government of Fiji to implementing actions to mitigate and adapt to climate change. However, given that both the policy and the structure are new, it remains to be seen how these will impact the implementation of adaptation actions on the ground.

At the local level, Lami Town Council has formed a Climate Change Steering Committee, which compris-

[8] Fiji (2009). Roadmap for Democracy and Sustainable Socio-Economic Development: 2010-2014 (Suva, Ministry of National Planning).

[9] Fiji (2012). National Climate Change Policy, p.14 (Suva, Secretariat of the Pacific Community).

es the Ministry of Local Government, Department of Environment, Department of Town and Country Planning, National Disaster Management Office, private sector and community representatives. This committee is interdepartmental, working across the five departments of Lami Town Council, which means that coordination and mainstreaming are a large part of the Steering Committee's remit. The Council has integrated climate change in their respective strategic and corporate plans and budgets since 2011. So far, a selection of hard engineering and ecosystem based mitigation and adaptation projects have been undertaken, and the Council continues to invest further to enhance the adaptive capacity of the natural and built environment. Capacity building of management and staff is conducted on an ad-hoc basis through in-house and external trainings and workshops.

04

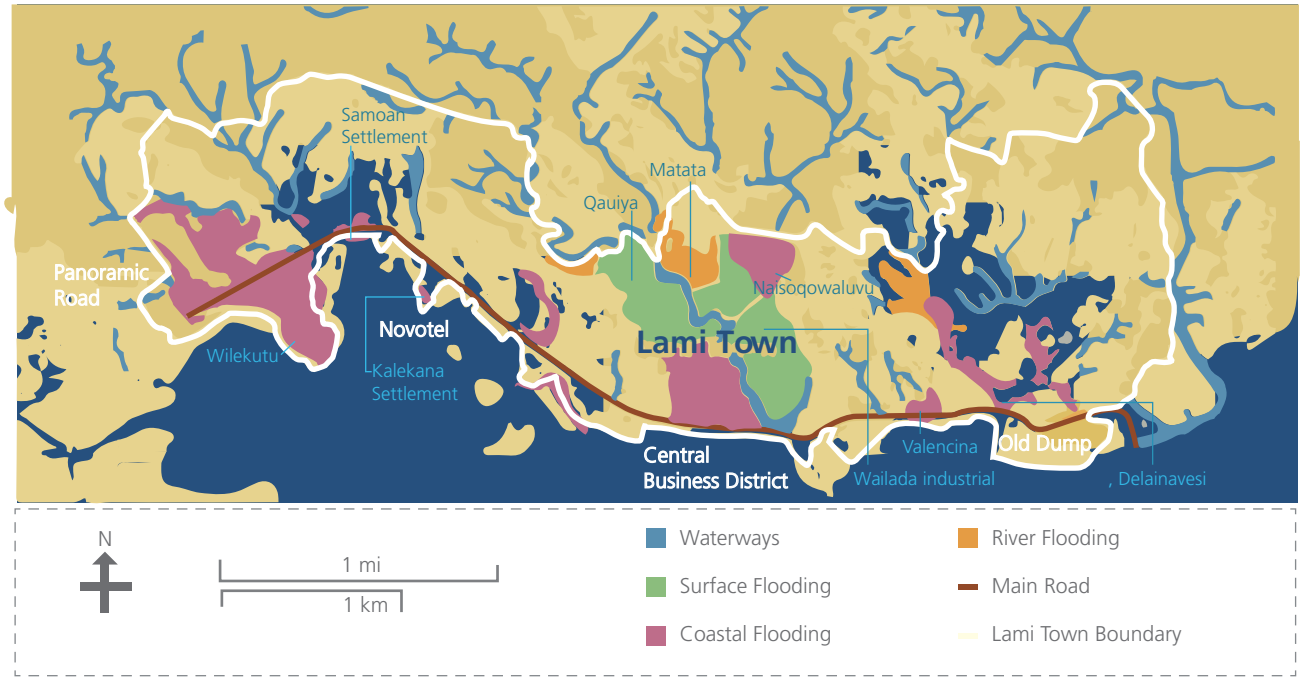
Vulnerable People, Places and Sectors

Lami experiences three types of flooding: coastal flooding as a result of storm surges or large waves from Suva Harbour, flooding that occurs as a result of excess water in the three rivers that run through the town, and flooding from water that gathers in low-lying areas during periods of excess rainfall. These three types of flooding affect different areas to different degrees, and often require distinct adaptation actions.

The increase in rainfall predicted by general circulation models is likely to lead to increased surface and river flooding. Adaptation methods are necessary for low-lying areas such as Wailada Industrial, Central Business District, Matata and Qauiya, where the risk of increased flooding is particularly high. The damage caused by flooding in these hotspots could be extensive: Matata and Qauiya are residential areas, so homes and informal economic activities are likely to be damaged and severely disrupted. The Central Business District and Wailada Industrial area generate a substantial amount of Lami's economic activity.

Coastal flooding and the threat of inundation affects several areas of Lami, as shown in Figure 9, in particular Delainavesi, Valencina, the Central Business District, Kalekana, the Samoan Settlement and Wailekutu. The Queen's Road, Lami's main transit route, also passes through low-lying areas close to the coast. The

Figure 9: Flooding hotspots in Lami Town



Source: Rao et all (2012). A comparative analysis of ecosystem-based adaptation and engineering options for Lami, Fiji.

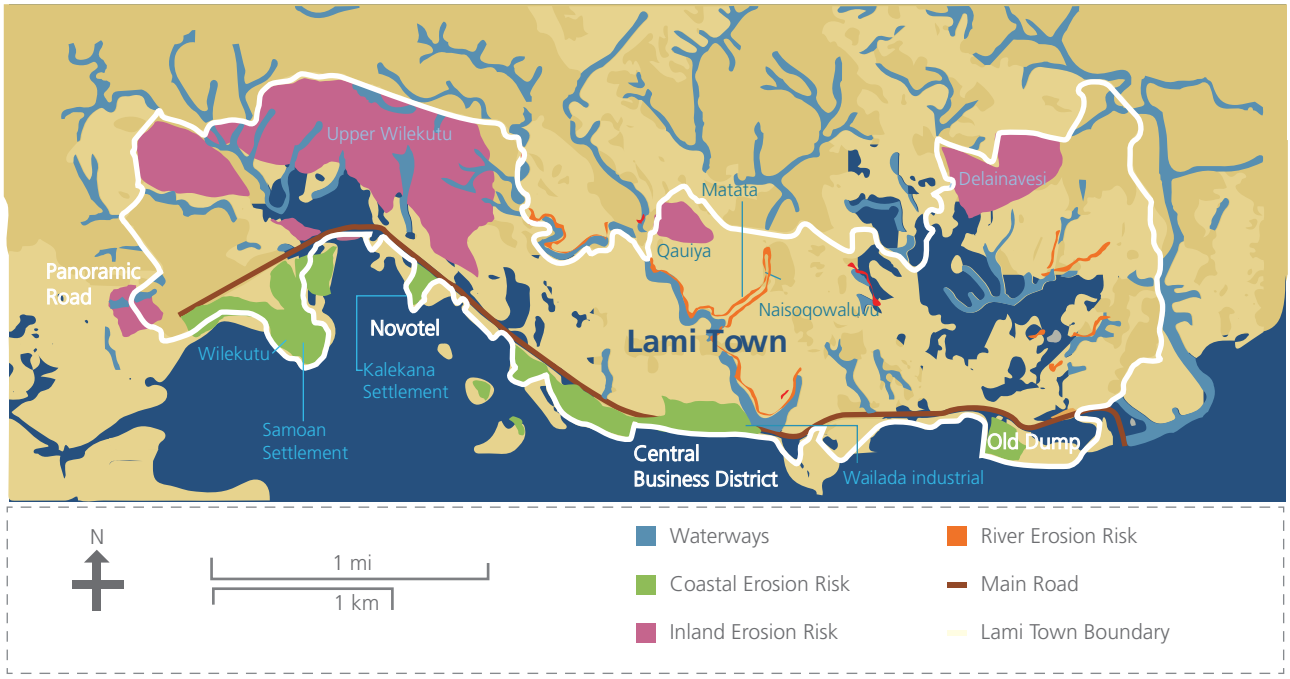
Central Business District is exposed to all three types of flooding analyzed here. The sharp rise in sea-levels observed in Suva Harbour since 2000, and projections of up to 20cm rises in sea-level under high emissions scenarios, demonstrate that adaptation actions are required in these coastal hotspots to offset damage to homes, infrastructure and economic activities.

The flood risks faced by communities, whether due to coastal or river flooding, are likely to affect the poor more severely. Taking the Kalekana Settlement as an example, up to 70 per cent of residents are employed in the informal economy, often as food vendors or transport providers. During flooded periods, especially when roads are affected, poor residents are unable to undertake income earning activities. In all informal settlement areas, construction materials such as timber and corrugated iron are more likely to be damaged in times of flooding. Non-poor settlement areas, where brick and stone are more often used as construction materials, are therefore more likely to withstand and recover faster from similar flooding events.

Lack of tenure security in the hotspot areas identified above - especially Kalekana, Matata, Naisogowaluvu and the Samoan Settlements - reduces the capacity of residents, particularly the poorest, to undertake measures which will improve the ability of their homes to withstand flooding. When communities lack tenure security, they are much less likely to make investments which will improve their homes, landlords are less inclined to install basic infrastructure such as piped water, and local government often cannot make improvements to the area. Lack of tenure security, especially in these four areas, creates a situation where it is difficult for the poor to make their homes less vulnerable to extreme weather events.

Lami also experiences several different types of erosion. Due to flooding, sea-level rise and inundation through cyclones and tsunamis, coastal areas are exposed to coastal erosion. As with coastal flooding, coastal erosion is likely to become a greater hazard as sea-levels rise. This will affect the Central Business District, the Samoan Settlement and the Kalekana Settlement in particular. Coastal erosion endangers houses in low-ly-

Figure 10: Erosion hotspots in Lami



Source: Rao et all (2012). A comparative analysis of ecosystem-based adaptation and engineering options for Lami, Fiji.

ing coastal areas, making foundations and structures unstable. It also damages infrastructure such as roads and water supply networks. As in the flooding scenario described above, erosion will disproportionately affect the urban poor as it will become more challenging to undertake usual livelihood practices.

Projections suggest that rainfall levels could increase steadily by 2025, likely resulting in an increase in groundwater and water levels in rivers and streams. This would mean greater risk of land and riverbank erosion, which has already been reported in settlement areas such as Matata and Naisogowaluvu. At present, the Government of Fiji is taking steps to increase its capacity to plan for and manage the future effects of climate change. However, the National Climate Change Policy is relatively new, having only been approved in March 2012, and is currently not accompanied by an implementation strategy. While climate change has been integrated into the strategic plan of Lami Town Council since 2011, it is not clear to what extent local or national government will be able to manage urban development in a way which increases resilience, especially among the urban poor, to climate change. However, in understanding the drivers of erosion, and the locations in which it affects people most severely, the Council's Steering Committee can take actions to limit its impacts of erosion.

Some climate hazards are likely to have city-wide consequences, however. The impacts of increased temperatures and drought are likely to affect the whole urban population, especially the poorest. Reduced access to potable water could cause declines in agricultural productivity in rural areas, which in a small island economy such as Fiji is likely to lead to greater dependence on imports. This would place the greatest burden on the poorest, who may not be able to afford higher food prices, or would have to compromise other areas, such as schooling or healthcare, in order to maintain a stable food supply. Increased heat can also lead to skin and respiratory problems, especially in the sick or elderly, and this also is likely to be a city-wide effect.

Sea wall
Photo © UN-Habitat / Bernhard Barth

05

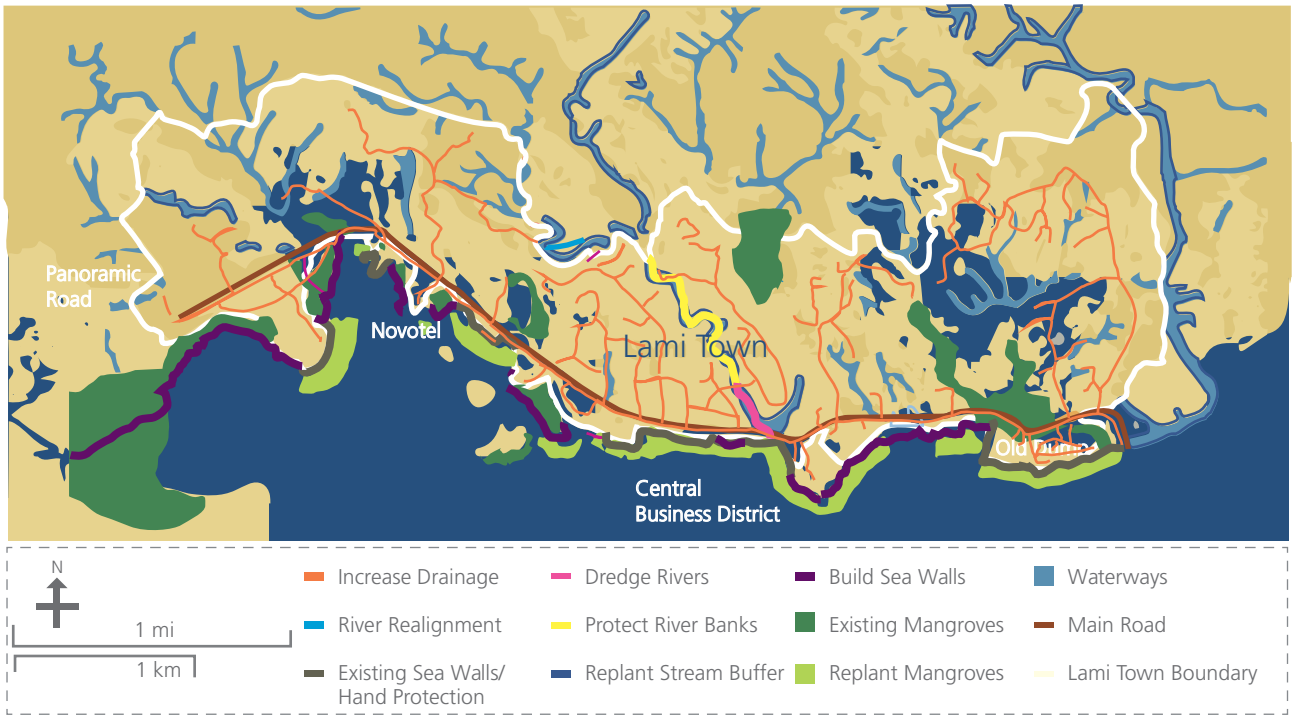
Identifying Key Adaptation Options

5.1 Cost-Benefit Analysis: Ecosystem Versus Infrastructure Based Adaptation

Lami's land area and geography mean that there could be numerous potential climate change impacts in several different locations, meaning many potential adaptation actions could be undertaken. The purpose of this section is to understand which offer the best value for money. In order to demonstrate the number of actions available, Figure 11 shows the locations where different adaptation actions could be implemented in the town. This cost-benefit analysis primarily covers ecosystem based adaptation and infrastructure options.

Infrastructure actions include reinforcing rivers, building sea-walls, improving drainage, strengthening bridges, land reclamation and the elevation of key flood-prone infrastructure. Rehabilitating old infrastructure or constructing new infrastructure is histori-

Figure 11: Locations of possible adaptation actions



Source: Rao et all (2012). A comparative analysis of ecosystem-based adaptation and engineering options for Lami, Fiji.

cally the preferred option of governments in response to climate change vulnerability. However, it is also usually the most expensive adaptation option, and therefore needs to be carefully considered against more cost effective options.

To analyze the costs of the various adaptation options, the implementation cost was estimated, including the projected maintenance costs (with a discount rate of 3 per cent over time) over a ten and twenty year period.

Table 3: Unit cost of adaptation actions

Adaption Action	Unit Cost	Cost in FJD	
		10 y	20 y
Replant Mangroves	m^2	$2.76	$4.67
Replant Stream Buffer	m^2	$2.88	$4.87
Increase Drainage	m	$16.29	$20
Build Sea Walls	m	$1,670	$2,050
Reinforce Rivers	-	-	-
Protect River Banks	m	$1,144	$1,404
Dredge Rivers	m^3	$18.52	$22.72
River Realignment	m	$923	$1,133

Source: Rao et all (2012). A comparative analysis of ecosystem-based adaptation and engineering options for Lami, Fiji.

Table 3 and Figure 12 outline the relative costs of ecosystem and infrastructure based adaptation options, both in terms of initial implementation and maintenance costs. (Note that in Table 3 'reinforce rivers' is broken down into its three constituent parts: protect river banks, dredge rivers and river realignment). However, some of these costs are not comparable, because they do not set out the total area covered by the action or the number of people they will benefit. Measuring the costs per unit area – that is, the cost of each action measured according to metre or square metre - it becomes clear that ecosystem adaptation options come at a much lower cost.

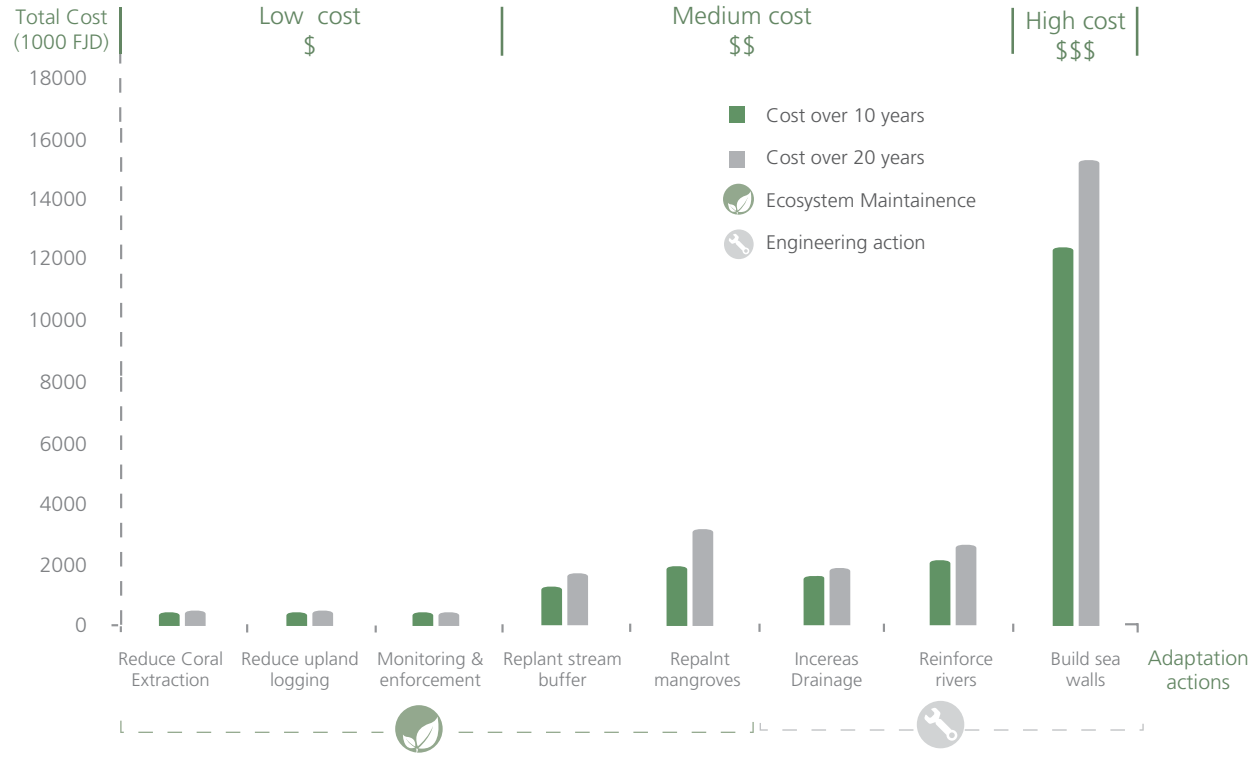
However, in addition to their cost effectiveness, the adaptive benefits these actions provide are a critical consideration. If ecosystem based adaptation options do not actually increase the adaptive capacity of vulnerable people and places in Lami, then they do not represent good investments, despite being lower cost. Table 4 therefore provides an estimate of the amount of dollars saved in avoided damage for every dollar spent on a given adaptation action. For example, if replanting mangroves leads to a 25 per cent reduction in damage from storm surges, every FJD 1 spent on mangrove replanting will result in a saving of FJD 38 in damages avoided. These include estimates of costs saved, such as health costs, damage to infrastructure, houses and businesses, and ecosystem services maintained or enhanced.

The data in Table 4 suggests that ecosystem based adaptation options are highly cost effective and offer significant benefits in terms of reducing economic vulnerability. This would imply that the local government in Lami should favour ecosystem based actions. However, it is also necessary to consider social and policy interventions that could be implemented.

5.2 Social and Policy Interventions

Socio-economic policy options that place people at the

Figure 12: Cost of adaptation actions avoided



Source: Rao et all (2012). A comparative analysis of ecosystem-based adaptation and engineering options for Lami, Fiji.

Table 4: Cost-benefit analysis of adaptation actions in terms of damage avoided

Adaption Action	Assumed % Damage Avoided		
	50%	25%	10%
Replant Mangroves	$77	$38	$15
Replant Stream Buffer	$146	$73	$29
Monitoring & Enforcement	$1,498	$749	$300
Reduce Upland Logging	$2,035	$1,018	$407
Reduce Coral Extraction	$2,988	$1,494	$598
Build Sea Walls	$15	$8	$3
Reinforce Rivers	$96	$48	$19
Increase Drainage	$140	$70	$28

Source: Rao et all (2012). A comparative analysis of ecosystem-based adaptation and engineering options for Lami, Fiji.

centre of decision making and implementation can, if well implemented, provide significant benefits to communities. It is especially beneficial to focus on 'quick wins' – where benefits are felt by communities within a short period of time – and 'no-regret actions' where communities will benefit even if there is no change in the climate. Socioeconomic and policy actions need to be implemented alongside ecosystem and infrastructure adaptations, maximizing benefits where possible through complementarity and interlinkages.

The National Housing Policy, adopted in 2011, is a significant policy development that offers the opportunity to improve the housing conditions and tenure security of the urban poor, making them less vulnerable to climate change. It identifies the challenges of informal settlements and their growth in Fiji's urban areas, as well as the limitations of national government in managing them. Implementation of the policy's recommendations will strengthen local and national government, enhance coordination between departments, promote 'proactive land use planning', prevent 'haphazard and unplanned' construction and improve building codes to consider climate change. Resettling coastal communities is also considered, but this should only be considered when absolutely necessary, and in conjunction with the communities themselves. Improving the credit available to communities will ensure that they can take ownership of their own settlement upgrading. Households in informal settlements, with uncertain tenure, are less likely to be inclined to make investments to improve their homes. However, if their tenure can be secured, improved credit access will enable communities to make the necessary improvements.

Formalizing disaster risk reduction, especially evacuation routes, is an important action to ensure community safety in the face of increasing disaster risk. At present, communities evacuate to other private residences on higher ground, so formal evacuation plans, routes and shelters would ensure that evacuation can be managed more effectively. Another option to consider is a city-wide early warning system, allowing people to protect homes and businesses. The need for improved disaster management and risk reduction has been incorporated into Lami Council's Strategic Plan 2010-2014, and Lami has joined the United Nations International Strategy for Disaster Risk Reduction (UNISDR)'s Making Cities Resilient campaign. These are important first steps towards implementing disaster risk reduction at a city level. Linking these to national level planning and development remains a challenge, however, as the National Disaster Management Office only responds to disasters retrospectively.

Other actions, which would complement ecosystem and infrastructure based adaptation actions, could include:

- Improved solid waste management, to ensure that drainage infrastructure is not blocked and reduce the likelihood of water contamination, leading to lower risks of health impacts during times of flood.

- Advocacy with the national government for reduced upstream logging, improving the capacity of river basins to cope with heavy rainfall and water runoff from higher ground, leading to a reduction in water levels in rivers and streams in Lami.

- Improved drainage so that standing water is minimized. Where standing water exists, mosquito prevalence can be reduced through use of chemicals. Where possible, however, it is preferable to eliminate the incidence of standing water.

5.3 The Cost of Business as Usual

Accurately estimating the cost of taking no action in Lami is difficult for various reasons. What will happen in the future is unclear, so estimates of damage in terms of cost are based on historical figures. As cost estimates for Lami Town itself are not available, the assessment used costs for other towns and cities in Fiji, or Fiji as a whole, to devise estimates. Costs on a national level are very significant, especially for a small island developing economy such as Fiji's. The last three major disasters in the country - the 2009 flash floods and Tropical Storms Mick and Thomas - between them caused over FJD 200 million in damage nationally, as well as the loss of 16 lives. A separate calculation revealed that, when assessing damage as a result of flooding to the cities of Nadi and Ba, the damage over a 20-year timeframe was calculated to be FJD 463 million. Cross-checking these costs, incurred as a result of disasters and not considering the more long term effects of climate change such as loss of livelihoods from flood damage, it is clear that the cost of taking no action will be significantly higher than the cost of implementing adaptation actions. This is particularly the case when these investments are designed to strengthen ecosystems, which will pay for themselves over a 10-20 year period.

06

Recommendations and Conclusions

6.1 Practical Actions at the Local Level

Each recommendation should be seen in the context of the priority hotspot areas, identified in section 4. The recommendations here are interlinked and will be most effective when implemented as a mix of actions, coordinated by Lami Town Council:

1. Protecting existing mangrove plantations in coastal areas and stream buffers in riverbank areas, and rehabilitating them where they have been degraded, could significantly reduce the vulnerability of coastal and low-lying settlement areas to flooding. Planting natural flood defences such as mangroves and stream buffers is a technical exercise, and therefore the relevant expertise should be sought before activities begin. This expertise can be sourced from local government departments, or partnerships can be established with national government departments, local academic institutions or the private sector. In order to be pro-poor and inclusive, local communities should be consulted about and where possible engaged in the planting and maintenance of mangroves and stream buffers. Local communities also need to be aware of the benefits of protecting, rather than exploiting, mangroves. All of the above measures should be coordinated and managed by the Special Climate Change Steering Committee at Lami Town Council.

2. Increasing drainage and dredging rivers will also help to reduce flooding and could possibly have secondary benefits by lessening erosion. While these actions are more focused on engineering measures, they are still low cost in terms of their implementation and potential to offset significant future damage. However, these two actions may still necessitate substantial additional funding that exceeds the financial resources available to Lami Town Council. Cooperation with national government and, if necessary, external donors would then be necessary in order to implement these activities. Seeking cooperation at this level will ensure that the relevant technical expertise can be found and utilized. Improved drainage will also reduce standing water, leading to fewer mosquitoes and lower risks of related disease such as malaria and dengue fever.

3. Implementing disaster risk reduction initiatives should be an important priority for the city. There are currently no community level evacuation strategies in place for any settlement areas in Lami or for Lami Town as a whole. The installation of an early warning system, for example, would be a valuable measure that, linked with the preservation and replanting of mangrove and stream areas, could protect settlements against severe flood waters.

4. Regularizing land tenure and construction could reduce vulnerability, especially in urban poor communities, by ensuring that houses are constructed to approved building codes designed to withstand the likely impacts of flooding and cyclones. Many houses in informal settlements would not currently meet minimum standards: they need to be supported to improve their resilience to climate change impacts, and the government has a role to play in ensuring that communities have access to finance to achieve this. Relocation of communities should only be considered as a last resort and only once proper procedures, including extensive community consultations, have been applied.

5. Improved water supply and, in particular, sanitation is likely to improve the health outcomes of Lami residents, especially in urban poor settlements such as Kalekana, Matata, Naisogowaluvu and the Samoan Settlement. Ensuring access to reticulated sewage systems, where possible, and improved septic tank storage and disposal, will help to ensure that flood waters are not contaminated with waste water. This is a long term and no-regret action.

6. The actions listed above feed into a broader requirement for land use planning which considers climate change and its impacts. This will allow residential settlements to be located away from areas which are affected by flooding, storm surge or erosion, for example, while also encouraging similar planning of commercial and industrial areas. This would have the additional benefit of reducing the impact of climate change on livelihoods. Land use planning can also facilitate the development of evacuation planning by allowing routes and locations to be set up, while at the same time mandating the protection of ecosystems such as mangroves.

6.2 Multi-Level Recommendations

1. Reducing upstream logging has the potential to greatly lower the likelihood of river flooding events. However, this practice takes place almost entirely outside Lami Town boundary and will require co-operation from various stakeholders, including the national government and private sector timber firms. Prevention of logging is challenging because of these different, and often competing, powerful interests. This process should also involve the community, as there may be some micro-level tree-cutting activities by households to secure fuel wood, for example.

2. Continued work and cooperation with the national government in its endeavours to implement the National Climate Change Policy should be encouraged. Involving a diverse range of stakeholders, particularly communities, NGOs, academic institutions and the private sector, will ensure enhanced 'buy-in' to climate change actions, higher awareness levels and a sustainable social base for adaptation actions.

6.3 Strategic Recommendations for Lami

1. Develop a city level strategic plan to respond to climate change. This abridged vulnerability assessment report only presents a selection of the possible actions which could be taken to reduce climate change impacts. These actions will then need to be integrated into a broader sustainable development plan for Lami. This will ensure that, ultimately, climate change is mainstreamed across all sectors and at all levels of government decision making.

07

Annex: Follow-Up Actions

Between the conducting of the vulnerability assessment in 2011 and the publication of this report, a number of follow-up actions have been carried out. These were taken due to the urgent need to counter the impacts of climate change and ongoing interest among local government decision makers. The follow-up actions taken are described here.

World Wide Fund for Nature (WWF) and Lami Town Council staff conducted a series of meetings with interested businesses, including an introduction to climate change and an overview of an ecosystem-based adaptation approach. Frequent flooding during king tides, high tides and heavy precipitation periods places many of businesses at risk and is exacerbated by the use of coral rubble for land reclamation, which increases the shallowness of the Lami river near the estate. Improper waste disposal by Wailada residents into Lami river is considered a non-climate related contributor to flooding, as it contributes to increased siltation and river bank erosion. The participants were very supportive of reforestation and mangrove replanting on the river, to be led by the town council and the national Department of Environment with the support of the businesses. They also stressed the critical need for improved enforcement of environmental and health regulations, and encouraged the establishment of more frequent multi-sector dialogue between the council, communities and businesses on climate change adaptation and environmental protection.

Ecosystem based adaptation options can be preferable because they are designed to complement natural resources and ecosystem services which have been depleted as a result of human activity. Because much of Lami's vulnerability to climate change centres on coastal flooding and erosion, adaptation actions such as mangrove plantation and reduced extraction of coral should be considered. Other measures to lessen the likelihood and severity of river flooding include the development of vegetation buffers to help reinforce the riverbank. Preventing upstream deforestation would also reduce runoff into the river.

In March 2013, WWF conducted a workshop on climate change and ecosystem based adaptation for the business sector within the Wailada Industrial Area. This was because the vast majority of business buildings are located along the Lami River bank, a location highly prone to flooding. Flooding disasters could significantly damage not only financial and economic sources, but also create health and environmental security issues. The consultation workshop was designed to raise awareness and generate support among the private sector for ecosystems based adaptation as a means to prevent coastal and river erosion and flooding, and to protect settlement areas. The workshop also assisted communities in Suvavou Village, Qauia Community and Lami Village and the private sector in the Wailada Industrial area to formulate action plans[10] .

In April 2013, a further consultation with the private sector in Lami was conducted, and the participants clearly identified flooding, soil erosion and waste disposal into rivers as the main climate change related and environmental threats. Despite devising an action plan that includes dredging, proper waste management for communities and businesses, reforestation and mangrove replanting along the river bank, they were concerned with the lack of monitoring and enforcement, especially relating to health issues and the environment[11] .

In terms of enhancing knowledge of climate change and disaster risk reduction in key vulnerable areas such as Suvavou, Lami and Qauina, Lami Town Council and UN-Habitat undertook a four month period of consultation to enable community members to have a better understanding of the causes of climate change and

[10] WWF South Pacific Programme Office. Lami Ecosystem Based Adaptation: Wailada Business Sector Awareness.

[11] Lami Town Council and UN-Habitat (undated). Vulnerability Assessment in Wailada Business Houses.

potential adaptation actions that could be undertaken. The action plans adopted by the villagers included undertaking consultations with the Department of Environment, replanting mangroves and native trees, reducing the use of chemical fertilizers and preventing upstream deforestation[12] .

In the Qauia community action plan, the workshop participants agreed that landslide, improper disposal of wastes, scarcity of marine and freshwater resources, flooding and the deterioration of the Lami river posed serious threats to the livelihood of the Qauia community, and they devised an action plan that highlighted the importance of conducting research to study types of trees suitable and adaptable to their areas, as well as emphasizing the need of community members to be more educated about the separation of waste materials to make their areas less vulnerable to climate change induced disasters[13] .

In June 2013, the second phase of activities conducted under WWF's leadership was the planting of around 3,000 mangrove seedlings along the Lami River, mainly connecting from the Qauia River to Suvavou Village. Approximately 40 km² of mangroves are now managed with community participation. This activity also played a pivotal role in raising more awareness of the community about the impacts of climate change on their surrounding environment[14].

In addition, the mangrove planting activities saw participation from the Fiji Police, National Rugby League Team and Lami Town Council, ensuring a diverse range of stakeholders were involved. The activities also included planting native fruit bearing trees and vetiver grass along the Lami River, which reduces riverbank erosion and flooding impacts[15].

A biophysical data survey was conducted in the Lami River catchment area in order to minimize land degradation within the city and in the broader catchment area stretching to Suva. The joint research by WWF and the Land Resource Planning and Development Division of the Ministry of Agriculture in Lami shows the major causes of land degradation in Lami to be overcultivation of cropland in the vicinity of the riverbank, upstream deforestation and farming in steeply sloping marginal land. The total land area of the Lami Catchment is 2,194 hectares. This has been subdivided into: i) 304 hectares of potential agriculture land, ii) 24 hectares of marginal land, iii) 1,209 hectares of non-arable land and iv) 657 hectares of protected area. The study found that marginal areas can be used for agriculture purposes, especially tree planting and animal grazing, on the condition that soil conservation measures are undertaken. Preservation of the protected area is of critical importance as it supports water resources and forest cover. If deforestation is allowed to occur in the protected area, soil erosion will take place as a result and flooding will happen more easily as a result[16].

[12] Lami Town Council and UN-Habitat Lami Ecosystem Based Adaptation: Suvavou Village, Lami Village and Qauia Settlement - Vulnerability Assessment Workshop Report.

[13] Ibid

[14] WWF (2013). Lami Riverbank Rehabilitation Program, 22 June.

[15] WWF (2013). Lami Riverbank Rehabilitation Program, 17 May.

[16] WWF. Biophysical Survey Report Lami Catchment Report.

UN-Habitat's Cities and Climate Change Initiative promotes enhanced climate change mitigation and adaptation in developing country cities. This document is an initial output of the Cities and Climate Change Initiative activities in Lami Town, Fiji. This abridged report is based on the SCOPE Pacific Ltd. *Lami Town Climate Change Vulnerability and Adaptation Assessment* 2011 (UN-Habitat); and Rao, Nalini S., Tim Carruthers, Paul Anderson, Loraini Sivo, Tracey Saxby, Trevor Durbin, Vainuupo Jungblut, Terry Hills and Stuart Chape (2012) *A Comparative Analysis of Ecosystem Based Adaptation and Engineering Options for Lami Town, Fiji* (Samoa, Secretariat for the Pacific Regional Environment Programme).

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Starting with a brief background to the city, this report addresses Lami Town's climate change situation from a climate vulnerability perspective that focuses on the exposure to hazards, the climate change sensitivity of key urban systems, and the adaptive capacity of the city. The report further summarizes key vulnerabilities of people, places and institutions and provides initial recommendations for climate change action.

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