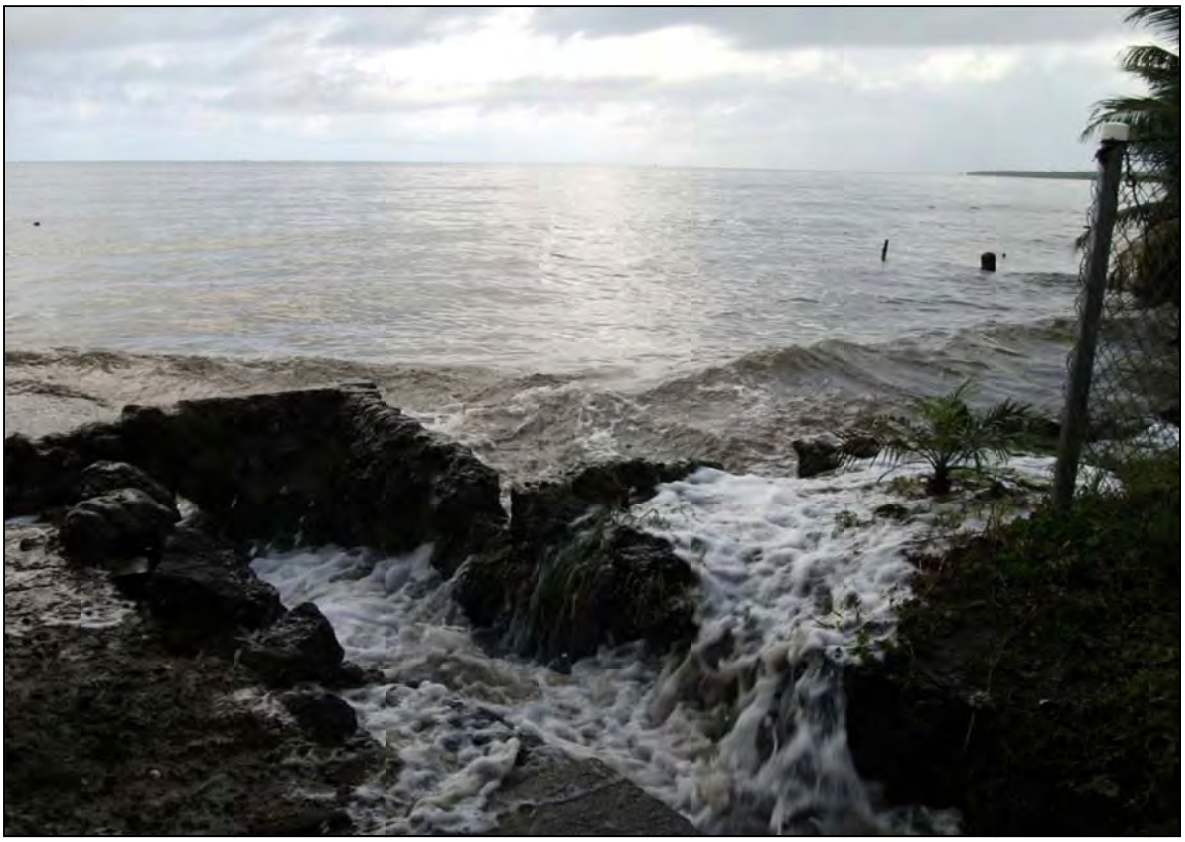
# CITIES AND CLIMATE CHANGE INITIATIVE:

## Lami Town

## Climate Change Vulnerability and Adaptation Assessment

## 2011



# Document history and status

| Revision | Date issued | Reviewed by | Approved by | Date approved | Revision type |
|---|---|---|---|---|---|
| Draft | 11th July 2011 | J Hughes | J Hughes | 12th Aug 2011 | Internal Review |
| Final Draft | 11th Sept 2011 | J Hughes | J Hughes | 26th Sept 2011 | Internal Review |
| | 26th Sept 2011 | S Mecartney UNH | S Mecartney UNH - Suva | 9th Oct 2011 | Client Review |
| | 26th Sept 2011 | P Ieli - Lami Town Council | P Ieli - Lami Town Council | 20th Oct 2011 | CCCI Partner Review |
| | 26th Sept 2011 | C Radford – UNH Fukuoka | C Radford – UNH Fukuoka | 23rd Oct 2011 | Client Review |
| | 26th Sept 2011 | B Bathe – UNH Nairobi | B Bathe – UNH Nairobi | 24th Oct 2011 | Client Review |
| Final | 9th Nov 2011 | J Hughes | J Hughes | 17th Nov 2011 | Final Internal Review |
| | 20th Nov 2011 | S Mecartney UNH | S Mecartney UNH - Suva | | |
| | 20th Nov 2011 | P Ieli - Lami Town Council | P Ieli - Lami Town Council | | |
| | 20th Nov 2011 | C Radford – UNH Fukuoka | C Radford – UNH Fukuoka | | |

## Distribution of copies

| Revision | Copy no | Quantity | Issued to |
|---|---|---|---|
| Final Draft | Soft Copy | 1 | Client (for review) |
| | | 1 | Partner (for review) |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| | |
|---|---|
| **Printed:** | 27 January 2012 |
| **Last saved:** | 27 January 2012 09:53 AM |
| **File name:** | C:\Users\jhughes\Desktop\V&A\Lami Town VA Assessment_Report_Final Issue to UNH 20Nov2011.docx |
| **Project Manager** | Jacqueline Hughes |
| **Author** | SCOPE Pacific Ltd |
| **Name of organisation:** | UN-Habitat |
| **Name of project:** | Cities & Climate Change Initiatives |
| **Name of document:** | Lami Town Vulnerability & Adaptation Assessment |
| **Document version:** | Final |

# Table of Contents


**1. Introduction 6**

**1.1 Assessment Framework 8**

**1.2 Formation of the Steering Committee 13**

**2. Lami Town: Climate Change Exposure and Sensitivity 16**

**2.2 Geographical Location 16**

**2.2 Governance Structure 17**

**2.3 Demographics 20**

**2.4 Urbanization Trends & the Growth of Lami Town 25**

**2.5 Land Use and Tenure 29**

**2.6 Physical Features 35**

2.6.1 Topography 35

2.6.2 Soils and Geology 36

2.6.3 Coastal River Systems 38

2.6.4 Coastal Processes 41

2.6.5 Climate 44

*2.6.5.1 Rainfall* 45

*2.6.5.2 Temperature* 47

*2.6.5.3 Wind* 48

**2.7 Extreme Events 49**

2.7.1 Tropical Cyclones 49

2.7.2 Storm Surges 50

2.7.2 Extreme Rainfall Events 54

2.7.3 Earthquakes and Tsunamis 54

**2.8 Hazard Mapping 55**

**3 Lami's Climate Change Hotspots 59**

**3.1 Residential 61**

3.1.1 Panoramic Road 61

3.1.2 Uduya Point 62

3.1.3 Naqumu Point 63

3.1.4 Vatuvia, Qeleya and Raghunath Singh Drive Residential 64

3.1.5 Nukuwatu Residential 65

3.1.6 Marine Drive Residential 65

3.1.7 Delainavesi Residential 65

**3.2 Settlements 65**

3.2.1 Naisogowaluvu Settlement 67

3.2.7 Matata Settlement 68

3.2.3 Samoan Settlement 69

3.2.4 Kalekana Coastal Settlement 69

3.2.5 Kalekana Inland Settlement 70

3.2.2 Koronivono Settlement 71

3.2.6 Naivikinikini Settlement 72

3.2.1 Wailekutu 72

3.2.8 Nadonumai Settlement 73

**3.3 Commercial and Industrial Areas 73**

3.3.1 Industrial Areas 73

3.3.1.1 Baro Industrial 75

3.3.1.2 Nukuwatu and Wailada Industrial 76

3.3.1.3 Wailekutu Industrial 77

3.3.2 Commercial Areas 78

**3.4 Civic Areas 82**

3.4.1 Recreational Areas 82

3.4.2 Schools 82

3.4.3 Health/Medical Centres 83

3.4.4 Nature Reserves, Foreshore and Mangrove (*Tiri*) Areas 83

**3.5 Infrastructure, Public Utilities and Waste Services 85**

3.5.1 Bridges 86

3.4.2 Roads 86

3.4.4 Drainage 87

3.4.5 Water Supply 87

3.4.6 Sewerage Disposal 88

3.4.7 Electricity 89

3.4.3 Streetlights 90

3.4.8 Solid Waste 90

**4 Identifying Key Adaption Options for Lami 93**

**4.1 Surface Flooding 95**

4.2 River Flooding 96
4.3 Coastal Flooding 96
4.4 Inland Terrestrial Erosion 97
4.5 Riverbank Erosion 98
4.6 Coastal Erosion 99
5 Critical Strategic Action Areas 100
5.1 Coastal zones 100
5.2 Flood-prone Areas 101
5.3 Human Settlements & Livelihoods 102
5.4 Public utilities and infrastructure 103
5.5 Water resources 103
5.6 Health 104
5.7 Disaster Risk Preparedness and Reduction 104
5.8 Lami GHG Emissions 105
6 Conclusion 107
7 References 108
8 List of Appendices 111
Appendix A 112
Appendix B 113
Appendix C 114
Appendix D 115
Appendix E 116
Appendix F 117
Appendix G 118
Appendix H 119
Appendix I 120

# 1. Introduction

Fiji is one of the many countries in the Pacific that are susceptible to the risks and effects of climate change and sea level rise. The effects of climate and sea level changes are very real and present a definite threat to the future environmental and socio-economic welfare of the country. Therefore adaptation to climate change and its effects is imperative; decreasing vulnerability to climate-related threats at the grass-roots level now can also aid in creating sustainable, resilient communities as well as help Fiji cope with future climatic changes down the line.

The UN-Habitat Pacific Cities and Climate Change Initiative (CCCI) aims to improve the adaptation capacities of cities and local governments to climate change as well as create opportunities for Pacific local governments and their city networks, associations and partners to implement gainful mitigation and adaptation actions or projects. Additionally, CCCI will play a part in the attainment of Millennium Development Goal (MDG) 7, which is 'ensuring environmental sustainability'. Through the CCCI project, resistance to climate change can be encouraged by incorporating principles of sustainable development into Fiji's policies and programmes and by undoing the loss of environmental resources in developing nations like Fiji.

In Fiji, the CCCI programme forms a component of the UN-Habitat Cities Alliance project and is being undertaken by the Ministry of Local Government, Urban Development, Housing and Environment in conjunction with Lami Town Council and Strategic Consultants in Planning and Engineering (SCOPE) Pacific Limited.

The CCCI project comprises of three main components – Vulnerability and Adaptation (V&A) Assessment which is the subject of this report, a National Scoping Study (NSS) and a Greenhouse Gas (GHG) Inventory. The implementation of the CCCI project in Fiji is important given the country's vulnerability to natural disasters like tropical cyclones, storm surges and geohazards such as earthquakes and tsunamis.

Fiji is geographically located in the South Pacific ocean at latitude 15° and 22° South and longitude 175° East and 178° West. It has a warm tropical climate with maximum temperatures ranging between 26°C - 31°C year round. The total land area in the Fiji group of Islands equates to 18,270 km2 and comprises approximately 322 islands of which only about 110 islands are inhabited. Fiji consists of large mountainous islands, small volcanic islands, low-lying atolls and elevated reefs (Fiji 1st National Communication, 2005). Viti Levu (10,544 km2) and Vanua Levu (5,538 km2) are the two largest islands and account for most of the population and economic activities.

In 2007 Fiji's population numbered 837, 271 with approximately 51% of the population residing in the urban centres. Suva is the capital city of Fiji and is located on Viti Levu's southeast coast while the only other city in the country, Lautoka, is located on Viti Levu's northwest coast. There are also 12 declared towns (Lami, Nasinu, Nausori, Nadi, Ba, Tavua, Sigatoka, Labasa, Savusavu and Levuka) and 7 town planning areas (Rakiraki, Vatukoula, Navua, Korovou, Deuba, Nabouwalu and Seaqaqa).

Fiji's economy is a small and open one with the main income earner being the tourism sector followed by the sugar sector (KBR Inception Report, 2011). The years of 1993 to 1996 saw real economic growth averaging 2.7%; however of this percentage, economic growth only grew by 1.6% in 1993 due to the adverse impacts of Tropical Cyclone Kina which emphasized how vulnerable Fiji's economy is to natural disasters (Feresi et al., 1999, cited in KBR Inception Report, 2011:9).

Lami town is adjacent to Suva City on the southeast coast of Viti Levu (see Figure 1), and is the pilot for the UN-Habitat CCCI Vulnerability and Adaptation Assessment. Lami was selected as the pilot project as it is a coastal town within the Greater Suva region which is the most densely populated region in Fiji with 62.1% of the urban population of Fiji living in this Region. In addition to being a coastal town it is also faced with limited flat land for expansion due to the hilly topography with runs parallel to the coast on its northern boundary. Lami town is also facing the pressures of limited local infrastructure to address coastal erosion, flooding, landslides, poor road and drainage conditions, poor sanitation with all of its residential population still connected to individual septic tank systems, unreliable public water supply and poor solid waste management systems.

**Figure 1 Map of Fiji with location of Lami town adjacent to Suva City. Source: Tourism Fiji**


Whilst excluded from its proclamation boundary, Lami town physically includes two proclaimed Fijian villages (namely, Suvavou & Lami villages), numerous traditional native reserve lands which have been informally leased out directly by the traditional owners for communal living and settlements and State foreshore land which mainly comprises mangrove swamps. These areas are facing increasing pressure to absorb the urban overspill of the Greater Suva Region, both in population and economic growth making it extremely challenging for Lami Town Council to control and plan for without it being in its

administrative role but whose growth has an immediate effect on Lami Town Council's resources and strategic outcomes and focus.

This report presents the results and recommendations of the vulnerability and adaptation assessment conducted in Lami town in an effort to aid the Lami Town Council and the Ministry of Local Government in identifying and building its case on Lami's vulnerability status and analyzing and developing ways of coordinating and adapting to the effects of climate change and sea level rise in the Lami area and within its local communities, as well as strengthening adaptation capacities to be able to meet current and future challenges related to climate change and disaster risk management.

## 1.1 Assessment Framework

The Vulnerability and Adaptation Assessment for Lami town focuses on estimating exposure, sensitivities, and adaptive capacities to climate change in an effort to ascertain the selected area's vulnerability.

In accordance with the Intergovernmental Panel on Climate Change (IPCC) 3rd and 4th Assessment Reports exposure is defined as the degree of climate stress upon a particular unit of analysis, and may be characterized as long-term change in climate conditions, or changes in climate variability including the magnitude and frequency of extreme events. Whilst Sensitivity is defined as the degree to which a system is affected, either positively or negatively, by climate-related stimuli, and 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 ("Sorsogon City Climate Change Vulnerability and Adaptation Assessment, 2008" (Sorsogon City CC Vulnerability and Adaptation Assessment)).

In undertaking the vulnerability and adaptation assessment, the project assessment team consisting of the Lami Town Council (LTC), the Department of Town and Country Planning (DTCP) and SCOPE Pacific Ltd reviewed the existing assessment tools and approaches which had been presented at the Train the Trainers Workshop held in Manila by the UN Habitat, and identified the following steps to be taken in conducting the vulnerability and adaptation assessment for Lami town which formed the Terms of Reference for this V&AA (see Appendix A):

| | **Steps** | **Action** |
|---|---|---|
| 1 | Orientation & brief Lami Town Council & Min Local Govt officials | The vulnerability and adaptation assessment process was well received by Lami Town Council, the National Climate Change Committee and various stakeholders and regular meetings were held between the consultant, LTC and MLG officials. |
| 2 | Set up Assessment Team & Confirm assessment purpose and scope | The setting of a Lami vulnerability and adaptation assessment Steering Committee was undertaken and the terms of reference and scope of works compiled by the Project Assessment Team was endorsed. The Lami Vulnerability and Adaptation Assessment Steering Committee comprised of the |

| | | |
|---|---|---|
| | | Department of Environment, Department of Town & Country Planning, Central Board of Health, Mineral Resources Department and the National Disaster Management Office whilst the project assessment team comprised mainly the consultant, LTC and MLG officials. |
| 3 | Map & Mobilize Stakeholders | The stakeholders and communities were mapped and consultation with the various stakeholders undertaken though delays in the consultation with the settlement/village communities, the residential/civic communities and the industrial & commercial sector within Lami were experienced. |
| 4 | Data Gathering | The data gathering exercise seems to be an ongoing process. Whilst some stakeholders have been willing to share data, there are cases of unreliable data, incomplete and missing data and resources. The meteorological data collected was not specific to Lami but rather to Laucala Bay in Suva whilst the rainfall data at the Lami Cement Factory had some data missing due to equipment failure. Interpreting this data to adjust and reflect the Lami situation will require some manipulation which the team struggled with due to lack of expertise. |
| 5 | Analyze Data | All data gathered including survey data captured from the residential/commercial/industrial sector surveys and the community & settlement consultations are required to be summarized, analyzed and incorporated into the report. |
| 6 | Scoping Critical Areas/Hotspots | The Lami Town Council had requested that an assessment of the entire residential, commercial, industrial and settlement areas in Lami town's boundary that could potentially be climate change hotspots. These potential hotspots were identified as part of the initial consultations made with Lami Town Council, relevant authorities and stakeholders and after reviewing the data collected. The Council felt that following this process and the community surveys, the team would be in a better position to know which areas were most critical and to be prioritized though these areas would need to confirmed during the community consultation & with various sectors and during the stakeholder validation meetings scheduled to be conducted and facilitated by Lami Town Council. |

| | | |
|---|---|---|
| 7 | Identify Key Priority Areas for Adaptation Actions & Critical Steps | The key priority areas and critical steps to be clearly highlighted in consultation with Lami Town Council based on the community and stakeholder consultation inputs and reflected in the draft VAA Report with a view to have these actions incorporated into Lami Town Council's strategic and corporate plans. |
| 8 | Consolidate Findings & Issue Draft Report | The draft report shall be reviewed and any gaps that are identified will need to be incorporated. |
| 9 | Stakeholder Validation Meeting | The stakeholder validation process will also be used as an opportunity to have the results of the draft report validated and clarified and any comments or issues identified shall be incorporated into the final report. |
| 10 | Final Vulnerability and Adaptation Assessment Report | The final Vulnerability and Adaptation Assessment Report will be issued to the UN Habitat & the Ministry of Local Government, Urban Development, Housing & Environment and to be used by Lami Town Council in the Strategic and Corporate Plans and to also guide the local communities in the local action plans. |

The Lami Town Council (LTC) & Ministry of Local Government (MLG) officials have been very proactive in raising awareness about the importance of the Vulnerability and Adaptation Assessment and in particular during the 2010 Lami Festival had erected an awareness display highlighting the CCCI project as well as had included within the festival programme the promotion of cycling to reduce carbon emissions. Lami Town Council also made a presentation to the 2010 Local Government annual forum in December where local government administrators and management from the 13 town and city councils were present and had also shown keen interest in undertaking a Vulnerability and Adaptation Assessment in their municipal boundary to be able to prioritize vulnerable areas and development in the strategic and corporate plans.

Additionally LTC was represented at the 3rd Session of the Global Platform for Disaster Risk Reduction in Geneva, Switzerland as well as at the 3rd Session of the Pacific Platform for Disaster Risk Management in Auckland, New Zealand whereby the Council presented their efforts in mainstreaming Disaster Risk Reduction and Management and Climate Change Adaptation at the local level. This is being implemented through the identification of sensitive and vulnerable areas with validation by the population served through council meetings, public awareness (council circulars, schools, festivals, etc.), and parallel dialogue with national authorities such as the MLG and Disaster Management Committee (DISMAC) to encourage synergy with national frameworks for risk management. The inclusion of different communities, particularly those in under-served settlements, in DRR and CCA has also been an

objective by LTC and the Council encourages active ownership by the community in DRR and CCA activities. Presentations for the Global and Pacific Platforms are attached as Appendix B & C.

LTC has also issued various press releases and awareness articles within the national newspapers regarding the Vulnerability and Adaptation Assessment, raising the importance of the exercise and the CCCI programme.

In addition to this the CCCI Project Assessment team has also attended several climate change training opportunities including:

- CCCI "Train the Trainers" Workshop in Manila undertaken by UN Habitat which provided an insight into the Sorsogon experience and familiarization with the methodology and approach to undertaking the Vulnerability and Adaptation Assessment and how it can be adapted and localized to the Fiji or Lami context.
- Urban management Tools for Climate Change Course at the Institute for Urban Development & Housing Studies in Holland sponsored by UN Habitat which provided training in the preparation of local climate change plans which address the global challenges yet focus on concrete local actions with specific practices to manage urban design and environmental infrastructure in particular energy, transport, housing and water.
- Training for Capacity Building in Climate Change at the University of the South Pacific in Suva, Fiji funded by AusAid which provided training of pacific regional participants of how climate change is affecting local communities and how the information should be interpreted to undertake local assessments in communities to provide good sound mitigation and adaptation actions for these
- CCCI Pacific Regional Training Workshop in Suva undertaken by UN Habitat and Commonwealth Local Government Forum (CLGF) which included pacific regional participants to obtain updates from each of the countries CCCI programme and progress to date, review their work completed to date by highlighting opportunities and constraints in undertaking the Vulnerability and Adaptation Assessment & GHG profiles and ways forward in order to complete the Vulnerability and Adaptation Assessment Report & GHG Profiles.

The CCCI assessment team were also invited to and participated in the UN- Habitat CCCI Asia/Pacific Regional Partners Meeting in October 2010 held in Changwon where the Changwon Declaration was signed promoting cities responding to climate change in recognition that the Asia/Pacific region is known to be the most affected by disasters, experiencing 90% of the world's weather related deaths. The Changwon meeting had city representatives from Korea, China, Indonesia, Mongolia, Nepal, Papua New Guinea, Philippines, Samoa, Sri Lanka, Thailand, Vanuatu, Vietnam and Fiji all sharing their city experiences of conducting vulnerability and adaption assessments and developing and implementing climate change adaptation and mitigation actions.

In addition, the community consultation process adopted by Lami Town Council included monthly meetings with the community leaders and an introduction and training session of the community leaders on the CCCI project as per the leaders request to ensure that the leaders were well informed

and familiar with the key issues and objectives of the project before going out to their communities to broadcast that the consultation process was going to commence. The leaders were also instrumental in setting up the meetings with the community members and their involvement and cooperation with the settlement surveys. Out of the total community settlements and villages in Lami, seven (7) settlements were selected by Council and provided to the assessment team to work with and due to time constraints only 4 out of the 7 were presented to and surveys undertaken within these four communities.

Nevertheless, it is Council's intention to continue with the settlement and community surveys within all the existing areas to enable them to have a better understanding of the key issues and concerns that these local people have with regards to climate change. The four settlement surveyed has allowed Council to learn from the experience and mainstream the community consultation process in their annual programme to enable Council to have access to firsthand knowledge of the community issues as well as assist the communities in working on the local area actions plans in order to adapt to the climate change effects that they are experiencing.

As part of the community consultation process, it was also requested by the communities in Lami who are predominantly Fijian, that climate change awareness brochures and materials be produced in the Fijian vernacular as all the climate change brochures that had been produced by the Department of Environment were in English which made it hard for the grass root level communities to understand. The draft Fijian climate change brochure was reviewed by the I'Taukei (Fijian Affairs) Ministry and the Department of Environment and was also issued to the Ministry of Education for their endorsement to be used in schools. The presentations to the communities were also conducted in Fijian with the exception of the Samoa community where most of them spoke in English.

Recently, through the influence of CCCI programme, Lami town became the first city in the South Pacific to be listed and participate in the "Resilient Cities" campaign which is linked to the global platform for Disaster Risk Reduction and the Pacific Platform for Disaster Risk Management. This participation together with the CCCI programme has enabled Lami town to build awareness amongst its people on climate change issues and bring to the forefront concerns about their livelihoods, resources, infrastructure, property and assets that need to be considered when planning for the future. The CCCI programme is timely in that Fiji is in the process of preparing its first Climate Change Policy which is aimed at establishing the principles, objectives and individual strategies that will improve Fiji's resilience to the impact of climate change, and support the mitigation of further greenhouse gas emissions. The main aim for the Climate Change Policy is to address the need to improve governance arrangements, data collation and dissemination mechanisms and community education and awareness raising programs as well as specific climate change adaptation and mitigation initiatives. It is also hoped that the Climate Change Policy will address the need for Fiji to continue to participate in regional and international processes. The final draft Climate Change Policy was released in November 2011 to the various stakeholders that participated in the formulation of the Policy and it is encouraging that the Policy has identified the urban and housing as sectors of importance.

One of key challenges of undertaking this Vulnerability and Adaptation Assessment despite having the framework was accessing the required data to compile the report together with the reliability of the data, unreferenced data and also missing data. What was also of key concern was the reluctance of stakeholders to share key information and advice on access to data. These constraints were overcome by making inferences and assumptions of the available data and recognizing the need for a national database to be held with the Department of Environment on various programmes but were validated through the community consultation process which was conducted and through the hands on approach with Lami Town Council.

## 1.2 Formation of the Steering Committee

The Lami Vulnerability and Adaptation Assessment Steering Committee was formed in consultation with the National Climate Change Unit established within the Department of Environment under the Ministry of Local Government, Urban Development, Housing and Environment. The setting up of a Lami Vulnerability and Adaptation Assessment Steering Committee was brought about by the National Climate Change Unit to establish a communication link with the national government to ensure that the sharing of information and support was achieved for the CCCI programme and specifically the Lami Vulnerability and Adaptation Assessment and the GHG Profile.

The Lami Vulnerability and Adaptation Assessment Steering Committee that was setup comprised of selected members from the National Climate Change Country Team (NCCCT) including the Department of Environment, Department of Town & Country Planning, Central Board of Health, Mineral Resources Department, the National Disaster Management Office and Lami Town Council. The Steering Committee was provided with an introductory meeting whereby the Assessment Framework and Terms of Reference including the scope of work compiled by the Project Assessment Team were endorsed. The Lami Vulnerability and Adaptation Assessment Steering Committee advised the Assessment Team to provide updates to the Steering Committee through the Department of Environment's Climate Change Unit who is considered to be the main member. The Assessment team has kept in communication with the Department of Environment's Climate Change Unit who also participated in the Pacific Regional Workshop organized by UN Habitat and CLGF on the progress of the Vulnerability and Adaptation Assessment & GHG Profile updates of each Pacific Island country who also participated including Samoa, Papua New Guinea, Solomon Islands, Vanuatu, Tuvalu and Kiribati.

Members of the Steering Committee such as the Department of Town & Country Planning (who are also members of the NCCCT) and the UNH as CCCI partners/funding agency have since been approached for their input towards the ADB-supported Nausori Climate Change Adaptation project that focuses on climate-proofing of Nausori's water and infrastructure sectors, as well as in the consultation process of the National Climate Change Policy.

The NCCCT was set up to deliver the Second National Communications (SNC) Report for Fiji which is required to be submitted to UNFCCC in March 2012. Fiji signed United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and ratified it in 1993. The UNFCCC provides a unified means to combat the effects of climate change. It recognizes that while efforts are made to reduce greenhouse

gas emissions, measures should be taken to adapt to the already changing climatic conditions. Fiji's SNC to the UNFCCC is required to provide information on the Fiji's vulnerability to the adverse effects of climate change, and on adaptation measures being taken to meet the country's specific needs and concerns arising from these effects. Fiji's approach to the SNC will be a geographical one for the purpose of analyzing data which will ensure incorporating all existing sectors within a specific geographic area. The geographic areas for the assessment are based on the four divisions, Central, Eastern, Western and Northern focusing on island and mainland communities.

Under the NCCCT, the various sectors that have been identified by the Thematic Working Group on V&A which includes Agriculture, Fresh Water, Reefs, Biodiversity, Food Security, Public Infrastructure, Coastal Zone, Health, Tourism, Fisheries, Land Use Change & Forestry and Disaster Risk Reduction.

The key local stakeholders that were identified to be consulted and provide data for the CCCI programme (comprising of the National Scoping Report and Lami's Vulnerability and Adaptation Assessment & GHG Profile) included:

1. *Government Authorities & Statutory Authorities:* Ministry of Local Government, Urban Development, Housing & Environment, Ministry of Health, Central Board of Health, Suva Rural Local Authority, Ministry of Education, Department of Meteorology, Bureau of Statistics, Department of Energy, Department of Mineral Resources, Ministry of Finance & National Planning, the Office of the Prime Minister, Ministry of Work, Water Authority of Fiji, Fiji Electricity Authority, Department of National Roads, Lands Transport Authority, National Disaster Management Office, Ministry of Forestry and Fisheries, Department of Agriculture, Water Resource & Landuse, Department of Lands, Native Land Trust Board, Ministry of i'Taukei Affairs, Ministry of Information, Ministry of Social Welfare, Women and Poverty Alleviation, Ministry of Provincial Development, Rewa Provincial Council, the District Office (Suva).

2. *Non Governmental Organizations:* World Wildlife Fund (WWF), Live and Learn, International Union for the Conservation of Nature (IUCN), Pacific Conference of Churches, Pacific Centre for Development Fund (PCDF), Environmental Law Association, Greenpeace International, People's Community Network (PCN), Fiji Council of Social Services,

3. *Council of Regional Organizations (CROP) Agencies:* Secretariat of the Pacific Community (SPC) and Secretariat of the Pacific Community Applied Geo-science and Technology Division(SOPAC), Secretariat of the Pacific Environmental Programme (SPREP), Pacific Islands Forum Secretariat (PIFS), South Pacific Tourism Organization (SPTO), PPA

4. *Academic Institutes*: University of the South Pacific, Fiji National University, University of Fiji

5. *Private Sector/Enterprises*: Fiji Chamber of Commerce, Fiji Employers Federation, Fiji Islands Hotel & Tourism Association, Fiji Manufacturers Association

6. *Development/Funding Institutions:* Asian Development Bank (ADB), UN Agencies, GIZ, EU, AusAID, JICA, MFAT NZ.

The main objective of having the Lami Vulnerability and Adaptation Assessment Steering Committee was to enable the Assessment Team to be able to have open communication with the NCCCT and to share information and experiences to enable support for the urban agenda within the climate change realm at National level which seems to be non-inclusive with focus on rural communities and agricultural concerns. The inclusion of stakeholders who have a clear role in Urban-related climate change adaptation and resilience need to be included into the national framework for climate change as urbanization issues continue to reflect that climate change is one of the key factors affecting many of those who live, work and invest in the urban centres. The CCCI through the Vulnerability and Adaptation Assessment and GHG profiles promotion of the participatory process of all the relevant local stakeholders, particularly the local urban communities, the informal settlements and local economic contributors, need to be clearly highlighted together with the stakeholder's roles, responsibilities and possible contribution to strengthen greater efforts of collaboration and partnerships to address this global yet rather localized climate change concern that is affecting Lami and possibly other urban growth areas.

# 2. Lami Town: Climate Change Exposure and Sensitivity

This chapter aims to provide a description of Lami town's geographical location, a background into its proclamation as a town and governance structure, land use and tenure, population and growth projections, physical features such as topography, soils and geology, climate data and exposure and sensitivity to climate induced effects.

## 2.2 Geographical Location

Lami town lies 18° 7' 0" South and 178° 25' 0" East and is an urban area in Rewa Province, Fiji. It is located to the north-west of Suva City and has a land mass area of approximately 680 hectares. It was formally incorporated as a town in 1977 and has a population of approximately 20,000, accounting for 4% of Fiji's total urban population. Approximately 50% of Fiji's urban population is in the Greater Suva area (Lami-Suva-Nasinu-Nausori) corridor as shown in Figure 2 below.

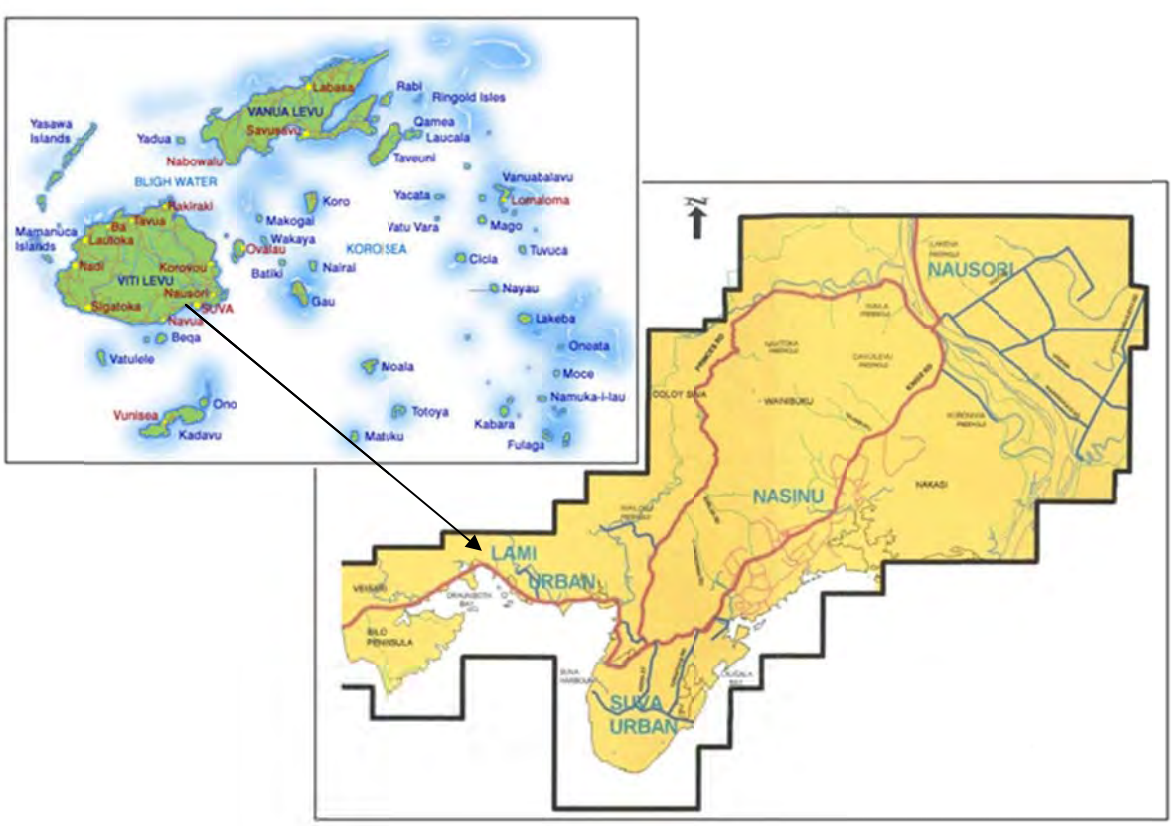
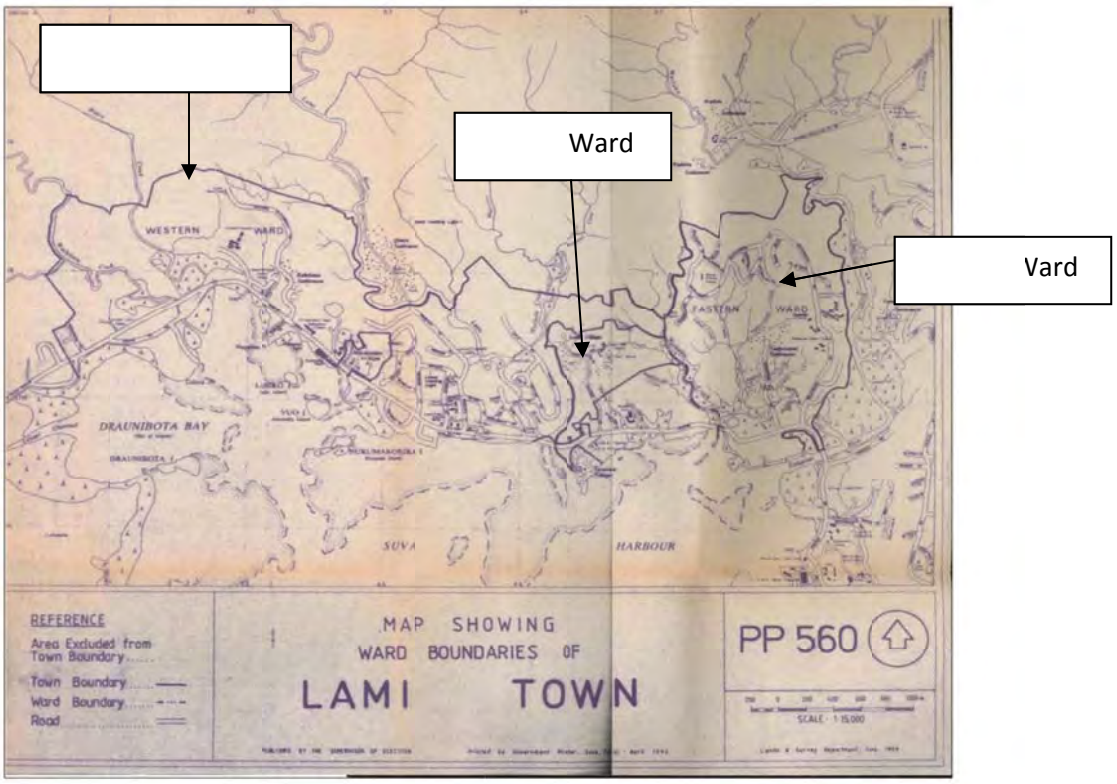


Figure 2 Map of Lami town. Source: Department of Lands

## 2.2 Governance Structure

Lami was established as a town by Ministerial declaration through the Local Government Act in March 1977. Lami is comprised of three wards (see Figure 3); the Eastern ward (the Delainavesi area), the Central ward (commercial centre and industrial subdivision), and the Western ward (extends from the commercial centre to Wailekutu). The town's boundaries were altered in 1988 to exclude some areas of native land opposite Suvavou village that were set aside as native reserve land. Lami's land tenure consists of all three categories of land that make up Fiji's land division system: native and native reserve land (more than 51%), state land (21%), and freehold land (28%).

Figure 3 Map showing ward boundaries of Lami town. Source: Department of Town and Country Planning, 2004



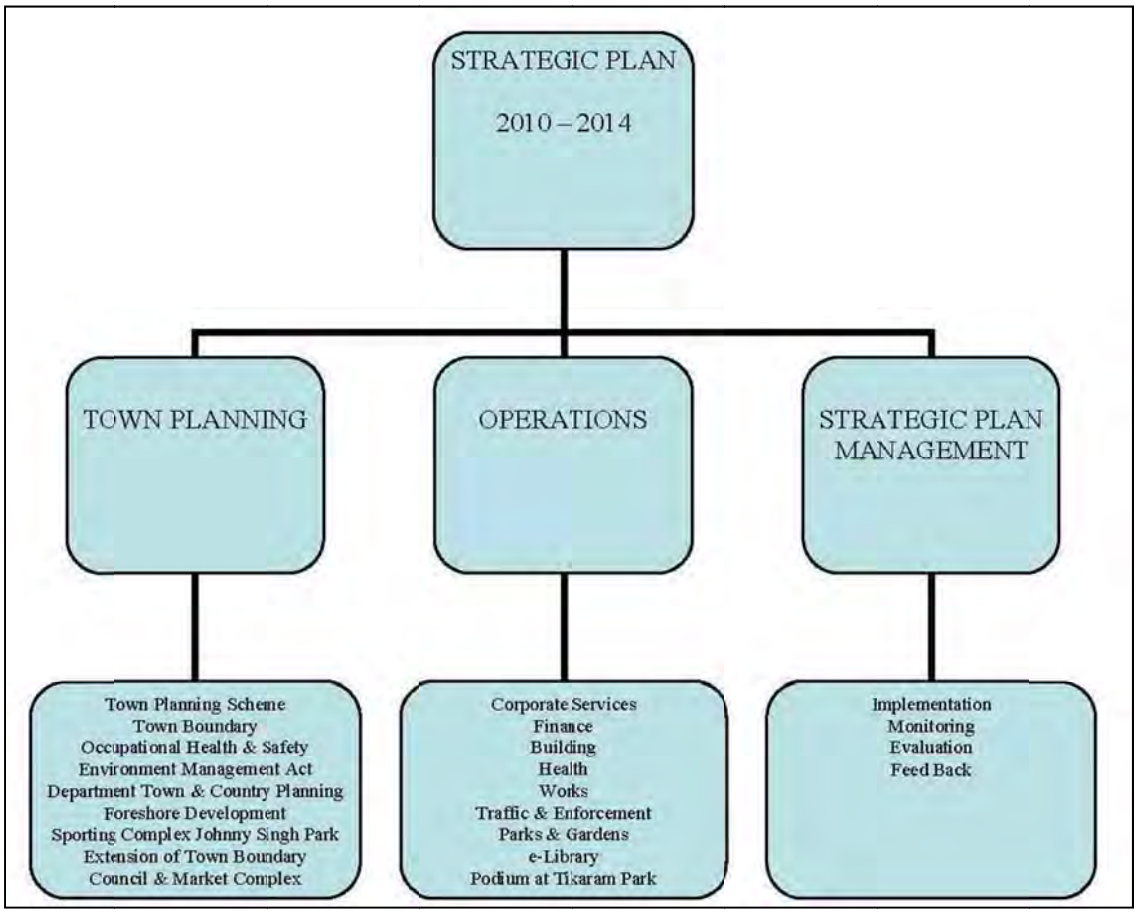

The town has general powers that relate to the promotion of health, welfare, convenience of inhabitants of the municipality and development of amenities. The council is governed by the Local Government Act, which details the provision of limited public utility services, road maintenance, streetlight, drainage and making By-laws on subjects prescribed to it by law i.e. Rubbish collection, rate payments, etc.

The Ministry of Local Government, Urban Development, Housing and Environment are the National level link with the Local Government level. The Councils are obliged to work in close consultation with its line ministry at all times via timely reporting and meetings.

The Council is headed by the Special Administrator who is tasked with paving the strategic path for the Council. The Special Administrator ensures policies and appropriate guidelines are incorporated within the Local Government Act and also the various other By-Laws to achieve a standard of service delivery that is both efficient and effective. The Chief Executive Officer is responsible for the implementation of all Council's policies and procedures and also ensures that the operations of the various departments as listed in the section below are managed in an orderly and timely manner. Each department of the Council is assigned with a manager who is responsible for the effective and efficient running of their individual section. Most issues of the Council require a collaborative approach by all managers.

Lami's Strategic Plan 2010 – 2014 is purposefully designed to pave a smooth path for the Council to efficiently and productively achieve its goals. It is designed to actualize the Council's vision for Lami to develop as a safe, prosperous, beautiful and peaceful home for its multicultural society. The plan has been objectively adopted to address three vital elements of the Town's governance; the Town Planning, Operational and Management of the Plan as shown in Figure 4 below.

**Figure 4 Lami Town's Strategic Plan Governance Structure**



The 2010-2014 Strategic Plan outlines the issues that Lami Town Council is facing with regard to the governance and operation of Lami town and identifies goals towards improving and mitigating these issues. The goals identified in LTC's latest Strategic Plan included much-needed infrastructure upgrading works, which the Council plans to implement and pursue through progressive rehabilitation of the road networks, progress on the Council's foreshore development projects that is aimed at increasing and improving land availability for commercial and recreational use, upgrading of rock revetments along the Lami foreshore to protect the town from rising sea levels and inundation, and a strategic approach towards preventing and curbing flooding issues in the Town by improving the existing drainage network system and dredging of waterways to improve stormwater flows.

The Vulnerability and Adaptation Assessment provides an opportunity for the Council to review the issues and goals outlined in the Strategic Plan and also prioritize key areas which may be more vulnerable than others within Lami and that are at risk of environmental degradation and climate change events. The Strategic Plan review can also include some of the key recommendations from the Vulnerability and Adaptation Assessment and adapt a community approach towards mitigation and adaptation of climate change.

The 5 year Strategic plan was a recommendation by the Local Government Review/Reform committee in their 2008 report and the directive from the Minister for Local Government, Urban Development and Housing and Squatter Settlements.

The Lami Town Council has the following departments:

1) Town Planning and Building Services

The Lami Town Planning Area as declared under the Town Planning Act also requires all within the town boundary to comply with the Town Planning Act and thus, the Lami Town Council is responsible for ensuring that all Town Planning issues is guided by the Lami Town General Provisions and this role is undertaken in close consultation with the Department of Town & Country Planning and other relevant Government ministries and departments.

2) Health and Environment Services

The Public Health Act is followed at all times to carry out all Health & Environment services in consultation with the Central Board of Health, Department of Environment and other relevant Government ministries and departments

3) Public Works and Services

Operations and services under the Public Works are performed within the guidelines of the Local Government Act. The Council ensures that it provides service at its best with the limited resources that it has. With the Central Government now playing a major part in the road rehabilitation of municipal roads will see that the Council can now concentrate more on the improvements to footpaths, drainage, street lighting, grass cutting and town beautification.

4) Enforcement and Parking Meters

The enforcement on various non-complying activities is instituted as per the various By- Laws of the Council. The introduction of Parking meters has also seen better management of Traffic in the Town Centre Area.

5) Finance and Administration Department

Financial management is a crucial element of the Council. The Local Government Act Cap 125 is the guiding instrument for the Finance and the administration department. Timely preparation of annual budgets, forecasts, strategic planning and budgeting together with operational revenue and expenditure record keeping and timely submissions are some of the core functions of the department.

The Councils workforce consists of 15 Management and Clerical officers and a total of 30 field workers. The workforce is comprised of skilled, semi-skilled and unskilled (field labourers) workers.

At present, Lami Town Council's 5 Year Strategic Plan does not have any specific objectives addressing climate change issues within their Council boundaries as part of their long term plan but are now recognizing this issue as a key concern as it is a cross-sectoral issue that requires coordination and better management of resources to address this global yet localized critical issue amongst its key stakeholders including the local communities/residents/businesses.

## 2.3 Demographics

In accordance with the 2007 National Census, the population within Lami town boundary alone is 10,752 whilst Lami's peri-urban area comprised of 9,777 people. Hence this brings the total urban population for Lami to 20,529 people.

Fijians are the dominant ethnic group in the Lami area (see Table 1, Table 2 and Figure 5 below), comprising 72% Fijians within the Western ward, 84% Fijians found in the Eastern ward and 84% of the Lami Peri-urban area are also ethnic Fijians. Lami has a very large Fijian population comprising of 81% (16,562), making Lami unique from all other urban areas in Fiji where Indians dominate the urban populations. This is due to the clusters of native land within close proximity to the town (though excluded from the formal town Boundary due to it being under native reserve land) that have been provided by landowners of the two main villages in Lami (namely Lami Village and Suvavou Village) which has aided the establishment of large Fijian settlements within the peri-urban area of Lami such as Nadonumai, Navesi, Waigasa, Naisogowaluvu and Motusa in the Eastern ward, and Vugalei and Matata in the Central ward. Other settlements within Lami are situated on either State-owned or freehold land.

Only 5% of Lami's population are Indians who mostly occupy freehold lots in Delainavesi (Eastern ward) and State-owned land in the Western ward whilst a significant portion also seem to be situated within Lami's peri-urban area outside the Western ward. About 12% of the population comprise of Europeans and Part-Europeans who have settled on freehold land in Uduya and Naqumu Points and in Delainavesi, while some also reside on native lease lots in the Lami residential subdivision areas at the back of the

Town Centre and also in Lami's peri-urban areas. At 2%, Rotumans make up the smallest percentage of ethnic groups that reside in Lami and are mostly situated in Lami's Eastern and Western wards. Other Pacific Islanders also comprise of descendants of Solomon Islanders who are mainly found in Kalekana within the Western ward and those of Samoan ethnicity who live within the Samoan Settlement in Wailekutu also within the Western ward of Lami.

Therefore, in considering there is a large indigenous population and a large number of indigenous settlements, there is a need for the LTC to expand its knowledge of the Fijian culture, traditions and protocols and improve its communication systems, to enable Council staff members to actively engage with local communities in implementing recommendations highlighted in this Vulnerability and Adaptation Assessment as well as in disaster risk reduction and management measures and climate change adaptation activities. This also includes increasing the amount of climate change awareness materials that are printed in the Fijian language for distribution to local communities.

**Table 1 Population Figures in Each of Lami's Wards (derived from 2007 National Census)**

| | Lami Western Ward | Lami Eastern Ward | Lami Peri-urban | TOTAL |
|---|---|---|---|---|
| **Fijians** | 4,100 | 4,251 | 8,211 | 16,562 |
| **Indians** | 334 | 255 | 424 | 1,013 |
| **Rotumans** | 102 | 173 | 95 | 370 |
| **Other** | 1,180 | 357 | 1,047 | 2,584 |
| **TOTAL** | 5,716 | 5,036 | 9,777 | **20,529** |

*Source: Bureau of Statistics, 2007*

**Figure 5 Percentages of Major Ethnic Groups within Lami**

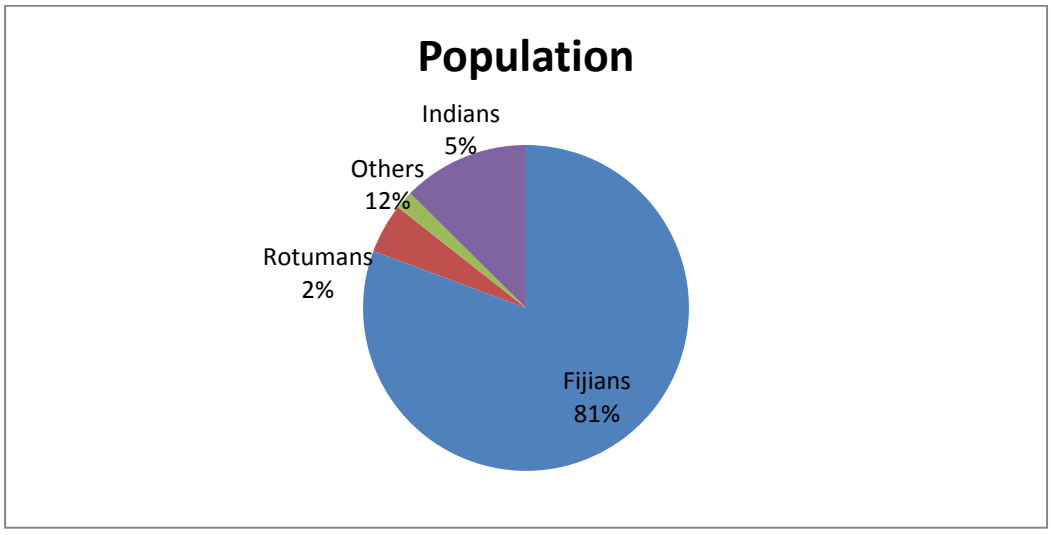


Table 2 Household Figures in Each of Lami's Wards (derived from 2007 National Census)

| NO. OF HOUSEHOLDS | | | |
|---|---|---|---|
| | **Lami Western Ward** | **Lami Eastern Ward** | **Lami Peri-urban** |
| **Fijian** | 703 | 659 | 1,437 |
| **Indian** | 91 | 63 | 101 |
| **Rotuman** | 19 | 36 | 19 |
| **Other** | 265 | 78 | 189 |
| **TOTAL** | 1,078 | 836 | 1,746 |

*Source: Bureau of Statistics, 2007*

Figure 6 below indicates the enumeration boundaries for Lami town as provided by the Bureau of Statistics and which were used as part of the National Census. The enumeration boundaries for Lami's peri-urban areas are also shown and these include areas to the western side of the boundary including part of Panoramic residential subdivision, wider Veisari including Waiqanake and Bilo settlement areas. Table 3 shows the corresponding enumeration numbers specifically for Lami town whereby those areas highlighted in red and depicted in red circles on the enumeration map in Figure 6, have between 5-7% of the Lami's population residing there and are considered the higher density areas within Lami.

Figure 6 Map showing Enumeration Boundaries and Reference Numbers for Lami town & Lami Peri-Urban (Source: Bureau of Statistics, 2007)

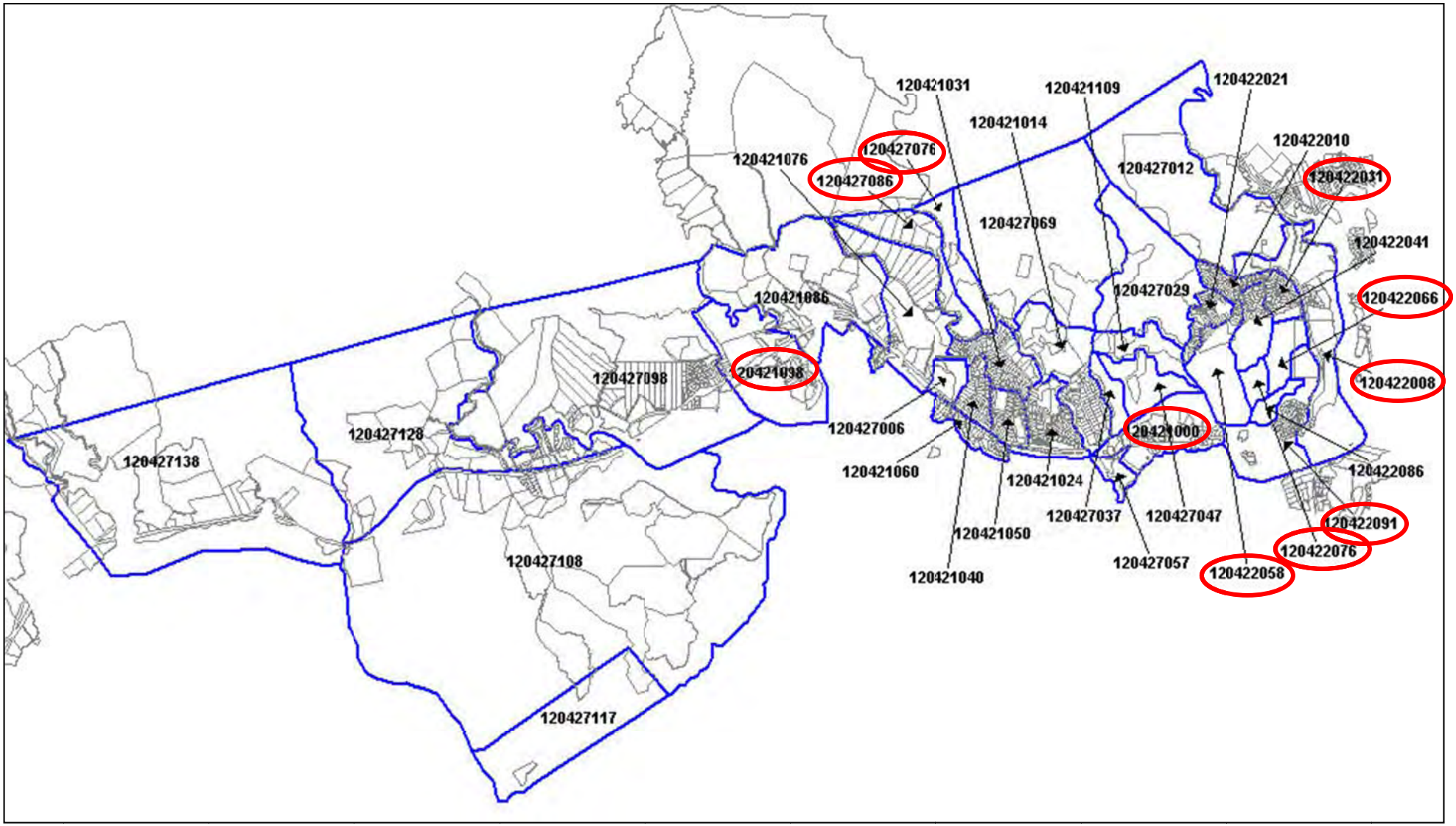


Table 3 Population and Households within Enumeration (EA) boundaries for Lami town (excludes Lami Peri Urban) (Source: CENSUS 2007: Fiji Islands Bureau of Statistics, 2007)

| Population & No. of Household for Lami Town Area (excludes Lami Peri-Urban Areas) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Enumeration Areas | Population | | | | | Household | | | | |
| | Total | Fijian | Indian | Rotuman | Other | Total | Fijian | Indian | Rotuman | Other |
| Totals | 10752 | 8351 | 589 | 275 | 1537 | 1914 | 1362 | 154 | 55 | 343 |
| 120421000 | 692 | 584 | 20 | 24 | 64 | 129 | 105 | 4 | 4 | 16 |
| 120421014 | 355 | 233 | 5 | 0 | 117 | 62 | 38 | 0 | 0 | 24 |
| 120421024 | 466 | 258 | 22 | 12 | 174 | 84 | 42 | 7 | 2 | 33 |
| 120421031 | 747 | 573 | 28 | 16 | 130 | 123 | 90 | 6 | 3 | 24 |
| 120421040 | 360 | 206 | 14 | 18 | 122 | 78 | 36 | 6 | 3 | 33 |
| 120421050 | 380 | 292 | 21 | 6 | 61 | 73 | 53 | 5 | 1 | 14 |
| 120421060 | 148 | 89 | 10 | 2 | 47 | 37 | 17 | 3 | 0 | 17 |
| 120421076 | 727 | 433 | 117 | 6 | 171 | 152 | 78 | 29 | 3 | 42 |
| 120421086 | 794 | 513 | 38 | 9 | 234 | 144 | 84 | 11 | 2 | 47 |
| 120421098 | 595 | 477 | 59 | 5 | 54 | 119 | 84 | 20 | 1 | 14 |
| 120421109 | 452 | 442 | 0 | 4 | 6 | 77 | 76 | 0 | 0 | 1 |
| 120422008 | 543 | 502 | 23 | 6 | 12 | 59 | 50 | 5 | 1 | 3 |
| 120422010 | 367 | 193 | 67 | 46 | 61 | 73 | 32 | 14 | 12 | 15 |
| 120422021 | 459 | 377 | 12 | 16 | 54 | 83 | 66 | 4 | 4 | 9 |
| 120422031 | 137 | 91 | 7 | 15 | 24 | 31 | 20 | 2 | 3 | 6 |
| 120422041 | 431 | 216 | 94 | 47 | 74 | 89 | 36 | 28 | 9 | 16 |
| 120422058 | 597 | 511 | 21 | 25 | 40 | 98 | 80 | 4 | 4 | 10 |
| 120422066 | 647 | 630 | 1 | 1 | 15 | 97 | 95 | 0 | 0 | 2 |
| 120422076 | 443 | 431 | 0 | 7 | 5 | 78 | 75 | 0 | 0 | 3 |
| 120422086 | 694 | 680 | 0 | 5 | 9 | 109 | 107 | 0 | 1 | 1 |
| 120422091 | 718 | 620 | 30 | 5 | 63 | 119 | 98 | 6 | 2 | 13 |

In 1975, the Department of Town and Country Planning formulated the Greater Suva Urban Structure Plan, which earmarked Lami's great potential for economic growth. This saw the preparation of District Planning Scheme that would form a firm base for future land subdivision and land use planning control. Accordingly, the Lami Planning Scheme Report of Survey was prepared in 1998 before the formulation of the Lami Town Planning Scheme, the purposes of which was to carry out a detailed planning survey of Lami area to identify the existing land use of each of the properties with the intention of highlighting the existing problems and opportunities available for residents, as well as attempting to find solutions to problems that were identified and to take advantage of the opportunities available in order for the orderly and planned implementation of the development of Lami as a new town.

The report of survey also looked at the socio-economic status of Lami as well as the status of public utilities and infrastructure in order to determine the future needs of the town, and it also examined Lami's natural and man-made amenities and proposed protection and conservation measures of these amenities. Finally, the report of survey gave suggestions as to which direction the commercial expansion of Lami could head in, should future local authorities have expansion works in mind.

Following the completion of the Report of Survey, the Lami Town Planning Scheme was created in 2004 and the objectives of the Scheme were to control the development of the land within Lami town, securing appropriate provision for traffic and transportation, disposition of commercial, residential and industrial areas, outline proper sanitary conditions, provision of public amenities and conveniences and recreational areas, marking of native reserved land, and creating suitable provision for the use of land for buildings or other purposes. The Lami Town Planning Scheme is attached as Appendix D.

## 2.4 Urbanization Trends & the Growth of Lami Town

Fiji's society is increasingly becoming more urban-based/urban-centred. Already, approximately half of the country's population resides in urban areas, which also produces about 60% of the national GDP. Urbanization can be seen in both a positive and a negative light; societies develop and in the process of doing so produce an increasing share of the growing national wealth, and in turn the increase in urban economic activities strengthens the development of rural economies by providing markets, agro-industrial production centres and trans-shipment points for rural produce. In this way, the development of urban areas provides beneficial changes in the production structure of a growing economy and is increasingly centred on secondary (industrial) and tertiary (services) sectors rather than the primary (agricultural) production sectors.

However, urbanization also leads to increasing pressure on local authorities and/or national governments to provide urban services such as infrastructure (local road networks), water supply, sanitation, garbage collection and disposal. Another significant problem faced by urban dwellers and their governments is the ability to acquire appropriate housing and access to land and urban services, and the financing of these. Additionally, despite the contribution of urban-based economic activities to economic growth, when unmanaged, urbanization usually has adverse impacts on both the environment and poverty; a good example of this is the growing number of under-served informal low-income settlements along the fringes of urban centres and Lami is no exception.

In Fiji's situation, the pressures of urbanizing have not been as severe or rapid as in other Pacific island countries that have limited land supply, high population growth rates and limited economic growth opportunities, all of which contribute to major urban management problems. However Fiji's urban population is growing at a rate of approximately 2% per year so urban issues are fast becoming unmanageable. On the other hand, because of the country's relatively small island economy coupled with special traits such as traditional land holdings, strong socio-cultural norms and values, and vulnerable eco-systems, Fiji still has some significant challenges to face in the wake of urbanization. Therefore improved urban management is needed along with the formulation of an effective and efficient urban development sector that is able to meet local, metropolitan and national needs.

Yet though urbanization continues, the rate of urban population growth has slowed considerably to a rate of less than 2% per annum. By contrast, population growth is higher in peri-urban areas than in incorporated town areas; between the census periods of 1986 and 1996, peri-urban population growth averaged 3.7% while incorporated town growth was drastically lower at 1.5%.

A major issue behind the low urban and national population growth rates is the rate of emigration from Fiji. Following the national census in 1986, the Greater Suva area (Navua-Lami-Suva-Nasinu-Nausori) comprised 63.1% of the national urban population. Ten years later the percentage of urban population contained within the Greater Suva area had dropped to 59.2%.

Lami town and its urban areas which include traditional Fijian villages[1] and their native reserves[2] are considered as an area which will absorb the urban overspill for the capital city, Suva, both in population and economic growth. The 2007 census reported an even distribution of population between Lami's Eastern and Western wards and the peri-urban area accounting for almost 50% of the total population. Assuming a 0.7% annual growth rate for Lami town (2007) indicates a 94 year doubling time. Lami's Eastern and Western wards have a 0.2% yearly growth rate while the peri-urban areas have the fastest growth rate of 1.4% as shown in Table 4 (below).

**Table 4 Projected Population for Lami Town & Lami Peri-Urban Based on 2007 National Census Data**

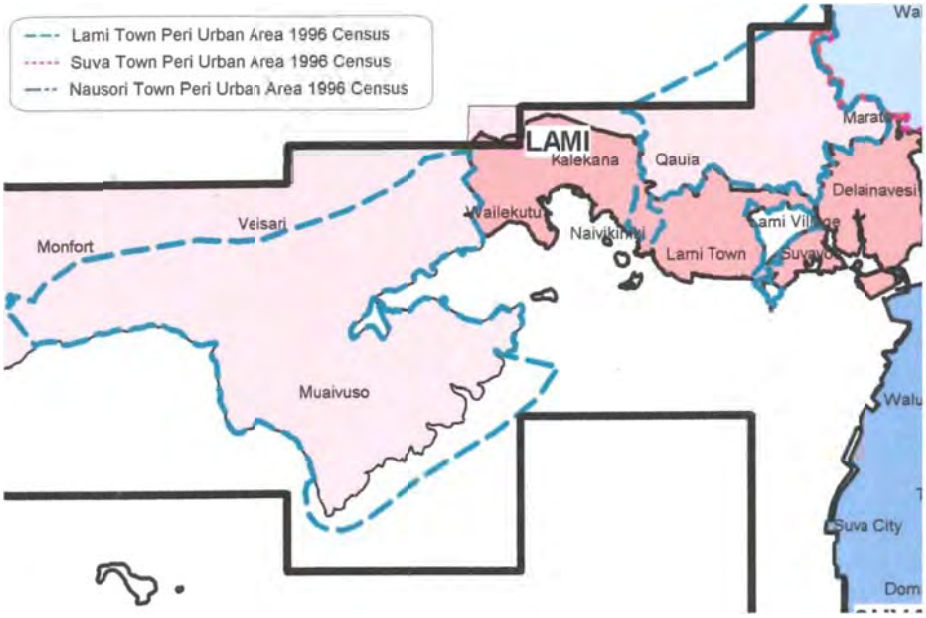
| | 2007 | Growth rate | Doubling time | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|
| **Lami All** | 20,529 | 0.7 | 94 years | 22,478 | 24,102 | 25,843 | 27,710 |
| **Town** | 10,752 | 0.2 | 417 years | 11,035 | 11,258 | 11,485 | 11,717 |
| **Peri-urban** | 9,777 | 1.4 | 49 years | 11,714 | 13,461 | 15,469 | 17,776 |

*Source: Bureau of Statistics, 2007*

[1] Villages of indigenous Fijians, or *i-taukei* – not formally defined by any legislation but recognised by institutions that manage indigenous affairs including TLTB, Ministry of I'Taukei Affairs, I'Taukei Affairs Board, Native Lands Commission & Ministry of Culture and Heritage.
[2] Native lands on which villages are situated.

Whilst Lami's peri-urban areas (as shown in Figure 7 below) are outside Lami's boundaries, people living in these areas use the services that are available within Lami and thus, results from the household surveys carried out within these peri-urban areas by the vulnerability and adaptation assessment team indicated that a considerable number of people living within Lami's peri-urban areas are also employed within Lami which means their livelihood is dependent on the resources and services within the Town. Additionally, peri-urban areas are also susceptible to projected climate change impacts for Lami, hence their inclusion in the Vulnerability and Adaptation Assessment.

Figure 7 Lami Peri-Urban Boundaries (Source: Urban Growth Management Plan (UGMAP), 2004)

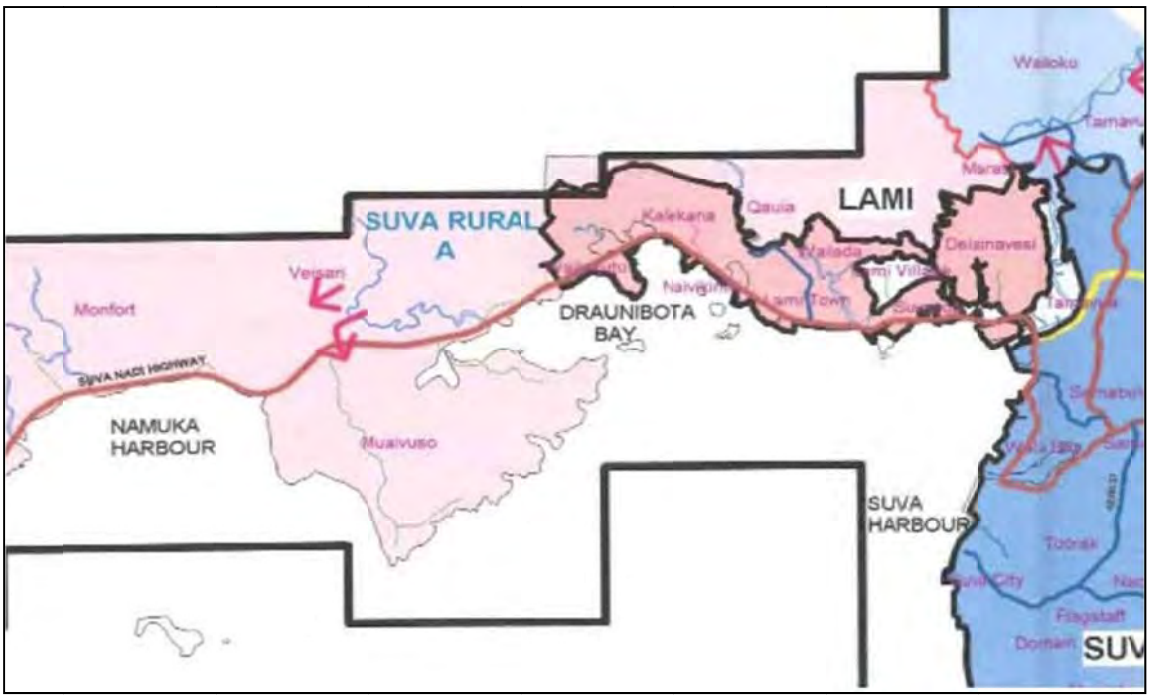



Growth in the urban areas of Lami has been at a much lower rate than that for the entire urban sector. The stagnation in the population growth rate may in part be attributed to the hilly topography within Lami town boundary's hinterland with relatively little scope for further extension inland. What growth has occurred is almost entirely in its peri -urban area (Census 2007).

The estimated contribution of the urban economy to national GDP in 2003 was approximately 60% compared to an urban population share of about 50%. Lami's economy predominately provides industrial processing and a range of financial, commercial and other services and provides market support functions for agriculture and marine based activities. Given the high unemployment rates recorded for the Lami area, there is a growing importance of the informal sector which includes small-scale and unregulated trading and manufacturing.

While this is no rapid growth within the Town boundary itself there remains an ever pressing challenge on improving land-use planning and management of the town and its immediate surrounding areas. Despite these areas following outside of its jurisdiction, Lami Town Council will need to take an active role in the management of land use and development in its peri-urban areas, particularly the areas towards Veisari and Muaivuso mainly because Lami's growth patterns are naturally inclining to go west towards Navua – the next Greater Suva Corridor as depicted in Figure 8 below.

Figure 8 Pattern of Urban Growth for Lami (Source: Department of Town and Country Planning, 2004)




According to the Urban Policy Action Plan (UPAP) Report (2004-5), the urbanisation and socio-economic trends were also resulting in poverty urbanising too. The UPAP Report stated that a 1997 interpretation by the UNDP of the 1990-91 HIES data indicated that 27.6% of the urban households had incomes below the then poverty line of F$ 100 per urban household per week. An updated urban poverty line estimate is F$ 147 per urban household per week in 2002. According to the 2002-03 HIES urban income distribution data, 29.3% of urban households had incomes below this income level. Comparable 1996 census and 2002-03 HIES urban unemployment data show that urban unemployment has increased by 122% in absolute terms, and from 7.8 % of the urban labour force in 1996 to 14.4% in 2002. In the greater Suva area the number of recipients of the Family Assistance Scheme has increased by almost 50% from 1998 to 2002. Thus, a sizeable and growing segment of the urban population suffers from one or more of the manifold manifestations of poverty.

The National Housing Policy (2011) reported the incidence of poverty has drecreased since 2002, yet remains high at 31 percent the population. It is important to note that urban poverty (19%) has decreased by the poverty in rural areas (43%) has grown significantly during the period. The Poverty and Household Incomes report for 2008-09[3] indicates that the national rural population declined for the two HIES of 2005-06 and 2008-09 while the urban population increased. The report also indicated that Total Household Incomes declined by 11% in rural areas and increased by 59% in urban areas, and that the Average Household Income declined by 14% in rural areas and increased by 26% in urban areas. According to the National Housing Policy, these indicators are signaling a potential for a higher rural-urban drift which would lead to serious implications on the already unsatisfactory housing conditions on the urban poor[4] as well as increased pressure on the already exhausted infrastructure services.

[3] Based on the 2008-09 Household Income and Expenditure Survey (HIES)
[4] Preliminary Report: Poverty and Household Incomes in Fiji in 2008-2009, September 2010

It is important to note that there is no specific socio-economic data available at the national level for Lami or any other town/city e.g. household incomes specific to local communities within towns/cities. However, the household surveys that were carried out during community consultations gave an indication of the types of incomes and livelihoods within several communities and the informal settlements as a whole. These are discussed more in Section 3.2.

## 2.5 Land Use and Tenure

Lami is a coastal town with hilly terrain and is characterized as an industrial centre. There are two[5] indigenous villages and several informal settlements[6] within the town boundary.

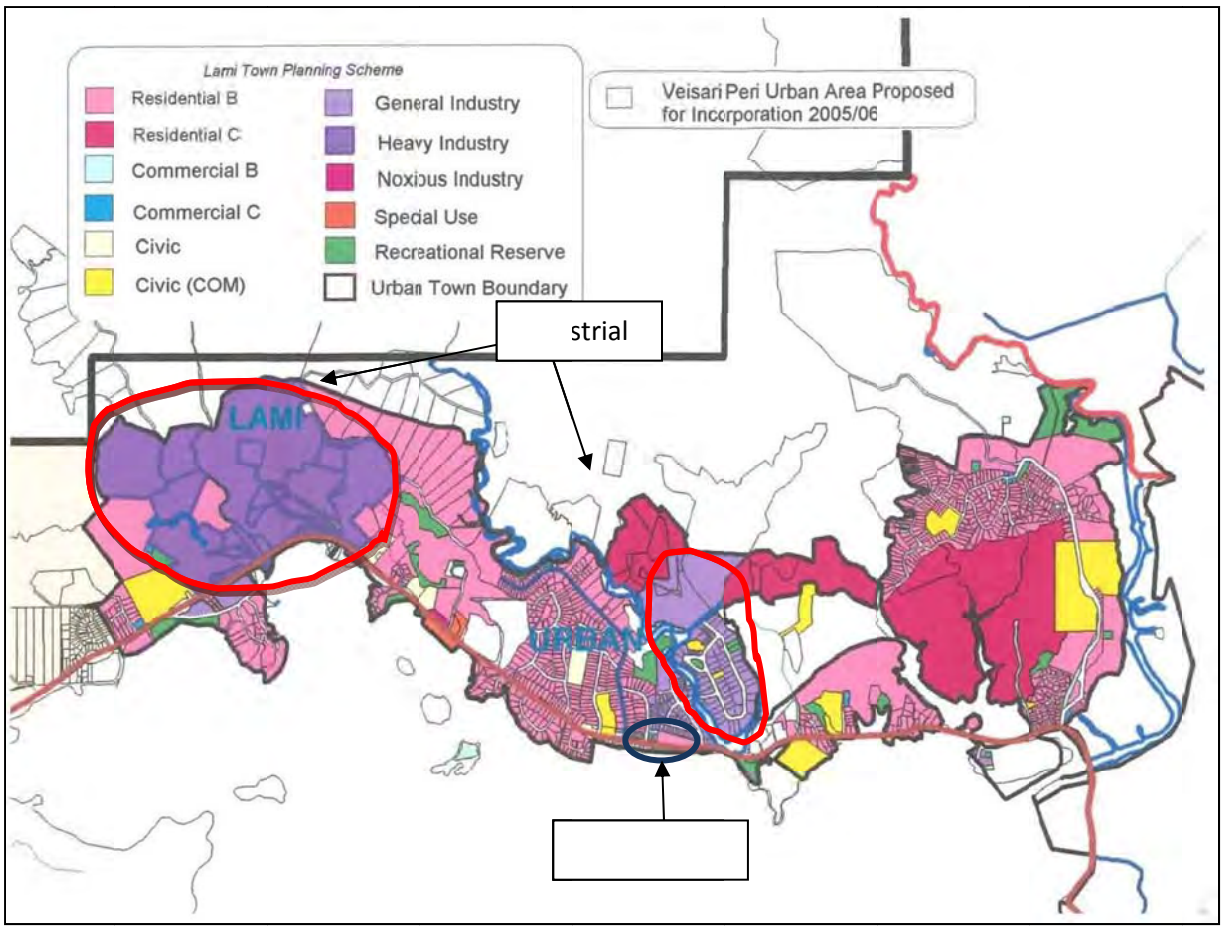
Figure 9 highlights the different land use areas within Lami identifying the locations of residential, commercial and industrial areas, as well as civic, recreation and special use areas.

Lami's commercial centre is a small area situated within the centre of Lami town which makes up only 4% of Lami's total land use. The town centre fronts onto a major (2 lane) national highway known as the Queens Road which links the Central/Eastern side of Viti Levu with the Western Division. Half of its town centre backs onto the coast line of the Suva Harbour including the Lami Town Council's Administration Office and Chambers.

The industrial zones in Lami are situated within both the Eastern and Western wards and comprise of 16% of the total land use in Lami. Whilst the industrial area in Eastern ward (namely Wailada and Nukuwatu industrial which are located within close proximity to the town centre) is zoned for General Industrial where operations such as warehouse, packaging, garment making and mechanical garages can be found, there are a number of Heavy Industrial operations also located within these areas including battery processing, paint making, gas and chemical storage and cement mixing plants. The industrial areas in the Western ward are zoned as both Heavy Industry and General Industry areas and are situated in the Wailekutu area and these include packaging, container yards and storage, and cement and fish processing factories, whilst a large portion of the industrial zoned land remains undeveloped. The industrial lands within Lami are mostly located on reclaimed mangrove swamp land adjacent and along the river flats and therefore, are subject to flooding and erosion of banks.

[5] There are two registered native *i-taukei or traditional Fijian* villages in Lami – Suvavou Village and Lami Village.
[6] Based on the UN-Habitat Programme definitions, an informal settlement within this Vulnerability and Adaptation Assessment is defined as 1) a residential area comprising of housing units that have been constructed on land that the occupants have no legal claim to, or which they occupy illegally; or 2) unplanned settlements and areas where the housing may not comply with planning and building regulations. The Vulnerability and Adaptation Assessment has identified 8 informal settlements within Lami that are deemed to be the most vulnerable to the impacts of climate change and natural disasters.

Figure 9 Land Use Map - Residential, Commercial, Industrial and Civic Use within Lami Town




*Source: Lami Town Planning Scheme, 2004*

The predominant land use in Lami is residential accounting for 74% of Lami's land use and these include both formal residential subdivisions and informal settlement areas that are found within Lami town and its peri-urban areas. The formal residential areas are either located on high ground inland though subject to landslides and erosion or along the coastal areas subject to inundation and coastal erosion. Whilst a significant proportion of the informal settlements can be found in low lying areas adjacent to nearby waterways and steep hills susceptible to flooding, erosion and poor accessibility to services.

Suvavou village and Lami village are native Fijian villages that are situated in Lami but are legally excluded from Lami town's proclaimed boundaries but still enjoy the services provided by Lami Town Council. Both villages are situated within the Eastern ward and to the east of Lami's commercial centre; Suvavou is situated along the coastal area though slightly elevated whilst Lami village is situated inland along a hilly area overlooking the Wailada industrial subdivision area.

Special Use & Civic zonings includes hotels, service stations, community services, public open spaces, recreational areas which comprises approximately 6% of total land use in Lami.

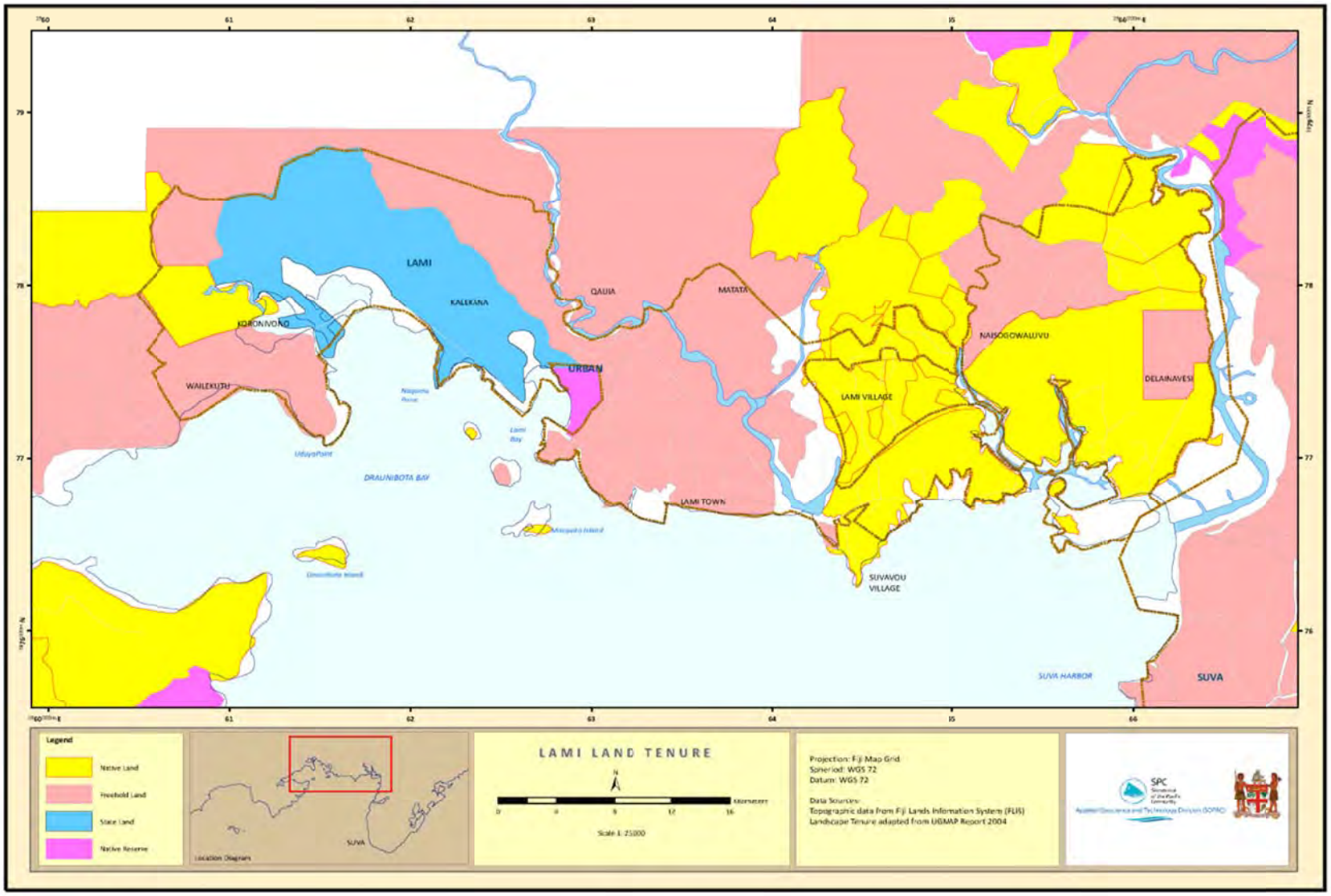
Table 5 Types of land use zoning within Lami and uses within each zone.

| Land Use Zoning | Uses | Percentage of total land use (%) |
|---|---|---|
| Commercial | - Retail & wholesale outlets<br>- Commercial offices<br>- Service Station | 4% |
| Industrial | - General Industry<br>- Heavy Industry<br>- Noxious Industry | 16% |
| Residential | - Residential subdivisions<br>- Informal settlements<br>- Native villages | 74% |
| Special Use/Civic | - Community Services ie. Police, Medical Centre<br>- Religious complexes<br>- Public open spaces and parks<br>- Recreational areas<br>- Hotel developments | 6% |

Section 3 of this report, will scope out the potential climate change hotspots within the various zones and uses including residential, informal settlements, industrial and commercial, civic and recreation, and infrastructure and public utilities.

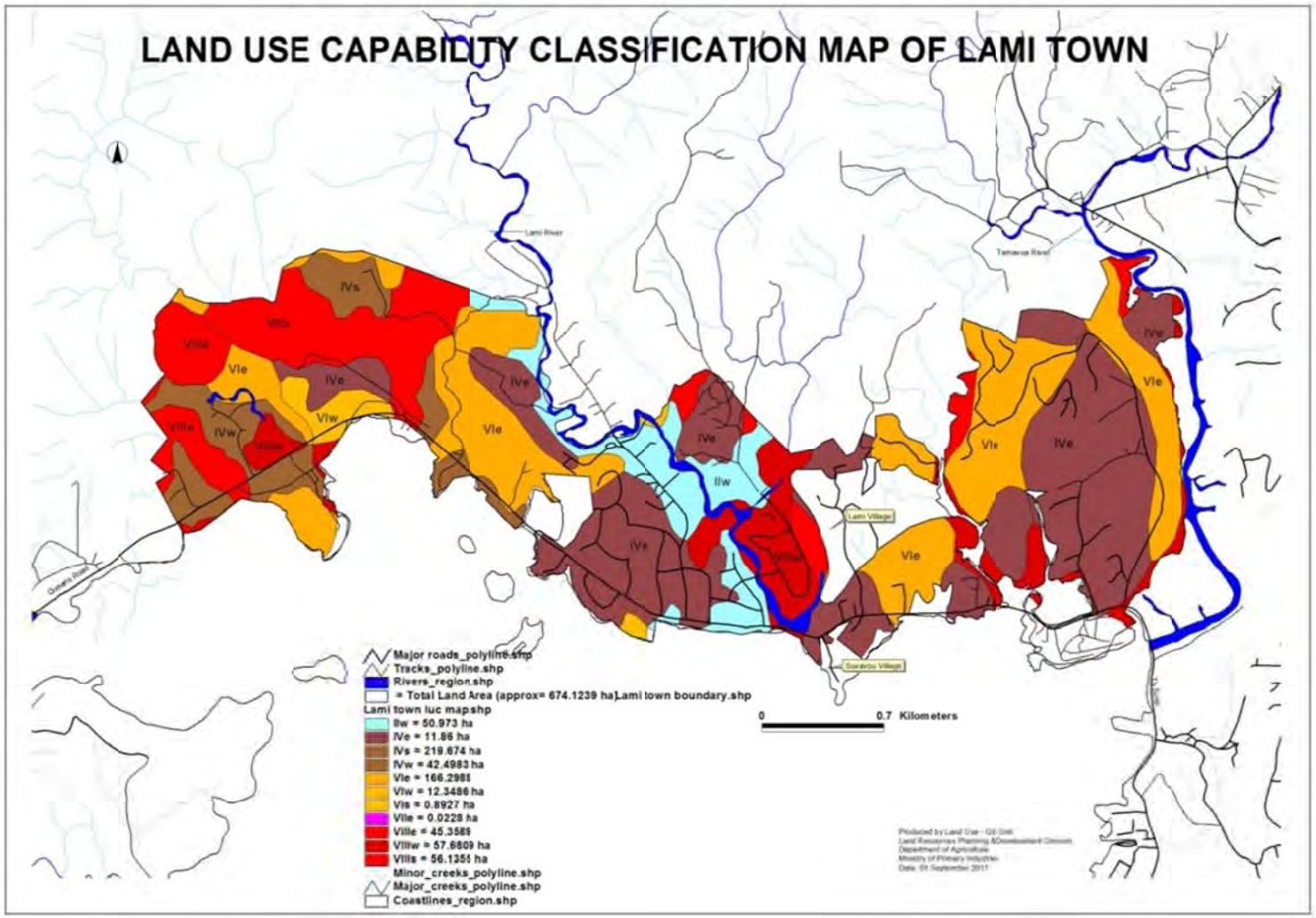
Lami's land tenure, as mentioned previously, consists of all three categories of land that make up Fiji's land tenure system: native and native reserve land (more than 51%), state land (21%), and freehold land (28%) as shown in Figure 10 below. Under this tenure system the Lami Town Council deals with the I-Taukei Land Trust Board (TLTB) for native lease land, the various traditional landowners for the native reserve land (although these lands fall outside of the formal town boundary), the Director of Lands for all State land and the individual private owners of the freehold land in Lami. In addition to this, the foreshore and mangrove areas including rivers and streams are all under the ownership of the State and therefore, use and development of these areas are controlled and managed by the Director of Lands.

**Figure 10 Land Tenure Map for Lami**




*Source: SOPAC/South Pacific Commission, 2011*

**Figure 11 Land Use Capabilities of Different Soils within Lami; (to be read in conjunction with Table below)**




*Source: Land Use Section, Ministry of Agriculture, 20*

**Table 6 Land Use Capability Classification Legend: Description of Different Classes of Land within Lami and their Recommended Uses**

| LAND CLASS | DESCRIPTION | MAP SYMBOLS |
|---|---|---|
| II | **Good Arable land**<br>Flat to gently undulating (0-7$^0$), deep fertile well drained alluvial and colluvial soils. Suitable for a wide range of crops or grazing.<br>Recommended use – wide range of crops like dalo, yams, vegetables, pawpaw, banana, vudi, etc or grazing.<br><br>Flat (0-30), deep well drained fertile, alluvial soil, which has slight to moderate risk of damaging floods. Suitable for wide range of crops or grazing | **IIw** |
| IV | **Marginal arable land**<br>Rolling land (12$^0$-15$^0$), deep to slightly shallow, moderately fertile soils well drained and highly – susceptible to erosion. Suitable for trees crops and subsistence cultivation using traditional methods of cultivation or grazing. Soil shallowness could be another limitation and would prefer a lot of soil enrichment or fertilize application to improve soil nutrients and fertility.<br><br>Recommended use – crops like yaqona, tree crops, cocoa, citrus, avocado pear, coconut, breadfruit etc. and subsistence cultivation of traditional root crops like dalo, cassava, etc. using traditional method of cultivation with good land conservation practices and regular application of fertilizers | **IVe + IVs** |
| VI | **Marginal grazing and forestry land**<br>Areas of steep slope (20$^0$-25$^0$), moderately shallow, well drained, infertile and moderate to severe susceptibility to erosion. Suitable for grazing or forestry. These can also be peat land or swamps due to its wetness and high water table.<br><br>Recommended use:-Grazing or forestry. | **VIe + VIw** |
| VII | **Land generally unsuitable for pastoral use but suitable for marginal forestry**<br><br>Areas of very steep slope (26-35$^0$+) very highly susceptible to erosion, infertile very stony and bouldery and best suited for marginal forestry or left alone in its natural state.<br><br>Recommended use:-marginal forestry or left alone in its natural state for catchment protection purposes. | **VIIe + VIIs** |
| VIII | **Land generally unsuitable for productive use in both agriculture and forestry**<br><br>Area of predominantly very steep mountain land mostly above an altitude of 2500 feet. This includes low land areas in unfavourable situations such as extreme erosion, highly susceptible to slumping or earth flow, included peat and mangrove swamps whose development is not likely to be economically feasible. The land is best protected and/or reserved for watershed and wildlife protection purposes, or left in its natural state untouched. | **VIIIe + VIIIs + VIIIw** |

*Source: Land Use Section, Ministry of Agriculture, 2011*

Notable from Figure 11 and Table 6, good arable soils in Lami are limited to low lying areas, flood plain areas along the Lami/Qauia River and the marginal arable soils are found in various clusters within each of the wards. Due to limited access to arable land for planting and the given the topographical

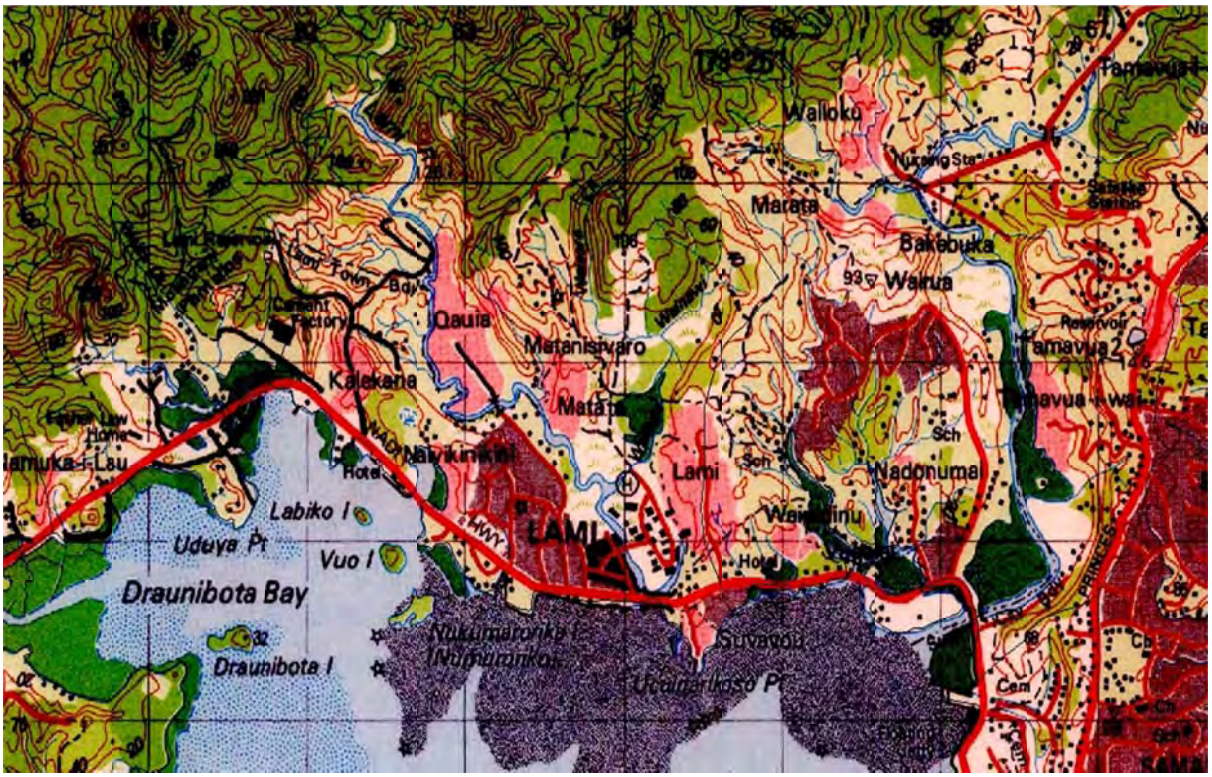
constraints of Lami, the local communities and settlements are often found clearing hills and slopes beside their homes for subsistence farming and as a source of income resulting in erosion and sedimentation of nearby waterways.

## 2.6 Physical Features

### 2.6.1 Topography

Lami is situated on undulating and hilly terrain (as shown in Figure 12 below) of Veisari Sandstone, Lami limestone and Suva Marls (see Figure 11 above). The Eastern ward consists of rolling hills that rise to over 75 metres high and flat land that is prone to flooding particularly along the Tamavua River. The Central ward has rolling hills that rise to over 75 metres in the Qauia Street area and Matata Settlement area. The Lami and Wailada river flats within the Central ward are also flood prone.

**Figure 12 Topographical Map for Lami**




*Source: Department of Lands, December 2005*

Inland the Western ward consists of steep and sloping terrain and with the exception of elevated areas at Naqumu Point and Uduya Point; the coastal areas along Queens Road are flat and interspersed with *tiri* (mangrove) vegetation and grass. By contrast the steep terrain, which is highly volcanic in nature, is characterized by dense rainforest.

Most of Lami's coastline comprises of flat land with some areas being slightly elevated e.g. Naqumu Point and some areas along the Marine Drive residential area and Suvavou Village. Reef systems include

a broad fringing reef and reef flat known as Namuka Reef that is situated immediately to the west of Suva Harbour, and the smaller Lami Reef located at the eastern end of the Namuka Reef complex (Atkinson and Collen, 2000). The two reefs are separated by a natural passage 20 – 30m deep known as Rat-tail Passage, and the eastern side of Lami Reef is marked by a natural deep-water channel into the Suva Harbour known as Daveta Levu. A smaller fringing reef is also situated along the coastline directly in front of Lami's commercial district. Other reef systems include the Suva Reef that borders the Suva Peninsula, and Nukuboca Reef that is situated adjacent to the Suva Reef and is in the Laucala Bay region of Suva (Atkinson and Collen, 2000).

### 2.6.2 Soils and Geology

Lami is dominated by Lami Limestone; the limestone horizon acts as a boundary between the Veisari Sandstone and the Suva Marl (Kailola et al, 2005). Additionally, the Lami Limestone overlies Veisari Sandstone which in turn overlies Vago Volcanics, and the last layer within the horizon is the Wainimala Group. Lami's eastern side has the Suva Marl overlying the Lami Limestone in some places.

Some parts of Lami, particularly along the peri-urban areas, also comprises shallow soils (nigrescent) or low fertility (humic latosols) soils on either rolling land with slopes of 12-15° that are highly susceptible to erosion, or on steep lands (21-25°) that are severely susceptible to erosion. Other parts of Lami consist of very steep mountainous land that is unsuitable for agriculture and forestry. Figure 12 below provides the different soil types within Lami.

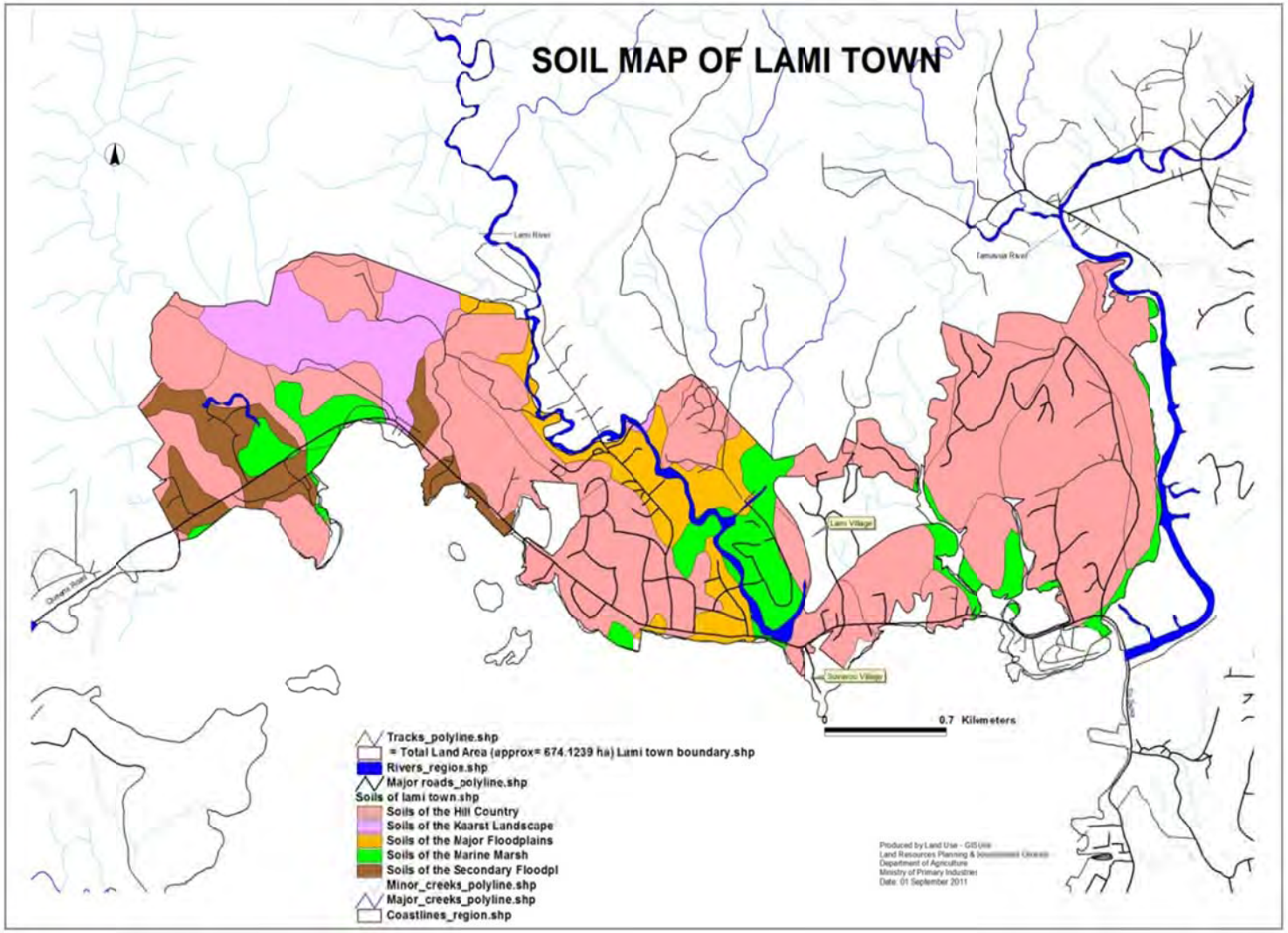
Parent rock comprises of raised indurated coral limestone and parent material consists of weakly weathered in situ rock. The slopes within Lami range from strongly rolling (16-20°) to moderately steep (21-25°) to steep (26-35°) and very steep slopes (>35°). Land elevation ranges from 10 – 150m above mean sea level. Soil permeability for Lami soils is moderate and there is the potential for severe sheet and rill erosion if forest vegetation is removed. Shallow landslides are common in the Lami area (as derived from Soil Taxonomic Unit Description Handbook, Leslie & Seru, 1998).

Soil profiles characteristically show 6 to 10cm of very dark grayish brown firm clay loam of weak medium nut structure, and slightly sticky and slightly plastic when moist, overlying 20cm of dark yellowish brown firm clay of weak medium nut structure, sticky and slightly plastic on very strongly cemented in situ limestone (Leslie & Seru, 1998).

Limitations of Lami soils include shallow profiles with the presence of surface and profile boulders, low potassium content and organic matter reserves, and the possibility of trace elements deficiencies and imbalances due to the slight alkalinity of soils (Leslie & Seru, 1998).

Vegetation mainly consists of light forest and subsistence gardens; soils are well drained and as mentioned earlier shallow landslips are common (Leslie & Seru, 1998). In residential areas land use mainly consists of housing and home gardening. Soils suitable for agricultural use vary between good arable land that can be used for a wide variety of crops to marginal arable land that requires proper drainage prior to agricultural use (refer to Figure 11 and Table 6).

**Figure 12 Different Soil Types within Lami**

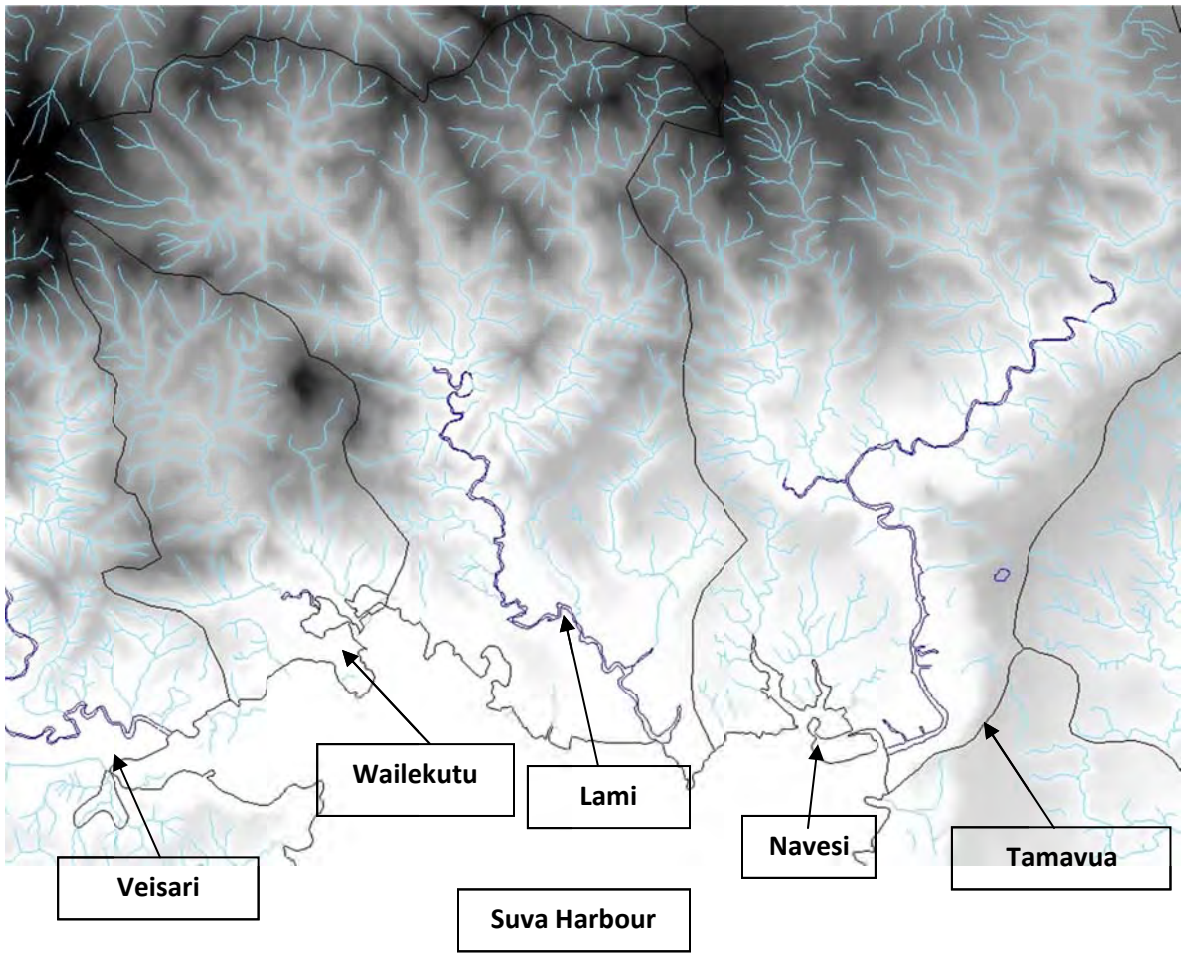



*(Source: Land Use Section, Ministry of Agriculture, 2011)*

### 2.6.3 Coastal River Systems

Coastal river systems within Lami include the Veisari, Wailekutu, Lami, Navesi and Tamavua rivers as shown in Figure 13 below. There is limited historical river flow modeling data found for any of these rivers within Lami, however, there has been some preliminary estimation on flows for the Lami River and a Hydraulic Study of the Suva Harbour as part of the Rokobili Port Development Environmental Impact Assessment (EIA) Report that was undertaken by Beca Pty Limited[7] for Fiji Ports Authority in 2005 which was submitted to Department of Environment for their approval.

**Figure 13 River Systems in Lami**




*Source: SPREP, 2011*

[7] Beca Pty Ltd is an Australian engineering and environmental services consultancy firm that provides engineering, project management and valuation services applied to industry, buildings, transport, environmental and management services. For the Rokobili Project, Beca were the appointed Engineers and Environmental Impact Assessment (EIA) Consultants engaged by the Fiji Ports Authority.

The Beca (2005) study indicated that river flows were considered minor in terms of overall flow circulation in the bay but they were included in the hydraulic model because of their importance for sediment inputs to the bay which were considered significant. For the purpose of the harbour sedimentation model, the study assumed that a single peaked storm event every five days would approximate typical runoff conditions for the catchments. A volumetric runoff coefficient of 60% was used which was considered reasonable at the time for a relatively undeveloped catchment. Storage within the catchments was also not considered. The assumed peak flows for the five rivers used in the flow model by Beca can be found in Table 7 below:

**Table 7 Peak River Flows for River Systems in Lami (as assumed for Flow Modeling by BECA for Hydraulic Study for Rokobili Port Development)**

| River Catchment | Catchment Area | Peak Flows |
|---|---|---|
| Tamavua | 26km² | 15m³/s |
| Lami | 20km² | 12m³/s |
| Navesi | 3.5km² | 2m³/s |
| Wailekutu | 8km² | 4m³/s |
| Veisari | 33km² | 19m³/s |

*Source: Beca, 2005*

However, the above flows rates had not included other stormwater catchments within the Lami urban areas which are also considered to be significant in terms of increased river flows and its effects on bank over-topping, flooding, bank erosion and sedimentation/siltation of the river system. Nor has these flows accounted for the impacts of any development activities in the upper catchment area including deforestation and logging of forest reserves.

The Lami River was recently assessed by the Department of Drainage & Irrigation after complaints were lodged to the Ministry of Local Government & Lami Town Council by residential property owners along the Lami River bank in Qauia. These complainants had reported that the boundaries of their properties that abut the river banks had been eroding into the river for some years now and that there was serious concerns that some of their building structures were at risk also. The outcome of the assessment revealed options of constructing revetment walls and also the option of dredging the river as well as diverting the river at a certain location to avoid further erosion of the banks and the loss of houses and private properties along the bank. The complainants believed that these works should ultimately be the responsibility of Lami Town Council to address as the river bank reserve that was a requirement of the subdivision when it was approved was to be maintained by LTC but has since eroded into the river.

A detailed hydraulic assessment of the Lami River should be undertaken to ascertain the peak river flows particularly during heavy rainfall and storm events. This assessment should also include a review of the landuse in the upper catchment of Lami River to identify the impacts and issues that may be contributing to the changes in the River dynamics and thus require effective strategic landuse planning of the upper catchment areas. All this data should then be used to undertake a cost benefit analysis of the recommended options (ie. River diversion, dredging and river bank protection as well as planting of river banks vegetation) to carefully assess and ensure that the option(s) selected will have long term benefits rather than negative impacts downstream particularly on other properties and communities along the river banks, including the Wailada Industrial area and public infrastructure assets, like bridges, existing revetments, stormwater drains, roads and service reticulation and plants.

With regards to the sedimentation of the five rivers in Lami, there was also no bathometry data found to establish the changes in depth of each of the rivers over time and also no data was available to accurately quantify the sediment yield from the five river catchments in Lami entering the north of the Suva Bay. Beca's Hydraulics Report for the Rokobili Port Development (2005) for the purpose of their study estimated the sediment yields for these five rivers based on published studies of sediment yields from the Rewa River catchment and therefore used the following estimated sediment yields in Table 8 for their hydraulics model of the Suva Harbour.

**Table 8 Estimated Sediment Yields from Five Rivers Catchment in Lami (as assumed for Flow Modeling by BECA for Hydraulic Study for Rokobili Port Development)**

| River Catchment | Sediment Yield (tones/year) | | |
|---|---|---|---|
| | Sand | Mud | Total |
| Tamavua | 18,200 | 72,800 | 91,000 |
| Lami | 14,000 | 56,000 | 70,000 |
| Navesi | 2,520 | 10,080 | 12,600 |
| Wailekutu | 5,600 | 22,400 | 28,000 |
| Veisari | 23,100 | 92,400 | 115,000 |

The sediment river loads are expected to be dominant sources of sediment to the Suva Bay, with 80:20 mud to sand ratio found in the Suva Bay particular as you move into greater depth of water. This reflects that the sand sized sediments tend to settle near the river mouth while mud sized particles are transported further afield, tending to settle in deeper water potentially affecting the marine and reef ecosystems as well as potentially affecting the coastal processes of the Bay area over time. This demonstrates that the river flows largely contributes to the sedimentation loads experienced along the coast waters near river mouths and therefore, the river catchment areas should be carefully monitored in terms of land use and deforestation.

### 2.6.4 Coastal Processes

The coastal processes within the Suva Bay area can be explained as being a low wave energy environment as the coral reefs act as a filter to incident ocean swell though waves greater than 0.5 metres being experienced are generally associated with storm events (Kench, 2005). According to Kench (2005), the filtering property of the barrier reef implies that waves in the harbour are controlled by local wind generation in fetched-limited setting therefore under such conditions wave heights are expected to be small.

However, a recent report prepared by the Department of Fisheries (2011) has revealed that a total of 117, 325 metric tonnes of both dead and live Porites coral are harvested off the Suva reef system for sale. These Porites boulders are commonly used for the construction of septic tanks; this practice dates back to 1965 under the Suva City Council regulations. According to the Department of Fisheries 2011 survey, harvested coral is sold along the Suvavou road in Lami and out of the eleven collectors interviewed by the Department of Fisheries, four had expired licenses while seven were collecting and selling coral without any license at all. This practice has been strongly recommended to be banned as it is a highly destructive activity that is destroying the reef system and structure, reducing the reef biodiversity and nursery area (affecting the fisheries productivity). It is likely to have a long term impact on the sea levels and wave energy recorded in the Bay area for Lami as a diminished reef system is unable to break the waves particularly during storm events.

The increase in the sea levels and wave energy experienced along the coastline in Lami and river mouths is a cause for concern with regards to wave overtopping[8], salt water intrusion affecting vegetation and crops, coastal erosion and further sedimentation of the foreshore area. The removal and damage to mangroves along the shoreline will exacerbate these concerns and future development of the foreshore areas, in particular major reclamation of land within the bay area, should be carefully considered as this could significantly change the coastal processes of the Suva bay and potentially accelerating these effects of climate change.

The water-level records often change according to seasonal, annual and inter-annual changes, which in turn result from both astronomical and climatic (e.g. ENSO) influences (Solomon and Kruger, 1996). Recorded levels within the Suva Harbour showed no trend until approximately 1987 and then increased rapidly until the early 1990s when a drop in sea levels occurred. Studies indicated that sea-level has been rising at a rate of 7.4mm $a^{-1}$ over 20 years, and with a correlation coefficient of approximately 0.5 (Solomon and Kruger, 1996). The rate of sea-level rise is considered to be very high compared to Pacific averages of 2mm $a^{-1}$ and should therefore be used as a basis for extreme cases of sea-level rise. Scenarios for future sea level rise in Suva Harbour were chosen based on past trends of sea-level rise and estimates of projected global sea-level rise as provided by the United States Environment Protection Agency (US EPA).

[8] the amount of water flowing over the crest of a coastal structure e.g. a seawall, a dike, a breakwater, or a revetment wall, due to **wave** action

Therefore the following four sea-level scenarios were evaluated by Solomon and Kruger:

- Present
- +0.25 m
- +0.50 m
- +1.00 m

Based on these Accelerated Sea Level Rise (ASLR) scenarios, storm surge water levels with varying return intervals were calculated and compared to the mean (average), maximum and minimum shoreline elevations at each site where the elevation was measured, including Lami. However the study carried out by Solomon and Kruger in 1996 does not indicate specifically the areas in Lami where the elevations were measured.

**Table 8 Storm-surge water levels in Lami for 2, 5, 10, 25, and 50 year storm return intervals (RI) Source: SOPAC Technical Report 242, Solomon and Kruger, 1996**

| Return Interval (RI) | Shoreline Elevation (m) | | | Present Water Level | 0.25m ASLR | 0.5m ASLR | 1m ASLR |
|---|---|---|---|---|---|---|---|
| | Minimum | Mean | Maximum | | | | |
| 2 year RI | -0.33 | 1.00 | 1.66 | 1.03 | 1.28 | 1.54 | 2.04 |
| 5 year RI | -0.33 | 1.00 | 1.66 | 1.22 | 1.47 | 1.72 | 2.23 |
| 10 year RI | -0.33 | 1.00 | 1.66 | 1.36 | 1.61 | 1.87 | 2.37 |
| 25 year RI | -0.33 | 1.00 | 1.66 | 1.62 | 1.87 | 2.12 | 2.62 |
| 50 year RI | -0.33 | 1.00 | 1.66 | 1.87 | 2.12 | 2.37 | 2.87 |

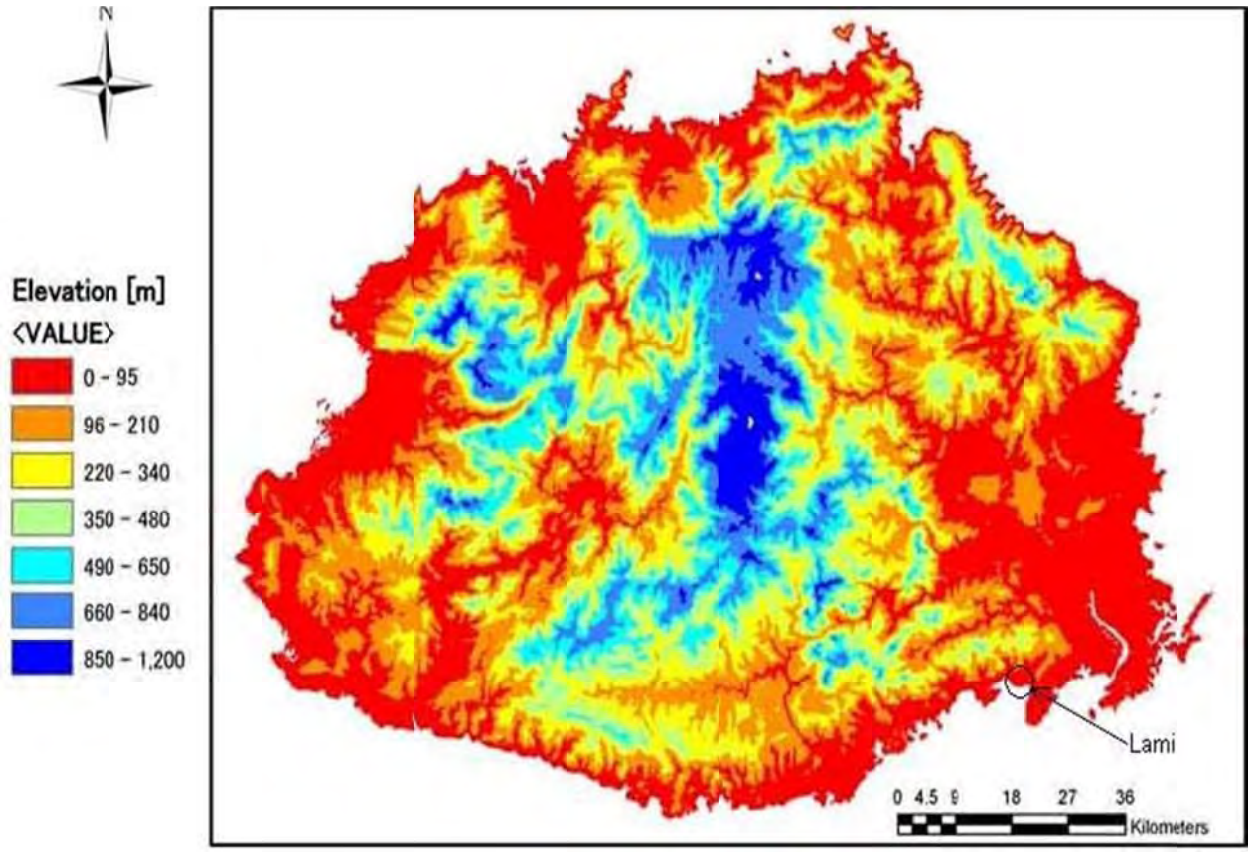
Note: Dark shading indicates storm-surge water levels exceeding maximum shoreline elevations, while light shading indicates overtopping at minimum elevations and medium shading indicates overtopping at mean elevations

Table 8 indicates that at present water levels there is only the possibility of storm-surge levels exceeding the maximum shoreline elevation of 1.66m following a 50-year return interval, and overtopping occurring at average elevations during 2 – 25 year return intervals. However under predicted ASLR, the possibility of storm surges exceeding maximum shoreline elevation increases with increases in sea levels.

Sea levels in Suva and the Rewa Delta are increasing and will have an effect on flooding patterns and extreme storm surges along the Suva Peninsular and Rewa Delta areas (KBR 2011:11). The KBR report's analysis of a digital elevation model of Viti Levu (see Figure 14) highlights areas of low elevation at risk of sea level rise that is, Viti Levu's coastal areas including Lami. The model identifies many of the main island's tourism establishments located within areas most vulnerable to sea level rise and storm surges including coastal towns and cities, human settlements (including native villages) and industries. Viti

Levu's two main highways, the Kings and Queens Roads, and their associated bridges are all susceptible to coastal erosion and inundation as they run parallel to the Island's coastline.

**Figure 14 Digital Elevation Model for Viti Levu (indicating areas of low elevation which are susceptible to sea level rise)**

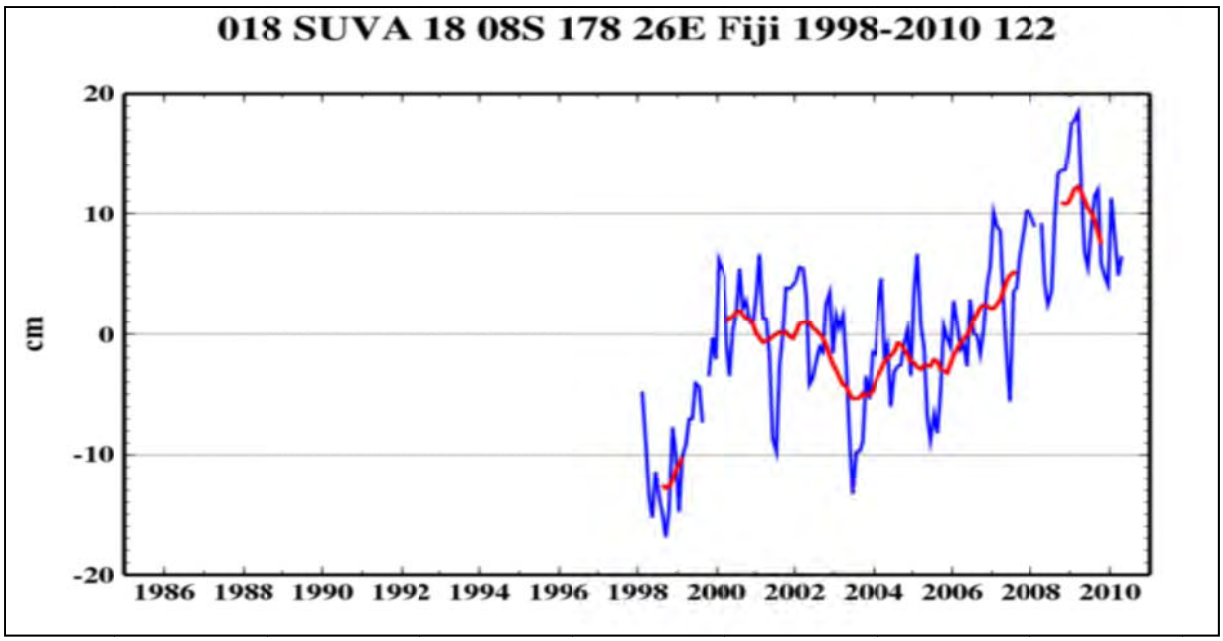



*Source: Gravelle et al. (2008) in KBR Inception/1st Progress Report, 2011*

The University of Hawaii Sea Level Centre (UHSLC) has operated and maintained a water level recorder in Suva Harbour since 1972. Data retrieved from the recorder ( Figure 15 below) indicates that there has been a marked increase in mean water levels, but extrapolating a medium term trend using data retrieved from the recorder may be imprecise as there are considerable gaps in the data (KBR Report, 2011). Despite these limitations, the data reveals important short-term traits of sea levels in Viti Levu such as strong seasonal fluctuations of 10 – 15 cm, and longer and larger inter-annual fluctuations in water levels of ±0.25m that may be coinciding with the timing of ENSO events.

Recorded data further indicated higher water levels between 1989 and 1994, with some sea level increases being cyclone induced e.g. during Cyclone Kina in 1993, which recorded water levels of more than 1m above the mean datum. The KBR Report (2011) notes that during high tides with sea levels of 1.15m above the current mean, approximately 1.13% of Fiji's land area will suffer inundation for at least a one hour period.

Figure 15 Water Level Plots for Suva for the Period 1998 – 2010 Showing a distinct increase in Mean Water Level




*Source – UHSLC in KBR Inception/1st Progress Report, 2011*

Historical reports have noted that anticipated climate changes over the 100 year period of 2001 – 2100 includes sea level rise of 10.5cm by 2025 and 49.9cm by 2100 when using midrange scenarios; however if basing the increase in sea levels on higher greenhouse gas emissions, it is anticipated that sea levels levels will rise to more than 20cm by 2025 and 1m by 2100 (Feresi et al., 1999, cited in KBR Inception/1st Progress Report, 2011: 18).

Whilst, sea level rise is anticipated over time it is inevitable and will have significant environmental and economic implications for Lami Town and its peri-urban areas because of its coastal nature and geographical location. Furthermore, its commercial and industrial areas are situated on flat reclaimed lands adjacent to coastal areas and rivers, and similarly its residential and densely populated settlements are also located in these vulnerable areas and are therefore also considered at risk to the effects of climate change.

### 2.6.5 Climate

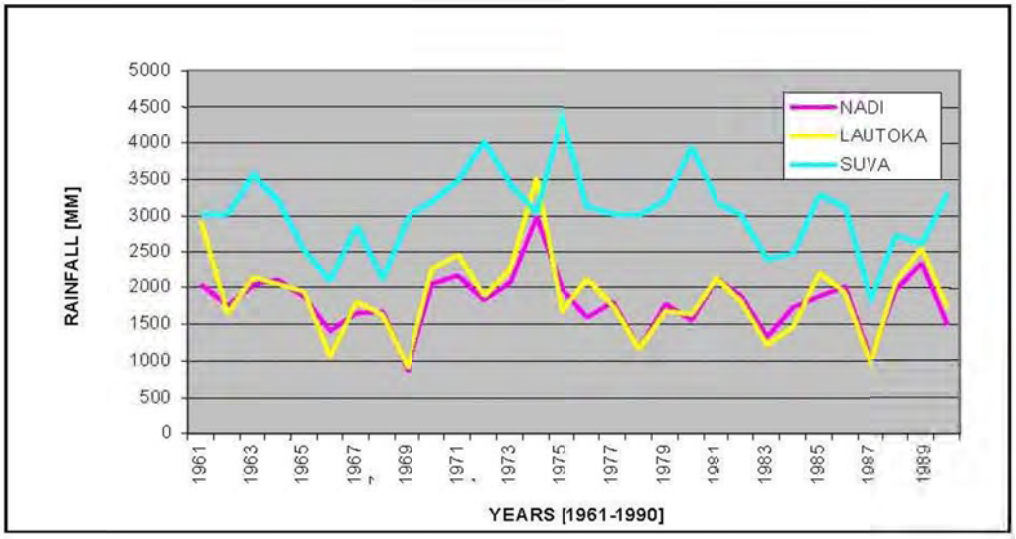
The climate data for this report was obtained for a variety of sources including the Fiji Meteorological Department. The closest meteorological station to Lami is Laucala Bay which is located across the Suva Harbour south-east of Lami Town. Nevertheless, the meteorological data is considered relevant for the purpose of this study as no other specific climate data was available for Lami. The Fiji Meteorological Unit's rainfall gauge at the Fiji Industries Cement Factory, Wailekutu has not worked since 2008 so rainfall data specific for Lami is not available. There is also information available about climate variability that provides generalities about the country climate but again no specific city climate variability data for Lami. The Fiji Meteorological Department had indicated that they could make inferences of the Laucala Bay meteorological data that was specific to Lami generalizing the difference

of Lami's weather conditions to that of Laucala Bay's data but this information was not forthcoming at the time of preparing this report.

### *2.6.5.1 Rainfall*

Fiji's wet season is generally from November to April with a dry season from May to October. Lami Town and Suva City experiences more rain than the distinctly drier western side of Viti Levu. Figure 16 provides a 30-year climate baseline for Viti Levu and indicates that higher levels of rain are experienced by the Greater Suva area compared to the western regions. The monthly average rainfall levels indicate relatively higher levels of rainfall in Suva compared to Lautoka and Nadi, except for January and February when the latter two urban centres experience higher rainfall levels.

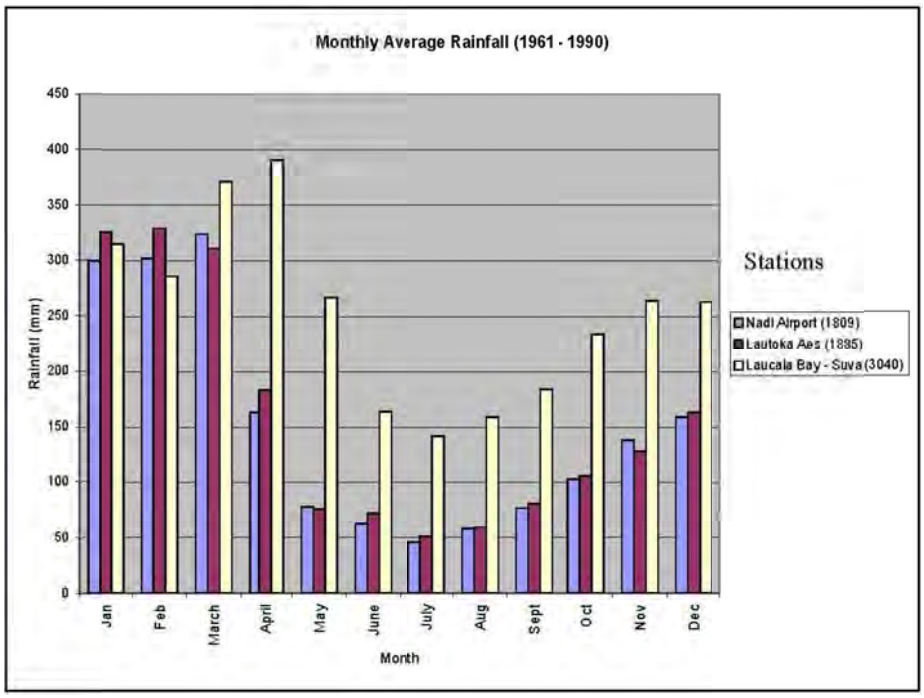
**Figure 16 Rainfall Pattern for Viti Levu over a 30-year Period (1961 – 1990)**




*Source: Fiji First National Communications, 2005*

Suva's wet season makes up about 53% of its total annual average rainfall of 3041mm (Figure 17). In the wet season rainfall varies between 264mm – 390mm per month, and localized flash flooding can occur quite often. The dry season averages rainfall of 142mm – 267mm (cited in Atkinson and Collen, 2000: 16). The Greater Suva area experiences rainfall on an average of 15 days every month and during cyclones continuous downpours of heavy rain is usually experienced. The high levels of rainfall has consequences for Suva Harbour and the coastal river systems as outflows from rivers, stormwater drains and runoff from land, together with high tides often result in flash flooding events along the river flats and coastal areas. Poorly maintained stormwater drains and sedimentation in rivers and streams are a contributing factor to accelerating the flooding effects along low lying areas during heavy rainfall periods. Lami is no exception to these events and the Lami Town Council staff has started to keep records of these events for future analysis of their frequency and degree of its impacts towards the local communities as well as its shorelines, river banks and infrastructure.

Figure 17 Monthly Average Rainfall for Viti Levu over a 30-year period (1961 – 1990)




*Source: Fiji First National Communications, 2005 (Atkinson and Collen, 2000)*

The Water Authority of Fiji (WAF)'s rainfall data in Table 9 was collected from the Savura Creek pumping station in Wailoku along the Tamavua River which is closer to Lami Town boundary than the Laucala Bay station.

Table 9 Annual Rainfall Data for the Wailoku Area for 2000 – 2010.

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total (mm)** | 3758 | 3483 | 4816 | 3176 | 3832 | 4662 | 3897 | 4114 | 4017 | 3677 | 1821 |

*Source: Water Authority of Fiji (WAF), 2010*

Table 9 depicts the last decade's recorded in Wailoku rainfall levels higher than the Greater Suva area's average annual rainfall levels of approximately 3041mm, with the lowest rainfall level (3176mm in 2003) still been higher than the Greater Suva area average. The 2010 rainfall level of 1,821mm is low in Wailoku is due to the fact that the Table 8 data was issued in September 2010 and does not include the total rainfall for the year.

Annual average rainfall for Lami ranges from 3,000 – 5,000mm. During the dry season of May to October rainfall ranges from 800 – 1,800mm and during the wet season of November to April rainfall ranges from 1,800 – 2,800mm (Leslie and Seru, 1998). Ideally, Lami Town Council should lobby the Fiji Meteorological Department to fix the range gauge at the Lami Cement Factory site or arrange to have it relocated to Lami Town Council's office to enable the Council to monitor the gauge on a daily basis to

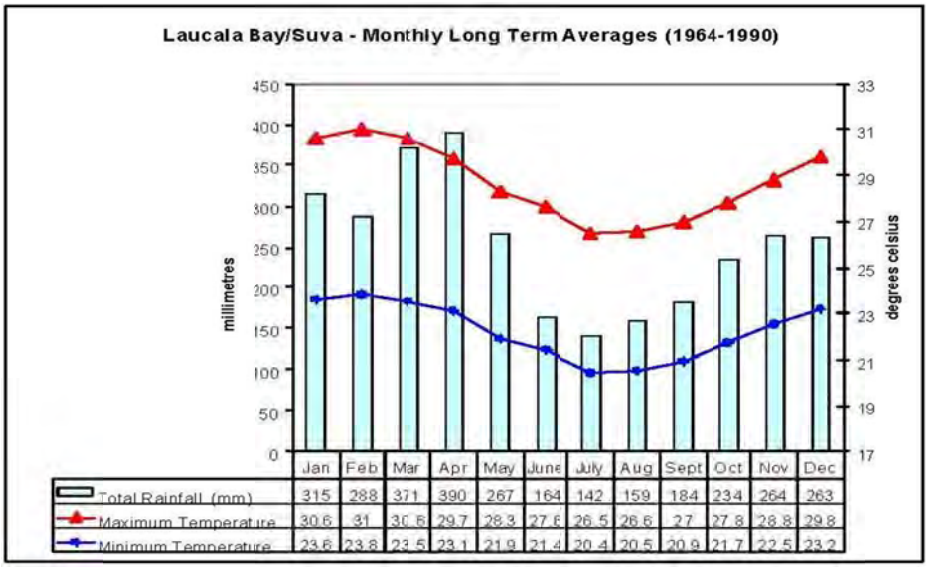
ensure it gets reliable and specific rainfall data for Lami's situation which seems to be higher than that gathered for the Greater Suva area.

### *2.6.5.2 Temperature*

Fiji has a warm tropical climate with maximum temperatures ranging between 26°C - 31°C year round. Changes in daily and seasonal temperature are minimal with average temperatures changing about 2°C - 4°C between the coolest months of July and August, and the warmest months of January and February (Fiji Meteorological Service, 2011). Coastal areas have recorded average night-time temperatures as low as 18°C and average day-time temperatures as high as 32°C.

Southeastern coastal areas like Lami experience constant cloudy and humid weather. Mean annual temperatures for Lami have been recorded to be 24°C (Leslie and Seru, 1998). Again, the Fiji Meteorological Department had acknowledged that there is likely to be a difference in the temperature and rainfall patterns between Suva and Lami but there was no specific recorded data to demonstrate this difference as it would need to be specifically analyzed. However, in our consultations with various residents, community members and LTC, it has been observed that Lami's weather patterns are often different to Suva's and therefore, the weather bulletin that is released for Suva may be unreliable for Lami as noted by the community members in Naisogowaluvu. This difference in temperature and rainfall patterns and the lack of specific data for Lami makes recording the changes in climate and determining projections difficult.

**Figure 18 Climate Data for the Suva - Laucala Bay Area Showing Monthly Long Term Averages for Rainfall and Temperature Data during the Period 1964-1990**



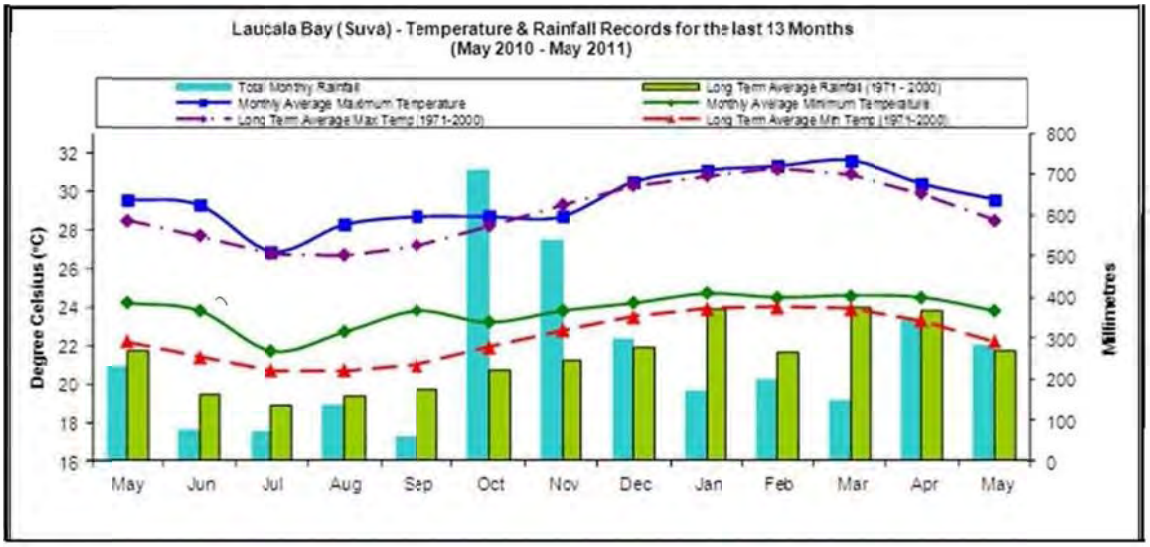

*Source: SOPAC Technical Report 324, 2000 (Adapted from Fiji Meteorological Service data)*

The Fiji Meteorological Services used average climate conditions over a 30-year period (1971 – 2000) to provide the baseline for Fiji's 'normal climate' (Fiji Meteorological Services, 2011). However, as shown in Figure 18 for Suva-Laucala Bay Area, the monthly average rainfall over a 30 year period is 253mm of

rain, with the maximum average monthly temperature of 28.7 degrees celsius and the average monthly minimum temperature recorded was 22.2 degrees celsius.

From May 2010 to May 2011, hotter than normal daytime temperatures were experienced with temperatures averaging 30°C in Suva with lower than normal rainfall levels (except for October and November 2010 and January 2011 that experienced extremely high/higher than normal rainfall levels. Maximum daytime temperatures sometimes rose to 33°C, especially in coastal areas, while inland and highland areas experienced milder temperatures. Daily temperatures in the Central Division ranged from 26.4°C - 32°C (Figure 19).

**Figure 19 Temperature and Rainfall Records for the Suva Area May 2010 (Fiji Islands Climate Summary – May 2011)**




*Source: Fiji Meteorological Services, 2011*

Atkinson and Collen (2000) noted that daily temperature variations are more significant than seasonal variations as maximum temperatures can vary by 4.5°C throughout the year but daily temperatures can vary between 6°C - 7°C.

Feresi et al. (KBR Inception Report, 2011:17) noted in the Climate Change Vulnerability and Adaptation Assessment for Fiji that anticipated climate change over a 100 year period from 2001 – 2100 includes an increase in temperature (using midrange emissions scenarios) by 0.5°C by the year 2025, and that this figure would increase to 1.6°C by 2100. Applying higher emissions scenarios, temperature increases in Fiji would be 0.6°C by 2025 and 3.3°C by the year 2100 (KBR Inception Report, 2011:17). This increase in temperature for Lami could increase energy demands, affect subsistence food supply, increase risk of diseases and increase the risk of coral bleaching affecting fisheries resources which the locals are dependent on for their livelihoods.

### *2.6.5.3 Wind*

Wind speeds are found to be low and changeable in direction during the wet season, with the occasional development of squalls; high winds and heavy downpours are more commonly felt during storms, low

tropical depressions and cyclones (Atkinson and Collen, 2000). Most of the areas in Lami are subject to the south east trade winds and therefore, during stormy periods these winds together with the heavy rain showers can often cause significant damages and risk to the built environment that house the local communities, residents and businesses particularly along the coast line and on the elevated lands. Poorly constructed houses and buildings particularly within the informal settlements are more susceptible to significant damage during high wind events such as cyclones. Increased saltwater sprays carried by winds also affect the structures within coastal areas as it increases the effects of corrosion and strong winds also significantly affect wave action causing significant coastal erosion. The only partially protected coastal area in Lami observed is the Bay of Islands area known as Draunibota Bay, where boats and ships are often found moored and sheltered during stormy and tropical depression events.

## 2.7 Extreme Events

### 2.7.1 Tropical Cyclones

Tropical cyclones occur between November to April, with the greatest frequency during January and January and February. This entails strong winds, elevated sea levels and very heavy rainfall causing intense and swift changes to shallow reef flats, coastal inundation and rapid coastal erosion. Cyclones affect Fiji at an average rate of 10 – 15 cyclones per decade; out of these numbers 2 – 4 cause severe damage (Atkinson and Collen, 2000:18). Very high rainfall and wind speeds are characteristic of cyclones, which rely somewhat on sea-surface temperature, indicating that El Nino-Southern Oscillation (ENSO) events and global temperature changes could affect the frequency, intensity and location of formation of cyclones (Solomon and Kruger, 1996).

Flooding of rivers and stormwater drains and increased runoff from land are also a common occurrence during cyclones, and may contribute to the effects on the reef (Atkinson and Collen, 2000). Fiji's Initial National Communication Report (2005) notes that flooding and numerous landslips caused by cyclones have significant impacts on Fiji's economy and infrastructure as well as having many negative effects on the population including damage to properties, increased health risk as a result of contamination to water sources as a result of infiltration of wastewater from septic tank systems thus, causing exposure and spread of water borne disease and loss of life.

The joint research report by the University of the South Pacific (USP) and the Secretariat of the Pacific Community Applied Geoscience and Technology Division (SOPAC) in 2005[9] noted the insufficient data available on floods and their impacts in Fiji (and Lami area), with estimates of flooding impacts being derived from the cost of damage to physical infrastructure; and highlighted improvements to disaster assessments in Fiji by including indirect and long-term impacts. The National Disaster Management Office (NDMO) has identified the major disasters in Fiji from 1985 to 2010 and the associated deaths and affected populations as well as estimated costs of damages, and is provided in Appendix E.

[9] *'Economic Impacts of Natural Disasters on Development in the Pacific – Vol.1'*, Australian Agency for International Development (AusAID).

In the past three years (2008 – 2010) Fiji has been hit with 3 major cyclones; Cyclone Gene (2008), Cyclone Mick (2009) and Cyclone Tomas (2010).

There is no cyclone data available specifically for Lami, but this is not to say that Lami does not sustain damages during cyclones. Community surveys have identified that the Lami Town Council (LTC) and/or the National Disaster Management Office (NDMO) have not identified for residents any specific evacuation centres or points within Lami, but several communities have prepared their own evacuation plans in the event of natural disasters occurring. These community efforts will need to be coordinated by LTC and NDMO together with other communities in order for these evacuation plans to be effective.

Several seasonal forecast schemes have been created and implemented over the past three decades that use both dynamic and statistical modeling techniques to predict tropical cyclone activity in several cyclone basins and sub-basins (Camargo et al. 2007). Tropical cyclone activity occurring over the Fiji, Samoa and Tonga regions (also known as the 'FST region') is seen to be strongly affected by the ENSO phenomenon; more cyclones form in the region during El Nino events while more cyclones enter the region during La Nina events (Chand et al. 2010).

### 2.7.2 Storm Surges

Storm surges are the increases or decreases in immediate water levels caused by factors other than tides and other seasonal water-level changes. These factors consist of a combination of changes in atmospheric pressure, winds and waves affecting basin geometry, as well as other factors like flooding from rivers and cyclone-induced storm surges (Solomon and Kruger, 1996).

Table 10 Cyclone-induced Storm Surge Levels in Suva from 1978 – 1994

| Cyclone | Day | Year | Surge re: LMWL (m) | Pressure (mb) |
|---|---|---|---|---|
| Fay | 1 March | 1978 | 0.198 | - |
| Meli | 27 March | 1979 | 0.153 | - |
| Arthur | 16 Jan | 1981 | 0.163 | 999 |
| Oscar | 1 March | 1983 | 0.214 | 983 |
| Gavin | 7 March | 1985 | 0.323 | 993 |
| Hina | 18 March | 1985 | 0.246 | 993 |
| Rae | 24 March | 1990 | 0.300 | 993 |
| Sina | 29 November | 1990 | 0.187 | 986 |
| Unnamed | 21 April | 1992 | 0.220 | 1001 |

| | | | | |
|---|---|---|---|---|
| Fran | 10 March | 1992 | 0.140 | 1000 |
| Kina | 4 Jan | 1993 | 0.433 | 973 |
| Unnamed | 26 March | 1994 | 0.213 | 999 |

*Source: SOPAC Report 242, 1996*

*LMWL – Local Mean Water Level; Observed Water Level during the Surge Period (Solomon and Kruger, 1996).*

Storm surges can also be caused by certain wave activity known as wave set-up, whereby energy and momentum are transferred at the point when waves break on a reef or shore reducing the water level at the point of breaking; the transferred energy or momentum then causes the water level to increase as waves approach the shore (Solomon and Kruger, 1996).

Gravelle et al. (2008) noted that storm surges are already affecting many coastal areas around Fiji, and because of climate change and sea-level rise, storm surges are anticipated to increase in intensity and frequency. This would greatly affect the tourism sector because Fiji's beaches and coastal environment play a key role in the tourism market and is also likely to affect the coastal residential properties, traditional villages and human settlement areas that are in close proximity to the foreshore and tidal areas affected by coastal flooding from storm surges and flood tides.

Examination of tidal records for storm surges identified 12 surges and these were used to generate return interval statistics and as a guide for developing predictive models (Solomon and Kruger, 1996). The largest surge to be recorded occurred during Cyclone Kina in 1993 and reached a maximum of 0.43m. The highest surge took place during the falling tide and it is suggested by some that the maximum height that can be attained by wave and wind induced surges may be limited by some factors like the size of the reef passage at Suva Harbour and the width of the reef; therefore it was mostly atmospheric pressure surge which is observed.

Suva tides are semi-diurnal (having two high tides and two low tides each day), ranging from about 0.9m during neap tides to 1.3m during spring tides (Solomon and Kruger, 1996). The analyses of identified water level records is crucial when trying to identify the conditions that cause important events to occur, and can help Lami Town Council to calculate storm surges under several sea-level scenarios and consequently form adaptive counter-measures to different sea-level rise scenarios.

The Lami area has a fast growing peri-urban population of approximately 20,000 (2007 census) and a significant proportion of this population is considered to be vulnerable to the effects of storm surges due to its coastal natural, restricted single road access (the only thoroughfare between Suva and Nadi), its limiting infrastructure and land mass inland. Whilst the natural environment is prone to moderate changes, it is not clear how damaging those changes will be. Similarly the make-up of the mangrove-forest environment has been changing as a result of local use and reclamation developments but the scale/extent of the changes and their associated effects on fisheries have not been investigated (Solomon and Kruger, 1996).

On 22nd March 2011 the southern and southeastern coasts of Viti Levu were inundated with stormwaves that swept several meters inland. Lami was affected as waves breached the seawall behind the Council building and inundated the back lawn (Pictures 1and 2), similarly Tikaram Park's foreshore experienced inundation and further coastal erosion despite previous coastal protection works by Council to retain this coastline (Picture 3 & 4).

**Picture 1 Storm Surges Inundating the Seawall behind the Lami Town Council Chambers dated 22/03/2011**

**Picture 2 Storm Surge Inundating the Lami Town Council Foreshore Area dated 22/03/2011**

*Source: Lami Town Council, 2011*

**Picture 3 Tikaram Park – Coastal Erosion & Inundation**


*Source: SCOPE Pacific (2010)*

**Picture 4 Tikaram Park – Coastal Protection Works**


*Source: SCOPE Pacific (2010)*

### 2.7.2 Extreme Rainfall Events

The leeward, western side of Viti Levu (Sigatoka to Rakiraki) receives an average of 2000 – 3000mm of rainfall annually while the rainfall levels on the windward, eastern side amount to an average of 3000 – 4500mm of rainfall annually. Suva has distinctive wet and dry seasons, and average annual rainfall of 3050mm. Solomon and Kruger (1996:19) noted the fifty-year return-interval to be 477mm in 24 hours.

Feresi et al. (1999, cited in KBR Inception Report, 2011:18) noted that although precipitation change as a result of climate change is expected over the 100 year period of 2001 – 2100, it is unclear whether precipitation would significantly increase or decrease. The South Pacific Convergence Zone (SPCZ) has a great impact on Fiji's climate therefore rainfall would either significantly increase or decrease in Fiji depending on the impacts of climate change on the SPCZ. However most general circulation models are predicting increased rainfall, with estimated figures being a 3.3% increase by 2025 or a 3.7% increase if there are higher emissions of GHG, and 9.7% (or 20.3% with increased emissions) by the year 2100 (Feresi et al., cited in KBR Inception/1st Progress Report, 2011: 18).

Floods occur regularly in Fiji, almost on an annual basis. Most major floods are related to incidents of severe weather such as cyclones and tropical depressions with their associated high intensity rainfall. Many of the rivers and streams in Fiji are quite small (<1000km2) and originate from steep mountainous areas. Thus the high intensity rainfall experienced during tropical depressions and cyclones, coupled with the small size and steepness of rivers and streams, results in the swift rise and fall of water levels. The timeframe between high intensity rainfall and floods occurring can be as quick as 3 – 4 hours (Fiji Meteorological Services, 2001). Flash floods are quite common, particularly during Fiji's wet/cyclone season of November – April.

This has major consequences for river discharge systems; Suva's discharge regimes are normally flashy with rather low levels most of the time and very high discharge levels during extreme rainfall events (Solomon and Kruger, 1996). As mentioned in Section 0 the small coastal river systems within the Lami area that discharge into Suva Harbour are Veisari, Wailekutu, Lami/Qauia and Navesi rivers. They would also be highly affected by higher rainfall levels, with the most common bio-physical effect being flooding. At present, the Lami/Qauia and Wailada river flats are flood prone, as is the flat land on the Delainavesi side of the Tamavua River.

As mentioned in Section 2.6.1, areas of Lami that are prone to flooding are the Lami/Qauia and Wailada river flats, as is the flat land on the Delainavesi side of the Tamavua River.

### 2.7.3 Earthquakes and Tsunamis

Earthquakes and tsunamis are not climate change related events but are geo-hazards that have been identified as a risk to Lami as a coastal town and is located near fault systems situated to the west of Suva and at the southern end of the Suva Harbour. Geo-hazards have been included for consideration as part of Lami's vulnerability with particularly emphasis on the need for disaster risk management during these events and also for hazard risk mapping to better prepare for these events.

As mentioned earlier, Fiji is located within the Pacific Ring of Fire. The main island of Viti Levu is situated on the Fiji Platform and is enclosed by zones of seismicity with the most active being the zone situated at the northern edge of the platform (Shorten et al., 2001). Everingham (1983, cited in SOPAC Technical Report 300, 2001: 22) carried out focal-mechanism studies that indicated that the Viti Levu plate region is situated in a zone of east-west tension. Thus though Viti Levu is not situated within well-defined seismicity zones (it is surrounded by them), Suva has in the past been affected by earthquakes that occurred in a weakly defined zone of seismicity on the southern side of Viti Levu (Shorten et al., 2001). A good example of this is the 1953 earthquake that hit Suva and was caused by a northwest-trending fault system situated about 15km west of Suva (SOPAC Technical Report 300, 2001:22), and there also may be a related fault system that affects the southern end of Suva Harbour (Shorten et al., 2001).

Because of its tectonic setting, Fiji is at quite a high risk of being affected by tsunamis (Atkinson and Collen, 2000). Eleven tsunamis were recorded in Fiji over a hundred year period, from 1877 to 1977, with the Suva Tsunami of 1953 causing the most damage (Atkinson and Collen, 2000).

The MS 6.75 earthquake that struck the Suva area in 1953 had its epicenter a few kilometres southwest off Namuka Reef and a tsunami hit the Suva area with waves achieving their maximum height when they broke against the reef at the entrance to Suva Harbour and along the south coast (Houtz, 1962, cited in Atkinson and Collen, 2000: 18). In the SOPAC Technical Report 324 authored by Atkinson and Collen (2000), aerial photographs of the Lami Reef indicate that the seaward edge of the reef has many cracks and loosened blocks of material (Atkinson and Collen, 2000).

The Seismic map of the Suva-Lami area (Figure) highlights locations and magnitudes of past earthquakes. No notable earthquakes have occurred in the Lami area; however four minor earthquakes have been recorded within shallow depths in Suva Harbour within the past 35 years (see Table 10) , with a 1980 earthquake occurring quite close to Lami town which is located on the northern shore of Suva Harbour.

**Table 11 Dates, Locations and Magnitudes of Past Earthquakes in the Suva-Lami area; to be used in conjunction with the Seismic map in Figure 20 below**

| Year | Month | Day | Longitude | Latitude | Depth | Mw | Epicentral area |
|---|---|---|---|---|---|---|---|
| 1976 | June | 07 | 178.4 | -18.15 | 10 | 2 | Suva |
| 1980 | February | 23 | 178.4 | -18.14 | 15.6 | 1 | S/East Viti Levu |
| 1980 | June | 21 | 178.4 | -18.12 | 15 | 0.6 | S/East Viti Levu |
| 1981 | April | 10 | 178.4 | -18.13 | 7.7 | 1.5 | S/East Viti Levu |

*Source: MRD, 2010*

## 2.8 Hazard Mapping

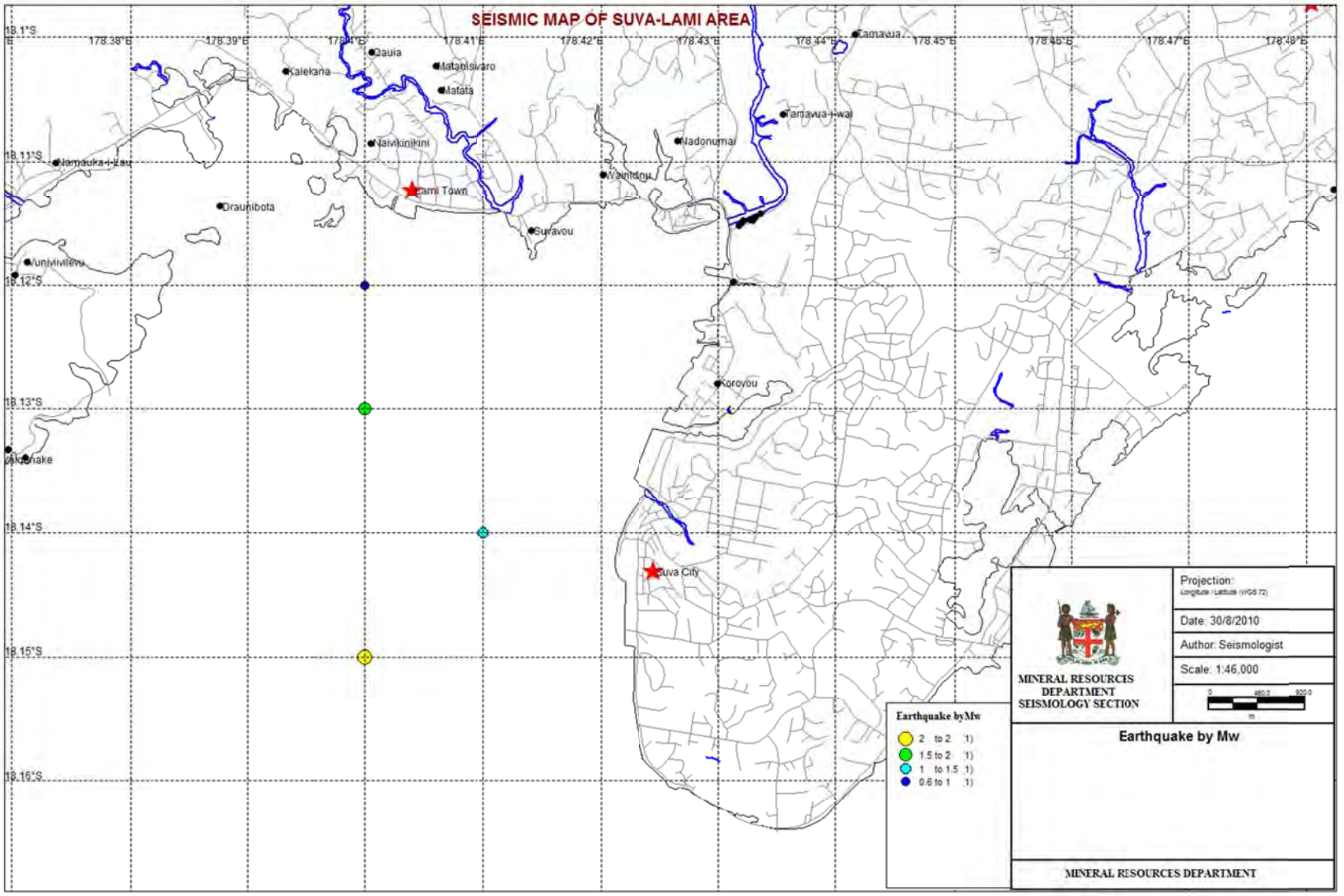
The Secretariat of the Pacific Community Applied Geoscience and Technology Division (SOPAC) is in the process of developing hazard maps that cover storm surges, cyclones (impacts of strong winds),

earthquakes and tsunamis for the Greater Suva area based on the area's built environment, under the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI).

The PCRAFI is a joint initiative between the Secretariat of the Pacific Community Applied Geo-science Commission (SOPAC), the World Bank and the Asian Development Bank with technical and financial support from foreign governments and other organizations, which aims to assist Pacific Island Countries (PIC's) with risk modeling and assessment tools to improve disaster risk reduction.

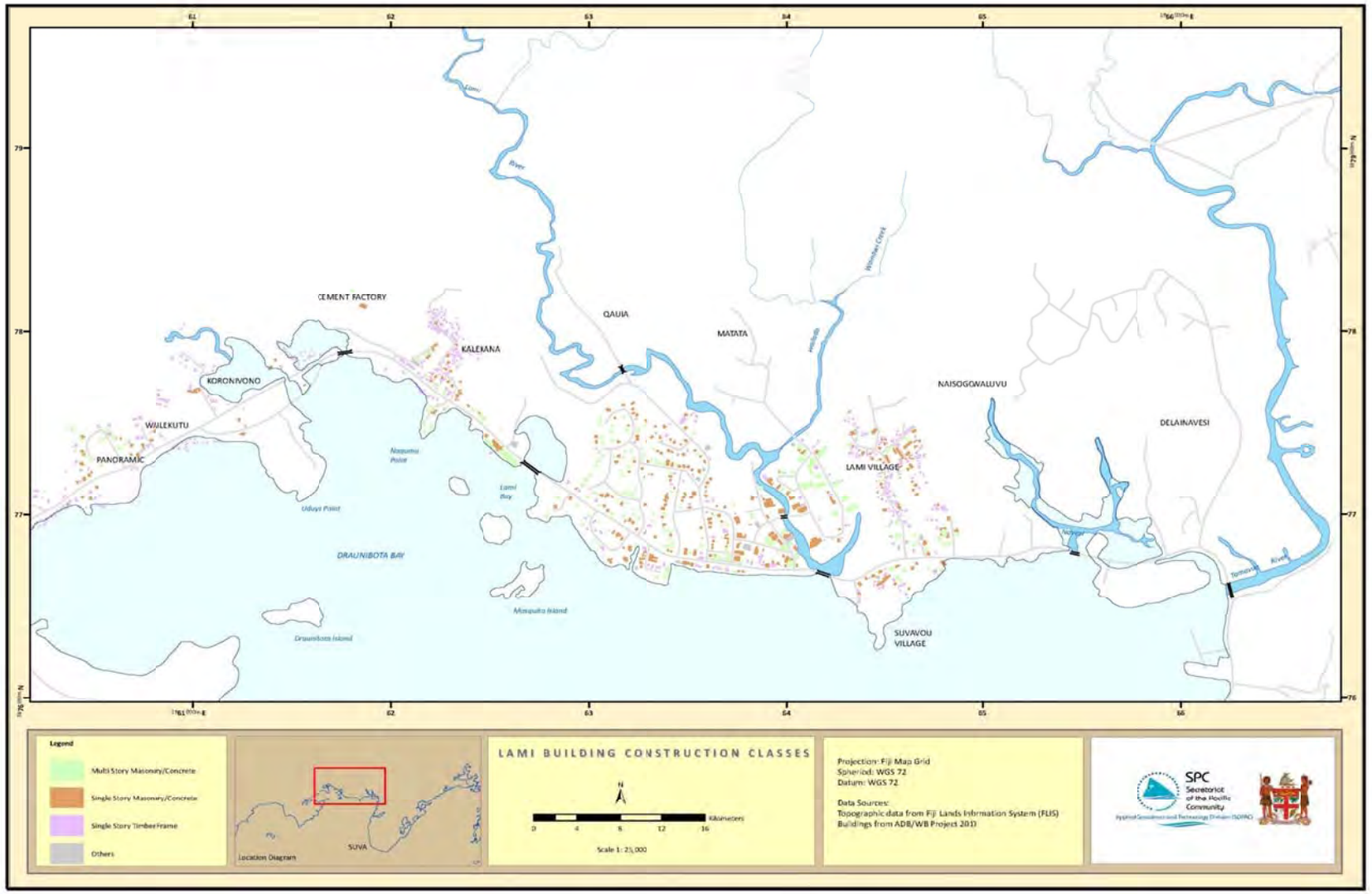
SOPAC is in the process of detailing the built environments and developing hazard maps for Fiji and Lami Town Council is currently liaising with SOPAC for the release of the final hazard maps that cover the Lami area for inclusion in the V&AA. A preliminary draft hazard map was issued for the purpose of finalizing this report but the final hazard maps will be issued directly to LTC upon completion for insertion into this report.

**Figure 20 Seismic map of Suva – Lami area, indicating locations and magnitudes of past earthquakes**




*Source: MRD, 2010*

**Figure 21 Draft Hazard Risk Map for Lami**



# 3 Lami's Climate Change Hotspots

This Section identifies hotspot areas that are at risk of climate change impacts such as coastal and river erosion, sea level rise, flooding and landslides. The areas that have been identified in consultation with Lami Town Council and have taken on board the issues and concerns raised in community consultation meetings and household surveys undertaken as part of this assessment as well as on the complaints received by Council from the area on issues relating to climate change impacts. Consideration of the 'hotspots' location, the use of the land, the condition of land, the nature and condition of existing structures, access to infrastructure and services have also been considered.

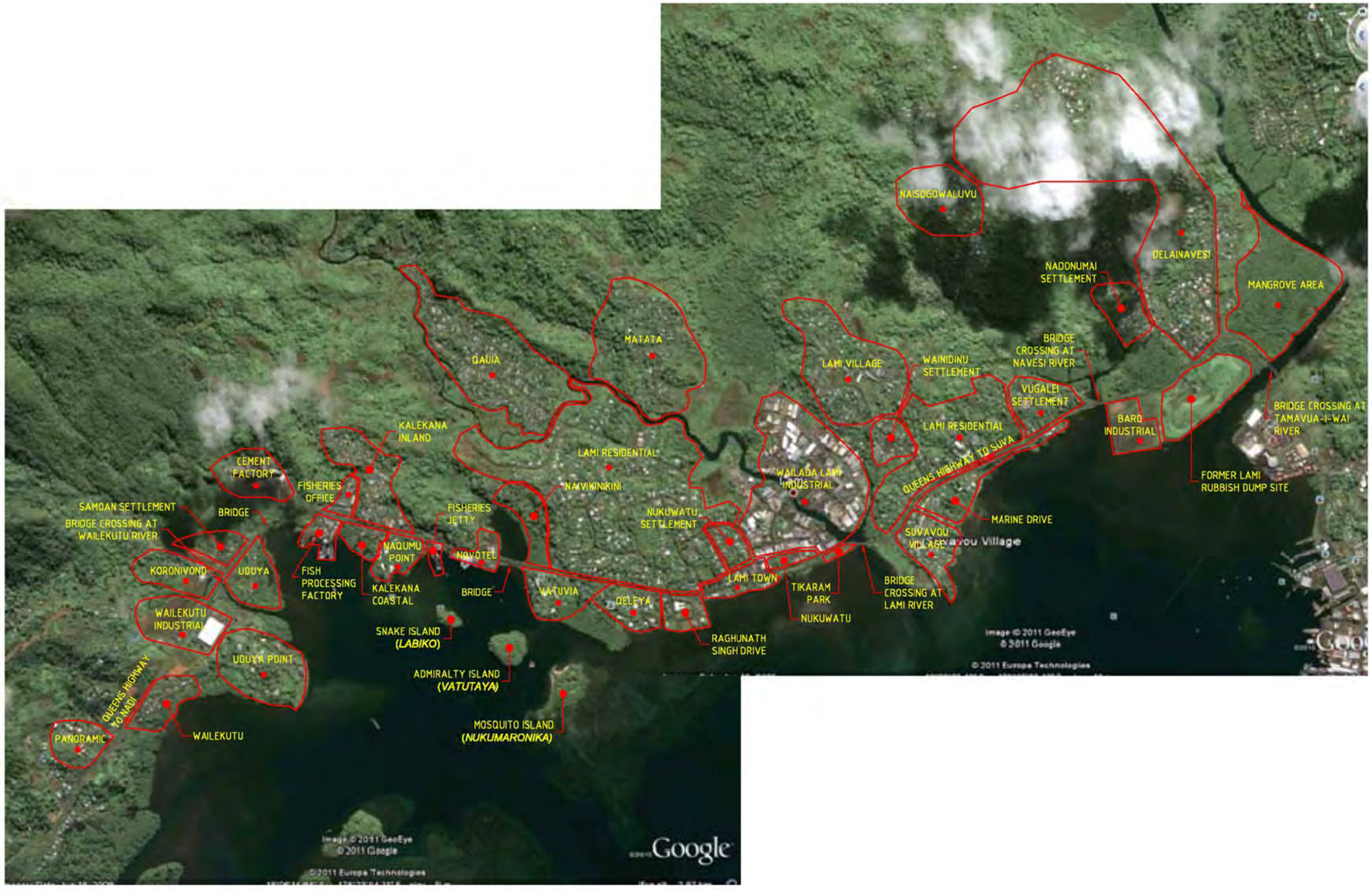
Land use in Lami town is pre-dominantly residential comprising 74% of the total land use. Industrial use comprises 16%, Special use comprises 6% and Commercial uses takes up the smallest area of land with 4% of Lami's town boundary.

Lami is particularly susceptible to urban flooding along its coastal areas, river banks and low lying river flat areas. Additionally, the lack of drainage capacity and poor solid and green waste management in Lami exacerbates surface water flooding during periods of high intensity rainfall. Some of the key hotspot areas for flooding are the, Wailekutu, Koronivono, Samoan and Kalekana settlement areas in Lami's Western ward; residential and settlement areas in Qauia, lower Matata settlement, Wailada Industrial area and the Central Business District (CBD) located within the Central ward; and Naisogowaluvu and Nadonumai settlements and coastal infrastructure in the Eastern ward.

Other impacts commonly experienced in Lami include coastal erosion and wave overtopping, which is prevalent in certain areas such as Tikaram Park, Council's Administration offices and Chambers and other commercial and residential properties in the Central ward; and increased river flows causing river bank erosion and bridge instability; and landslides along steeper slopes especially during high rainfall events.

The hotspots are presented according to the six classifications: Residential, Settlements, Commercial, Industrial, Civic Uses, and Infrastructure. Figure 22 identifies these areas, while Table 12 below outlines the classification of urban status of the residential and settlement areas.

Figure 22 Google image of Lami with locations of residential and settlement areas, commercial and industrial areas, and special use areas (Source: Google Earth imagery, 2009)



## 3.1 Residential

The residential areas identified within Lami town comprise of formally subdivided plots and zoned Residential 'B' in accordance with the Lami Town Planning Scheme (1994). These residential lots are restricted to a plot ratio of 0.2:1 as these areas are all on septic tank systems as the method of night soil disposal as the most of the town has yet to be connected to a sewerage reticulation system. Most of the residential lots are occupied by middle to high income earners and have constructed permanent houses on it with only a few lots remaining vacant. Table 12 below is provides a list of the residential areas in Lami.

**Table 12 Residential Areas in Lami studied for the Vulnerability and Adaptation Assessment**

| Area | Type | Classification | Land area (Ha) | No. of Households | No. of people |
|---|---|---|---|---|---|
| Panoramic Road | Residential | Peri-urban | No record | No record | No record |
| Uduya Point | Residential | Urban | 14.5 | 40 | 200 |
| Naqumu Point | Residential | Urban | 1.19 | 8 | 40 |
| Vatuvia | Residential | Urban | 3.1 | 23 | 115 |
| Raghunath Singh Drive | Residential | Urban | 2.26 | 20 | 100 |
| Nukuwatu | Residential | Urban | 1.58 | 16 | 80 |
| Marine Drive | Residential | Urban | 15.69 | 139 | 695 |
| Delainavesi | Residential | Urban | 114.02 | 27 | 135 |

### 3.1.1 Panoramic Road

Panoramic Road is located in the inland Wailekutu area west of Lami town jurisdiction on an elevated hilltop comprising of red clay/sandy earth making it very susceptible to landslides and erosion during extreme rainfall events and cyclone periods (see Pictures 5, 6 and 7). Attempts to retain the land from slipping have been difficult for the residents. Building close to the edge of the steep slopes should be restricted and major earthworks and cutting of the land should be avoided. The land is sparsely vegetated and residents should be encouraged to plant deep rooted plants such as vetiver grass to hold the soil in place during heavy rainfall and minimal clearance of vegetation should be encouraged.

Panoramic Road is directly accessed by the Queens Road so residents are able to access bus and taxi services along the highway. Utility services include electricity provided by the Fiji Electricity Authority (FEA), reticulated water from the Water Authority of Fiji, and telecommunication cables/lines provided by Telecom Fiji. Residents have individual septic tanks as the area is currently unsewered.

Panoramic Road residential area is outside of Lami's boundaries and under the jurisdiction of the Suva Rural Local Authority (SRLA) and solid waste is arranged with Waste Care Services who collect rubbish and deposit to the Naboro landfill.

Picture 5 View of Panoramic residential area from Queens Road


Pictures 6 & 7 Continually sliding area of land with rock revetment wall at entrance to Panoramic Road



### 3.1.2 Uduya Point

Uduya Point is a coastal residential subdivision in northwest Lami town (see Picture 8). There are a total of 15 lots with a majority comprising over 2,000m in area. The area has both flat and hilly terrain and is situated some distance away from the Queens Road. Only part of Uduya Point residential has had coastal protection walls constructed (i.e. the JS Hill Apartments) whilst the remaining residential lots have half their lots exposed to coastal erosion and inundation and the other half elevated which provides them with a good platform to construct their houses. However, any future development in the area Council needs to ensure that appropriate construction methodologies are adopted to avoid any landslides and erosion, particularly during heavily

precipitation periods and appropriate setbacks from the coast line should be adhered to or structures designed to be raised to withstand inundation.

Utility services include electricity, reticulated water and telecommunications. The area is unsewered with a predominance of septic tanks and solid waste collection service provided by the Council.

Picture 8 View of Uduya Point across Draunibota Bay


### 3.1.3 Naqumu Point

Naqumu Point residential area is located opposite Kalekana Settlement and is a small subdivision located in a coastal area to the northwest of Lami town. There are approximately 9 lots of over 2,000m$^2$ within this subdivision, and terrain is hilly in some areas and flat in others. Along either side of Naqumu Point are clusters of mangroves of which the northern western side is housing part of the informal Kalekana settlement. Part of this settlement had recently lodged an application to the Director of Lands to regularize the house sites but it is understood that the application was recommended for refusal by the Department of Town & Country Planning based on the grounds that the area was susceptible to sea level rise and inundation. The mangroves on the western side of Naqumu Point are fast becoming degraded as the local communities use them as a source of firewood, building materials, medicinal purposes and also for further clearance for their pig pens and for new structures.

Naqumu Point's coastal boundary is at risk of future coastal erosion and inundation should these clusters of mangroves be removed and therefore, this should be raised as a concern to the authorities by Lami Town Council and Department of Town and Country Planning. Removal of these mangroves may require these residential properties that abut the foreshore to construct seawalls to protect their land from storm surges and erosion.

It is directly accessible to the Queens Road via Naqumu Point Road; thus in addition to owning private vehicles residents also have access to the public transportation services that are available

along the Queens highway. Utility services available in the area include electricity, reticulated water and telecommunications. Residents also use backup storage tanks for water as disruptions to reticulated water supply are common in this area. Because of the intermittent water supply, WAF also provides water supply tanks at certain areas around Lami that are refilled on a regular basis by water supply trucks. The area is unsewered and residents use septic tanks. Solid waste is collected by the Council.

### 3.1.4 Vatuvia, Qeleya and Raghunath Singh Drive Residential

Vatuvia Road, Qeleya Road and Raghunath Singh Drive are coastal residential areas situated in Lami's central ward. The Vatuvia subdivision is adjacent to Mosquito Island on the eastern point of Draunibota Bay. Terrain for all three subdivisions consists of mainly flat land but is also slightly elevated in certain areas. A large portion of Vatuvia's and Qeleya's foreshore areas is dominated by mangroves; with the exception of Raghunath Singh Drive residential area. The latter is a relatively new subdivision on reclaimed land with seawalls constructed as part of the civil works. Similarly, the mangrove areas in front of Vatuvia and Qaleya form a natural protection barrier for these coastal properties and assist with the absorption of nutrients and pollutants being drained into the bay. They should be retained and protected as mangroves also act as a breeding, nursery and feeding ground for the marine ecosystem.

The subdivisions have access to the public transportation services that are available along the Queens highway. Utility services include electricity, reticulated water and telecommunications with the use of septic tanks as the area is currently unsewered. Reticulated water supply is mostly intermittent and the majority of residents use backup storage tanks as an additional source of water. Solid waste is collected by the Council.

Picture 9 View of Vatuvia residential area from Queens Road

### 3.1.5 Nukuwatu Residential

Nukuwatu residential area consists of 1.2ha of freehold land along Marine Drive road/Queens Road in Lami town. It is adjacent to Lami's commercial centre and industrial zone and part of this residential is along the coastal foreshore and is vulnerable to inundation from wave overtopping and coastal erosion. This area is exposed to strong winds and is sparsely vegetated with coastal plants. The land is low lying and in some areas experiences localized flooding ponding from stormwater drain overflows.

Public transportation services are directly available to residents, and utility services include electricity, water reticulation and telecommunications; the area is unsewered and septic tank systems are used. Solid waste is collected by the Council.

### 3.1.6 Marine Drive Residential

Marine Drive residential area is a small area of freehold land east of Suvavou village. It is coastal and slightly elevated in some areas which comprises of small embayments, separated by sedimentary rock headlands. This shoreline ranges from relatively low, coarse sandy beaches (2 to 5 metres wide rising 1.5 to 2 metres in elevation) to extensive mangroves stands. Haphazard constructions of groynes have also been observed along this shoreline causing minimal erosion and undercutting. This type of haphazard coastal protection structures should be restricted and carefully monitored in the future.

Marine residents have direct access to Queens Road and often resulting in the slowing of traffic along the main highway when the vehicles entering and exiting properties. It is adjacent to the proposed Baro industrial subdivision and the former rubbish dump site. Utility services include electricity, water reticulation and telecommunication and private septic tank systems. Solid waste is collected by the Council.

### 3.1.7 Delainavesi Residential

Delainavesi residential area is in the eastern boundaries of Lami, adjacent to the former Suva rubbish dump site. The single entrance, Delainavesi Road, off Queens Road quickly elevates towards residential area located on hilly inland terrain overlooking the Lami/Suva Harbour. Poor access to services, an unreliable water source and collection of solid waste, landslides, rock falls and poor road conditions (as a result of poor drainage of stormwater) are considered significant concerns for these residents living in Delanavesi.

Public transportation services are readily available to residents (a local bus company), Shore Buses Limited, services the Delainavesi area daily and few taxi bases are located along Delainavesi Road. Utility services include electricity, water reticulation and telecommunication and private septic tank systems. Solid waste is collected by the Council.

## 3.2 Settlements

Settlements within Lami are built-up areas that house both temporary and permanent structures for low to middle income earners. The majority of the settlements are situated on state and native land; however one settlement, the Samoan settlement, occupies freehold land. These settlements are based on communal living whereby there is no formal security of tenure for each of the households but rather a communal arrangement with the landowners or illegally.

Four out of the seven settlements that have been identified by Lami Town Council as significant hotspots were surveyed and had community presentations within the timeframe of the reporting periods. However, the community profiling can easily be extended to the remaining settlements and other communities within Lami Town Council in due course and as part of updating this report. In addition to the seven settlements initially identified by LTC, LTC also requested the inclusion of two more settlements, Kalekana Coastal and Naivikinikini, which have been included in Table 13 below. Copies of the community presentation, household survey questionnaire and the profiles of these four communities based on the surveys are in Appendix F, G & H.

**Table 13 Settlement Areas in Lami Identified for the Vulnerability and Adaptation Assessment**

| Area | Type | Classification | Land area (Ha) | No. of Households | No. of people | Percentage Employed (%) |
|---|---|---|---|---|---|---|
| Naisogowaluvu | Settlement | Urban | No record | 12 | 62 | 33% |
| Matata | Settlement | Urban | 3.24 | 28 | 174** | 31% |
| Samoan | Settlement | Urban | 4.65 | 17 | 92 | 24% |
| Kalekana Coast | Settlement | Urban | No record | 10 | 50 | To be surveyed |
| Kalekana Inland | Settlement | Urban | 3.85 | 127 | 690* | 48% |
| Koronivono | Settlement | Urban | No record | 20 | 100 | To be surveyed |
| Naivikinikini | Settlement | Peri-urban | 6.1 | No record | No record | To be surveyed |
| Wailekutu | Settlement | Urban | 2.7 | 22 | 110 | To be surveyed |
| Nadonumai | Settlement | Urban | No record | 14 | 70 | To be surveyed |

** 495 people in 88 HH in the survey, have added an avg. # of 5 each for the remaining 39 houses that were not covered so 495 + 195 (5x39) = 690 people*

*** 144 people in 22 HH in the survey, have added an avg. # of 5 each for the remaining 6 houses that were not covered so 144 + 30 (5 x 6) = 174*

Data presented in Table 13 indicates that all four surveyed settlements have recorded less than 50% employment; of the settlements the Samoan settlement has the lowest recorded employment rate within the settlement of 24%.

88 households out of the 127 households within Kalekana settlement were interviewed in the house-to-house survey. Of this number, 48% are in paid employment and 52% are unemployed; a majority of the unemployed were domestic housewives.

Employment status records for Lami from the 2007 census indicated that only approximately 29.5% of Lami's population was economically active and a approximately 68% of the population were not involved in any economic activities.

A survey carried out in Kalekana by students of the MBBS program of the former Fiji School of Medicine[10] in 2009; the study was titled the *Kalekana Profile* and illustrated the health status of the community. The survey found that of the 285 people that were in paid employment, 137 were in permanent paid employment, and that most of the employed worked as fishermen and security guards, most commonly with the nearby Fiji Fish Company Limited. Other sources of employment included the Fiji Industries Limited cement factory that is within walking distance of the settlement, and those that engaged in self-employment activities within and outside the community e.g. grass-cutting, carpentry and driving public service vehicles. On the other hand, only a very small number of the community worked in the public sector. Other income-generating activities included canteen-keeping, selling kava and food packs, and sewing clothes (Kalekana Profile, 2009).

The average income for Kalekana settlement was calculated by taking into account the average weekly income earned by all 127 households; the total figure calculated was $166/week. The Government drew the poverty line to be $147/week for a family of 5 in 2005. According to this basis 52% of the households within Kalekana were living well below the poverty line. This may be because a large number of those within the working class age group (22 – 60 yrs) are unemployed due to the low level of education attained and lack of technical skills.

A similar study was also carried out in Matata in 2009 by medical students of the Fiji National University; the study was titled the *Matata Community Profile* and the survey found that of the settlement's total population of 190 people, 59 are in paid employment and of these 40 are in permanent paid employment while 19 are in temporary paid employment. Those that are in the 18 – 25 age bracket number a total of 19 people that are unemployed and a key factor behind this is illiteracy; many of them are school dropouts that could not complete their education because of financial constraints (Matata Community Profile, 2009). Many of the employed work in nearby factories in Wailada which is within walking distance to the settlement. The Matata Community Profile also estimated that the average income per household was $70 - $90 per week which was also below the national poverty line.

The unemployment rate within Naisogowaluvu settlement is high at a rate of 67%, and a majority of the residents interviewed comprised of retirees and domestic housewives. The most common type of work for those employed was work as fishermen or ship crew. The Samoan settlement has the highest unemployment rate of the four settlements surveyed, at 74%. Those employed commonly work as taxi drivers, wharf labourers, carpenters or ship crew.

It was expressed in the community consultation meetings if LTC could assist with providing employment opportunities for the young men and women within their communities as there were many of them within the village and settlement that possessed skills that could be used like grass cutting, cleaning, gardening etc.

### 3.2.1 Naisogowaluvu Settlement

Naisogowaluvu settlement is situated in the upper, hilly regions of Lami and is accessed by a concrete footpath extending from Delainavesi Road and a bridge over Waikalou Creek and via dirt tracks from Lami village. The settlement is situated along the banks of the upper Navesi River with

[10] The Fiji School of Medicine merged with the Fiji National University in 2010 and is now known as the College of Medicine, Nursing and Health Sciences.

limited flat land available for house construction. The river floods after long periods of rain and is worse when high tide occurs simultaneously. This makes it extremely difficult to cross the creek which only has to concrete piles laid vertically as a crossing without any rails. These conditions are difficult for the minority groups including the elderly, disabled and children. The community members have noted creek bank erosion and had requested bank protection measures in order to address the eroding banks. Though sparse clumps of vetiver grass are used along the creek banks, the community has requested concrete walls be constructed to protect the creek crossing and buildings close to the creek edge.

Despite its location away from developed areas, electricity and reticulated water are available in the settlement. FEA have extended power lines to the settlement, and the Lami Town Council has also set up streetlights within the settlement. The Lami Report of Survey (1998) prepared by the Department of Town and Country Planning highlights that a proper subdivision of the area with related infrastructure and other services could be easily provided if services available in Lami village are extended to the area. Requests for a communal rainwater tank have been made to Lami Town Council to improve access to water as carting the water from the main road is difficult and challenging (long distance and transporting water in buckets).

Residents use septic tanks and/or pit toilets for nightsoil disposal. Because of difficulties faced in accessing the settlement, individual households have allocated in-ground bins where rubbish is buried or burned for solid waste disposal. The Council had indicated that collection services can be made available to the community for a nominal amount. The community members are keen to use this Council service though raised concerns on transporting rubbish to collection points (the main road in Delainavesi or Lami Village) and to protect the rubbish bags from pests prior to collection.

### 3.2.7 Matata Settlement

Matata settlement is in Lami's inland area north of Lami town, on approximately 3.24ha of unsubdivided native land. This area has been settled since the 1970's along the eastern side of Lami River. It is adjacent to another settlement, Qauia, separated by an area of hilly, elevated land. Matata is accessible via a substandard access road that extends from a bridge at the end of the Wailada industrial subdivision. Topography of the area consists of flat lands along the river banks and hilly areas further inland; a majority of the houses are constructed in hilly areas however there are several houses along the river bank and in some slightly flat lands inland.

Public transportation is not directly accessible to residents as the settlement is located in an isolated, inland area away from Lami's commercial areas; buses and taxis only provide services up to the end of the industrial area. Utilities services available to the settlement are reticulated water and electricity; during times of water cuts, carted water provided by the WAF is stored as is rainwater for drinking purposes while those that do not have access to FEA-provided power lines use kerosene lamps and candles for lighting purposes.

The settlement is unsewered so residents provide their own septic tanks and pit toilets for treatment and/or disposal of sewage. Solid waste is disposed of in the settlement via allocated in-ground bins that rubbish is buried in.

### 3.2.3 Samoan Settlement

The Samoan settlement is adjacent to Koronivono in a sparsely populated area west of Lami town. Its residents are descendants of Samoan settlers that colonized the area in the early 1950's with inter-marriages between the Samoans and other ethnic groups e.g. Fijians, Rotumans and part-Europeans, resulting in a somewhat multi-cultural society within the settlement.

There are 17 households on freehold land which has been zoned as a residential area. More than half of the households have resided in the area for more than 20 years and are living on a communal basis with majority of the residents having communal ownership of the land and individual ownership of their homes. Topography of the area consists of relatively flat land that gradually elevates to the hills and the geology mainly comprises red clay/sandy earth. The Queens Road is accessible via a feeder road and squatter buildings line the Queens highway at the beginning of the feeder road. The only access is via a footpath that is situated at the end of the feeder road. Residents use the Queens Road to access public transportation, which is the main mode of transportation for most.

Utility services include electricity, reticulated water and telecommunications. 76% of households within the settlement have access to electricity; the remainder use kerosene lamps, lanterns and candles as for lighting purposes within their homes. Additional sources of water include rainwater that is stored for drinking, spring water, and carted water supplied by the Water Authority of Fiji (WAF) during times of water cuts. Residents also use nearby springs and creeks to bathe or wash in during water cuts. 59% of households have backup water supply tanks and drums, buckets and bottles. The cartage of water to the area by WAF trucks is considered unreliable in that frequency of service does not meet household needs; and service extends only to households in the low lying areas and those living in elevated areas cannot be reached.

Although water-related health issues are not experienced by a majority of the settlement, diarrhea and skin diseases were noted as common when using a nearby spring during times of water cuts, possibly due to contamination of the water source. Residents provide their own septic tanks and/or pit toilets for sewage treatment and disposal with solid waste collected by the Council. Liquid waste generated by households includes wastewater from kitchens, bathwater and water used for washing clothes; a majority of the households discharge wastewater directly into nearby drains and waterways.

### 3.2.4 Kalekana Coastal Settlement

Kalekana coastal settlement is west of Lami town and flanked by several commercial areas; the Novotel resort, the Ministry of Fisheries jetty, the Land Transport Authority and the Fiji Fish Company and the Naqumu Point subdivision. The area consists of flat land and the Queens Road is located at an elevation of 1 – 2 metres above the settlement. Some houses are located within the mangrove areas and residents within these areas are prone to water-borne and mosquito-related diseases, as well as coastal inundation during cyclone-induced storm surges.

**Picture 10 & 11 Below Left – Views of Some Households within the Settlement below the level of the Queens Road; amongst the Mangrove Areas; Below Right**



Services include public transportation along the Queens Road, reticulated water and electricity. During times of water cuts, residents use carted water supplied by WAF and they also store rainwater for drinking. Diesel generators are used by those residents that are not connected to the Fiji Electricity Authority, and kerosene lamps and candles are used for lighting purposes. Pig pens are constructed within mangrove areas for easy disposal of pigs' food and fecal wastes into the mangroves; the pens are constructed above the mean high water mark to prevent inundation during high tide.

The area is unsewered so residents use septic tanks and pit toilets to treat and/or dispose of sewage. Solid waste is collected by Council-owned garbage collection trucks while liquid waste (kitchen water, washing water) is disposed of via septic tanks, waste traps, and nearby drains and waterways.

### 3.2.5 Kalekana Inland Settlement

Kalekana inland settlement sits on approximately 3.85 ha of state land opposite Kalekana coastal settlement. A majority of the settlement comprises of Solomon Island descendants. Access to Queens Road is via a graveled feeder road known as Kalekana Road maintained by the Public Works Department, and terrain comprises of flat land along the Queens Road that gradually elevates to the end of the feeder road. This elevated area within this settlement when exposed to long periods of heavy rain are subject to landslides and poor road conditions as a result of poor drainage. These areas prone to erosion need to be heavily vegetated and clearing for subsistence farming well managed in order to ensure that the cleared areas are replanted immediately and not exposed to long periods of heavy precipitation. Additionally, new structures should also be advised to construction away from slopes to avoid damage to foundations in the event there are slippages.

A majority of the residents use the Queens Road to access public transportation, which is their main mode of transportation. Other services include reticulated water supply, FEA-provided electricity that is available only to some households, and telecommunications. To supplement the sometimes intermittent or irregular supply of water, residents also have back-up storage tanks that store carted water supplied by the WAF and they also store rainwater for drinking purposes. Households without access to electricity tend to use kerosene lamps and candles for lighting purposes.

Other services in the settlement include 2 shops and 2 churches to cater for daily shopping needs and religious services (Lami Town Planning Scheme Report of Survey, 1998).

Since the area is unsewered, residents have septic tanks and pit toilets for sewage disposal. Solid waste is collected by the Council while liquid waste (kitchen water, washing water) is disposed of via septic tanks, waste traps, and nearby drains and waterways.

### 3.2.2 Koronivono Settlement

Koronivono settlement is also situated on the western boundary of Lami. The settlement is situated in the inland of the Wailekutu area and sits on flat terrain with the geology comprising of mainly red clay/sandy earth. The settlement mainly consists of a number of native landowners from the Waiqanake vicinity outside Lami's boundaries; the landowners have re-located to this new area for undisclosed reasons but could possibly be over land dispute issues which are quite common in Fiji.

This area is very low lying and was once a mangrove swamp area but the mangroves were cleared to make way for the homes. The area is also below road level and likely to be below mean sea level and therefore, is often inundated during spring tides or storm surge conditions and due to the clay like soil texture is often boggy during high precipitation events. Immediately adjacent to this settlement is recently reclaimed industrial lots whose ground levels have been raised above the land occupied by the Koronivono settlement.

The Queens Road is accessible via a short feeder road; public transportation is available and is in fact the main mode of transportation for many residents. Electricity, reticulated water and telecommunications are available in the area; however not all residents may have access to these services. Therefore additional sources of water include rainwater that is stored for drinking, ground water, and carted water supplied by the Water Authority of Fiji (WAF) during times of water cuts. Sewage is disposed via septic tanks and/or pit toilets as the area is unsewered. Solid waste is not collected by the Council; instead individual households have allocated bins where rubbish is buried. However the Lami Town Council is currently trying to incorporate Koronivono into its garbage collection route.

Picture 12 & 13 Views of Wailekutu settlement from Queens Road

### 3.2.6 Naivikinikini Settlement

Naivikinikini settlement is on native reserve land outside of the Lami town boundary within what is known as the peri-urban area of Lami and therefore is outside of Lami Town's jurisdiction. Despite this, the settlement has been identified by Lami Town Council as a potential hot spot area due to it being located on slope by a waterway with no access via road but rather via a concrete footpath off Marine Drive before the Novotel Convention Centre and inland from Qauia Street. The area has limited flat area in which to construct their houses and is susceptible to landslides as a result of increased runoff from the hills during heavy rain periods. Similarly vegetation clearing should be kept to a minimum and all buildings should be located away from slopes. Depending on the steepness of the lagoon embankment adaptation options for protection of the embankments should be investigated to either plant mangroves or vetiver grass in order to stabilize erosion and run-off into the lagoon.

Public transportation is accessed via the Queens Road. Utility services include reticulated water supply and electricity for those that can afford it is available. Additional sources of water include carted water from WAF stored in back-up storage tanks and rainwater stored in containers for drinking.

Residents provide their own septic tanks or pit toilets to treat and/or dispose of sewage. Although Naivikinikini is a peri-urban area that is situated outside Lami's boundaries, the Council still collects household rubbish from the roadside at Qauia Street. Similar concerns should be noted with regards to appropriate collection points to avoid strewn rubbish polluting the road sides prior it being collected by the Council rubbish trucks.

### 3.2.1 Wailekutu

Wailekutu settlement is located on the western inland boundary of Lami adjacent to a mangrove swamp. It was initially established by erecting pole like structures amongst the low lying swamp land to adapt to inundation but over time reclaimed the land to provide a haphazard flat terrain comprising of red clay/sandy earth for nearby hills. The mangrove swamp that abuts this settlement acts as a natural barrier to protect the homes from inundation but during extreme storm conditions and spring tides these areas often are close to inundation. The mangrove areas are subject to degradation and damage, and should be protected as a natural adaptation measure to sea level rise and as an important ecosystem which local communities rely on for their livelihoods and source of food.

It is directly accessible to the Queens road and public transportation for residents. Utility services include electricity, reticulated water and telecommunications; however not all residents may have access to these services. Additional sources of water include rainwater that is stored for drinking, ground water, and carted water supplied by the Water Authority of Fiji during water cuts. Residents provide their own septic tanks and/or pit toilets for sewage treatment and disposal. Solid waste is collected by the Council and/or Waste Care Services, and green waste is normally recycled.

Picture 14 & 15 Views of Wailekutu settlement from Queens Road



### 3.2.8 Nadonumai Settlement

Nadonumai settlement is in an inland area east of Lami town and is accessed from the Queens Road via a feeder road known as Nadonumai Road. The native land within this area is owned by land owning units from Suvavou village. Topography of the area consist of flat and hilly terrain, however dwelling houses are confined to the flat buildable areas along Nadonumai Road as well as flat hilltops and hill bases (Lami Town Planning Scheme Report of Survey, 1998). Indigenous Fijians are the dominant inhabitants of this settlement, as they are for all the other settlements within Lami; of this ethnic group, a considerable majority is made up of rural-urban migrants from the island of Kadavu as well as from some of the southern islands in the Lau Group (Lami Report of Survey, 1989).

Most houses are constructed of timber and concrete and reticulated water is available to the whole settlement, with some residents also having back-up storage tanks to store carted water from WAF during times of water cuts to the area. Electricity is however only available to those houses situated close to Nadonumai Road, to some households in an incomplete subdivision within the settlement, and to more than 50% of the upper Nadonumai area. Public transportation is accessible to the settlement via Nadonumai Road, and some residents also own private vehicles.

Nadonumai is unsewered so residents are responsible of providing their own septic tanks for sewage treatment and disposal, and solid waste is collected by Council-provided garbage collection trucks.

## 3.3 Commercial and Industrial Areas

Survey questionnaires were handed out to commercial and industrial sectors within Lami's Central Business District (CBD) and the Nukuwatu and Wailada industrial subdivisions; the information contained in the questionnaires form the basis of this section on Lami's commercial and industrial sectors together with information provided by Lami Town Council.

### 3.3.1 Industrial Areas

Industrial areas within Lami consist of the Baro industrial subdivision to the east of Lami town (Eastern ward), the Wailada industrial subdivision within the town area (Central ward), and the cement factory, CJ Patel complex and Williams & Gosling industrial areas in and near Wailekutu to the west of Lami town (Western ward).

The industrial categories in Lami are General, Heavy and Noxious.

Table 14 Industrial Zone in Lami

| Category | Land | % Total | Total No. of Lots |
|---|---|---|---|
| Heavy | 40.04 ha | 42.9% | 11 |
| General | 50.90 ha | 54.5% | 171 |
| Noxious | 2.39 ha | 2.6% | 1 |

Table 14 above refers to the industrial areas that have been developed and built upon. Heavy industrial refers to the site of the Fiji Industries Limited cement factory and Wailekutu industrial subdivision while General industrial refers to the CJ Patel complex in Wailekutu that houses the Nestle and Colgate-Palmolive factories, the Nukuwatu and Wailada industrial areas, and Baro industrial subdivision. The old Lami rubbish dump used to be the only Noxious industrial area; however it was closed down in 2005 and is being rehabilitated; the site of the Noxious industrial area is now the Novotel Sewerage Treatment Plant.

Table 14 also indicates that General industry covers the most land area in the industrial sector at 54.5%; however though they occupy the highest number of lots at 171, the actual land area covered by the lots is much smaller than those covered by Heavy industry which have a lesser number of lots (11) but which cover 42.9% of the total land area available for industrial use.

Table 15 below lists the types of businesses within the industrial area in Lami:

Table 15 Types of Industrial Businesses in Lami, 2011

| Types of Industrial Business in Lami | |
|---|---|
| Builders/repairs of ships/boats/yachts/small punts | Manufacturer Garments |
| Builders/suppliers of pre-fabricated building materials | Manufacturer Ice |
| Commercial Bulk store/ Warehouse storage | Manufacturer Iron, Tin, Other metal products including electroplating |
| Contractor Building and Painting | Manufacturer Nails and Other Metal products including electroplating |
| Contractor Electrical | Manufacturer not otherwise defined |
| Contractor Garbage Removal Services | Manufacturer Paints and Varnish |
| Contractor not otherwise defined | Manufacturer plastic bags |
| Contractor Road-building and Earth-moving | Mill not otherwise defined |
| Engineer Air-conditioning | Packer |
| Food Processing and Distribution | Pest control and Weed control |
| Hauler | Repair Air-conditioning and Refrigeration |
| Manufacturer Battery or Reconditioning | Repair Motor Vehicle Body |
| Manufacturer Cement | Shop Agriculture Industries and Chemical sales |
| Manufacturer Concrete Products | Shop Motor Mechanic |

| | |
|---|---|
| Manufacturer Detergents and Soaps | Supplier Ready-mixed Concrete |
| Manufacturer Domestic and Industrial Gas | Welder Arc, Gas and Electrical |
| Manufacturer Footwear | Factory Meat, Fish including other Canned/Bottled food |

#### 3.3.1.1 Baro Industrial

Baro Industrial Subdivision is situated on reclaimed State land adjacent to the western boundary of the old Lami rubbish dump. The area is zoned as General Industrial with almost all the lots still vacant and only a few used for storage of derelict trucks. Baro's topography consists of flat land that is comprised of engineered fill overlying various layers of lagoon sediments (soft mud), coral detritus (silts/sands/gravels/coral silts), deltaic deposits (silts/clay/organics) on top weathered Suva Marl (siltstone/mudstone/sandstone) (Corerega, 2010). The coastal perimeters of the subdivision are bound by a rock revetment wall in parts with geo-textile material to prevent coastal erosion; however the revetment wall is eroding in some places with loose and fraying geo-textile material also visible.

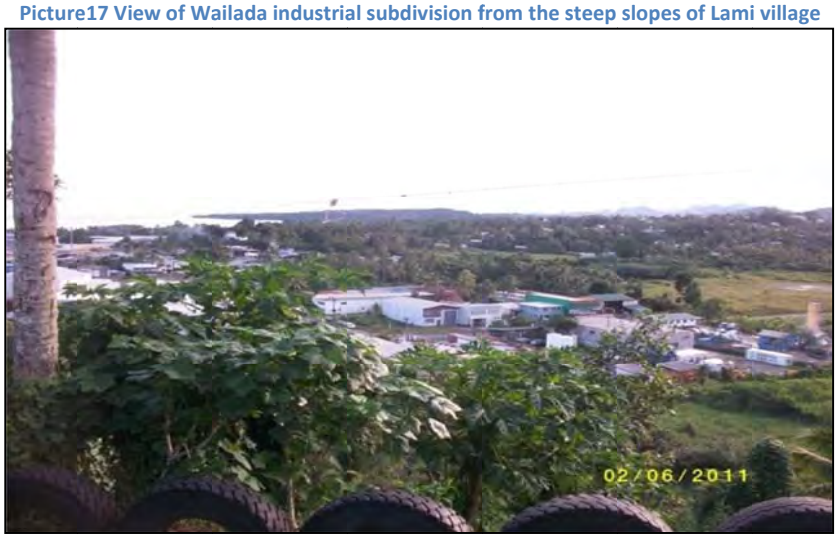
Reticulated water and power lines have been installed within the subdivision and access into the subdivision is off the main highway. The internal subdivision access roads are also in a deteriorated state overgrown with grass and subject to weathering and erosion.

**Picture 16 Bottom left – Coastal erosion along Baro subdivision foreshore, eroding rock revetment wall containing loose and fraying geo-textile material.**

#### 3.3.1.2 Nukuwatu and Wailada Industrial

Nukuwatu and Wailada industrial subdivisions are in Lami's Central ward on flat terrain. The eastern perimeters of Wailada are immediately backed by steep slopes that form the boundaries for Lami village.

Picture17 View of Wailada industrial subdivision from the steep slopes of Lami village




There are approximately 158 industrial lots within this subdivision (zoned as general industrial areas) with only two remaining vacant industrial lots available (September, 2011). The increase in demand for industrial land within Lami has resulted in the opening up of native lease land between the existing Wailada industrial area and the Matata settlement area where an industrial subdivision scheme plan has been approved.

With the increase pressures of development, the small clusters of mangrove abutting the north eastern Wailada industrial area is the subject of a foreshore lease application to be reclaimed for industrial purposes (i.e. cement factory). This area is part of the stormwater catchment area which has over time silted up –causing some of the flooding downstream due to the lack of maintenance.

The majority of the Wailada industrial area is on reclaimed land and abuts the Lami River on the western side of its boundary. These industrial lots are prone to flooding during extreme storm conditions, heavy rainfall and spring tides. Poor drainage capacity and the low lying nature of the Wailada industrial land is also a cause for concern and therefore, should be taken on board when considering new development applications in the area to include raised ground or floor levels for all new structures and a re-assessment of the existing coastal protection and drainage options being used or proposed taking into account sea level rise and increase river flows as a result of high precipitation.

Public transportation (bus services) is the main mode of transportation for employees in the two industrial areas with a modest number of employees (residents n nearby settlements and communities) walking to work particularly. Utility services in these industrial areas include electricity, reticulated water and telecommunications. The Wailada industrial subdivision is connected to a reticulated sewage system via a pump station which is managed by the Water Authority of Fiji, however, it is likely that not all wastewater are being disposed via the reticulated

system and on-site requirements for storage, treatment and disposal of wastewater should be carefully monitored by the Lami Town Council, Water Authority of Fiji and the Waste Unit within Department of Environment. Solid waste is generally collected by the Council and industrial waste is often stored on site and/or disposed of by the industrial operator which similarly should be monitored carefully to avoid irresponsible disposal of solid waste.

Picture 19 Walida Industrial surrounded by Lami River


#### 3.3.1.3 Wailekutu Industrial

Wailekutu industrial area is on the western perimeters of Lami's boundaries and is a Heavy industry zone, with businesses ranging from the manufacture of detergents (CJ Patel) to the manufacture of cement (Fiji Industries Limited). The cement factory is one of the longest running businesses in the area, having commenced operations in 1962. It supplies cement for Fiji and other Pacific island countries, and has an approximate production capacity of 300 tonnes of cement per day.

Topography of the area comprises of flat to gently sloping with some areas being reclaimed using engineeed fill to raise the ground levels, whilst a large portion behind the cement factory comprises of steeply sloping and hilly terrain. The reclamation areas have included on-site drainage which is diverted to adjacent low lying areas and seems to be causing some flooding issues for nearby settlements and communities. Furthermore, these raised platforms will also need to ensure that its periphery embankments are appropriately stabilized and protected to avoid erosion into the adjacent areas. These protection measures can either be engineered with rock walls, gabion rock baskets or geotextile sand bags but options for more traditional approaches through the planting of vetiver grass should be encouraged. In terms of the hilly terrain at the backdrop of the industrial area, this area is still covered with dense forest cover and is relatively undeveloped and therefore, any future development of this industrial zoned land should be carefully considered by Lami Town Council to ensure that minimal vegetation clearance is encouraged, cleared areas are not exposed to long periods heavy rain to avoid landslides and sedimentation of nearby waterways and to ensure appropriate building structures and drainage catchments are constructed in the area.

Utility services in the area include electricity, reticulated water and telecommunications. Wailekutu is unsewered and industrial businesses are primarily responsible of providing their own septic tanks for sewage treatment and disposal, whilst solid waste is collected by Council.

### 3.3.2 Commercial Areas

Lami's Central Business District is a small area situated on either side of the Suva Nadi Highway within the coastal centre of Lami town boundary and houses most of Lami's commercial business services. Other smaller commercial businesses, in the form of dairy shops, tailors and home offices, can be sparsely found in residential subdivisions within Lami but is very limited. Commercial zoned land makes up only 4% of Lami's total land and because of the lack of commercial space within Lami, options for expansion are limited and the request for conversion or re-zoning of some residential areas into commercial areas seem to be gradually growing, with small pockets of wholesale/retail and commercial offices also found within the industrial areas.

Over the last 7 years from 2005 to 2011, Lami Town Council has received a total of 48 applications (see Table 16 below) for commercial purposes including construction of new buildings. Interestingly four rezoning applications to convert residential zoned land into commercial zone indicate an increasing trend for demand for the need for the town centre expansion to create additional commercial areas.

**Table 16 Building and Rezoning Applications for Commercial Purposes in Lami from 2005-2011**

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|
| Building Applications for Commercial Use | 7 | 6 | 10 | 10 | 7 | 8 | 4 |
| Applications for Re-zoning from Residential/General Industrial to Commercial | - | 1 | - | - | 1 | 2 | - |

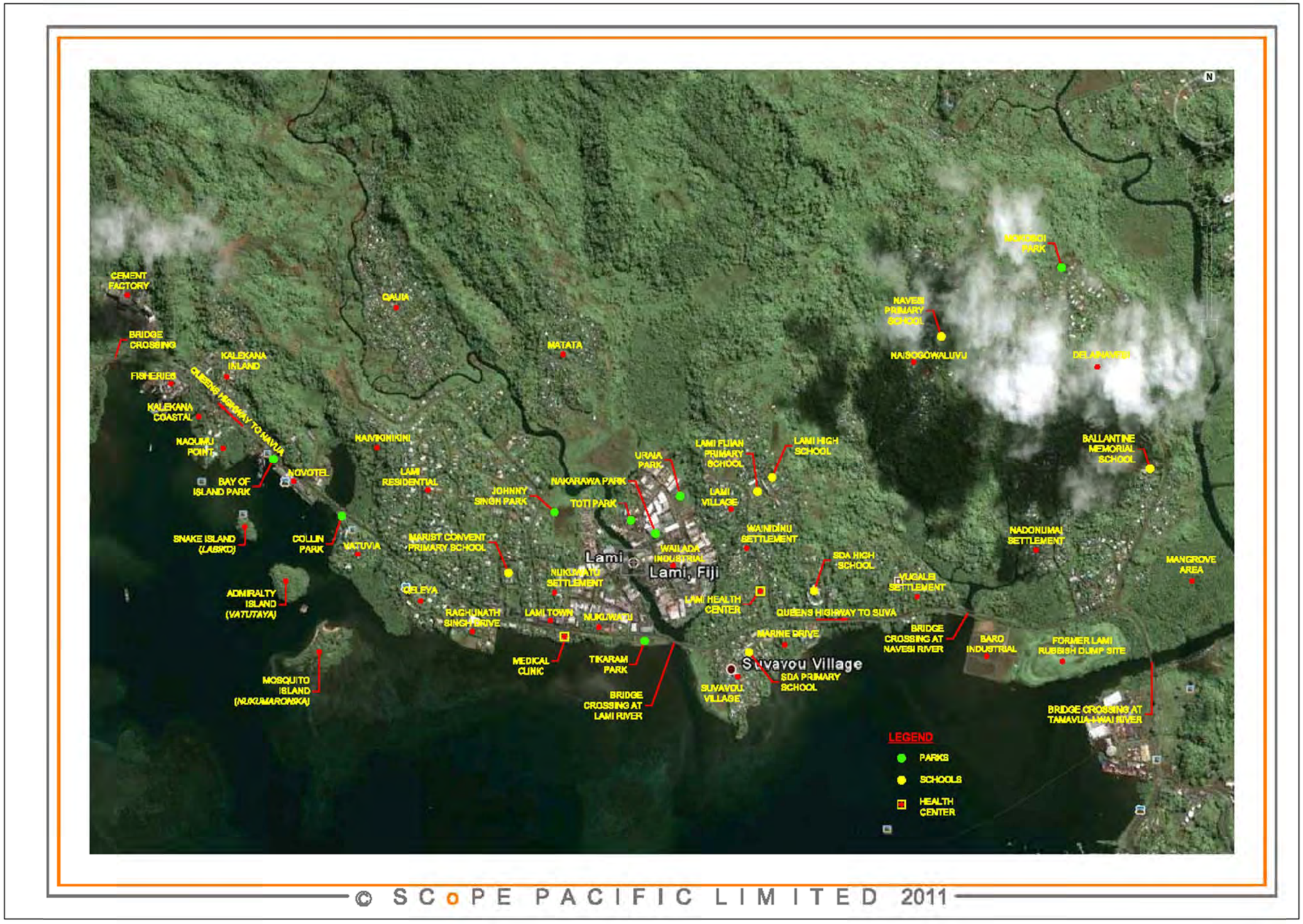
Table 17 lists the types of businesses in Lami and are considered to be of a variety but with opportunity for smaller business operations to cater for the growing population in the peri-urban area. A decentralized town centre may also be an option for Lami Town Council to reduce the clutter and congestion often experienced in Lami Town during peak periods.

**Table 17 Types of Commercial Businesses in Lami**

| **Commercial Business Types in Lami** | | | |
|---|---|---|---|
| Agent Bank | Driving School | Maker Handicraft and Smallware including Woodcarving | Service Station with retail outlet |
| Agent Betting | Engineer Mechanical | Manufacturer not otherwise defined | Services Investigation |
| Agent Communication | Engineer not otherwise defined | Masseur | Shop Engineering small light |
| Agent Gas (Cooking) | Exporter Goods not otherwise defined | Medical Practitioner | Shop Green Grocer |
| Baker with retail price | Exporters Fish, Vegetables, Fruits, Root crops and Kava | Nursery Plant | Shop Large Supermarket type without liquor licence |
| Barber and Hairdresser | Garbage Fees Collector | Operator Proprietor Bus | Shop Large Supermarket with liquor licence |
| Beauty Salon | Hauler Heavy Goods | Operator Proprietor Taxi (per car) | Shop not otherwise defined |
| Book Shop with Stationary | Hawker others | Pest Control and Weed Control | Shop not otherwise defined |

| | | | |
|---|---|---|---|
| Business not otherwise defined | Hawker selling from other means | Photographic Studio | Shop Retail |
| Business or Profession not otherwise defined | Hawker selling from vehicles | Pounding Kava and other goods | Shop Small Retailers |
| Butcher not otherwise defined | Hire not otherwise defined | Processing Food Distribution | Shop Tailor and Drapery |
| Chartered Accountant/Auditor | Hire Plant | Refreshment bar | Shop Wholesale |
| Chemist | Hire Video Films | Repairer Office Equipment | Small Engine Repair |
| Commercial Bulk Store/Warehouse Storage | Hotel with Liquor Licence/ Refreshment Bar/Restaurant | Restaurant with liquor licence | Structural Engineer |
| Consultant Environmental and Health Services | Installer Car Alarm Systems | Restaurant without liquor licence | Supplier Gas |
| Consultant not otherwise defined | Installer of Alarm Systems | School Commercial | Takeaway |
| Dealer not otherwise defined | Instructor of Scuba Diving / Surf Sailing | Scrap Buyers | |

Figure 23 Different Areas within Lami including Residential, Commercial and Industrial areas, Bridge Infrastructure, Parks, Schools and Health Centres (Source: Google Earth, 2009 imagery)



## 3.4 Civic Areas

Figure 23 above is an aerial image which shows the locations of schools, parks, health centres and a cemetery along with residential, commercial and industrial areas and some of the major infrastructure such as bridges within Lami Town.

### 3.4.1 Recreational Areas

Lami is a coastal town and provides opportunity for residents to use foreshore areas and waterways for recreational purposes that include swimming, fishing, water sports, having picnics, etc. Places most widely used for these activities include the Navesi river and foreshore area to the east of Lami town and Draunibota Bay, also known as the Bay of Islands, to the west of Lami town. Other recreational areas within Lami include 8 parks or public open spaces that are situated in both residential and commercial subdivisions and which are commonly used for sporting activities, picnics, public gatherings, etc.

It is important to note that Lami's foreshore areas and waterways are a source of livelihood for many lower-income residents in Lami's settlements. The community surveys noted that many such residents use the foreshores and waterways to fish and collect shellfish and crabs for subsistence use, and sometimes for bathing and/or drinking purposes and for washing clothes. River systems within Lami include the Tamavua-i-wai, Navesi, Lami, Wailekutu and Veisari rivers; these rivers are sometimes used for the abovementioned activities, as are smaller springs and creeks in upstream areas that are used for drinking purposes during lengthy periods between water cuts by WAF.

It is also important to note that though situated within Lami, foreshore areas come under the control of the State and not the Lami Town Council so the local municipality has had difficulty in controlling/ keeping up with foreshore developments that arise within Lami. As a result, there has been some controversy over current and/or proposed foreshore developments that are predicted to have a negative impact on surrounding communities and areas but are out of the local authority's jurisdiction.

### 3.4.2 Schools

There are a total of seven schools within Lami; 4 primary schools and 3 secondary schools.

These are listed below in Table 18:

**Table 18 List of Schools and their Locations in Lami**

| Lami Schools | | |
|---|---|---|
| **Primary School** | | **Location** |
| 1 | Marist Convent Primary School | Solomoni St, Marine Drive |
| 2 | Lami Fijian Primary School | Lami Village |
| 3 | Navesi Primary School | Nakauvadra Rd, Delainavesi |
| 4 | SDA Primary School | Marine Drive |

| Secondary School | | Location |
|---|---|---|
| 5 | Ballantine Memorial School | Delainavesi |
| 6 | Lami High School | Lami Village |
| 7 | SDA High School | Marine Drive |

Schools are also included in the V&AA study due to their common use as evacuation centres during times of natural disasters. School buildings and infrastructure are often located on higher ground and considered more secure than most of the shelters within the nearby settlements in low lying areas and are safe areas for many people during flooding, cyclones and tsunami events. In Lami, the only school that could potentially be at risk is the SDA Primary school located on the coastline and though slightly elevated may still be at risk in the event of a tsunami and during cyclones.

### 3.4.3 Health/Medical Centres

There are 3 health centres in Lami as listed in Table 19. Of these, one is a public health centre on Lami Village Road and caters for the entire Lami area and two are private medical clinics situated on either side of the Lami Town Council building in Lami's commercial centre.

Table 19 List of Health/Medical Centres locations in Lami

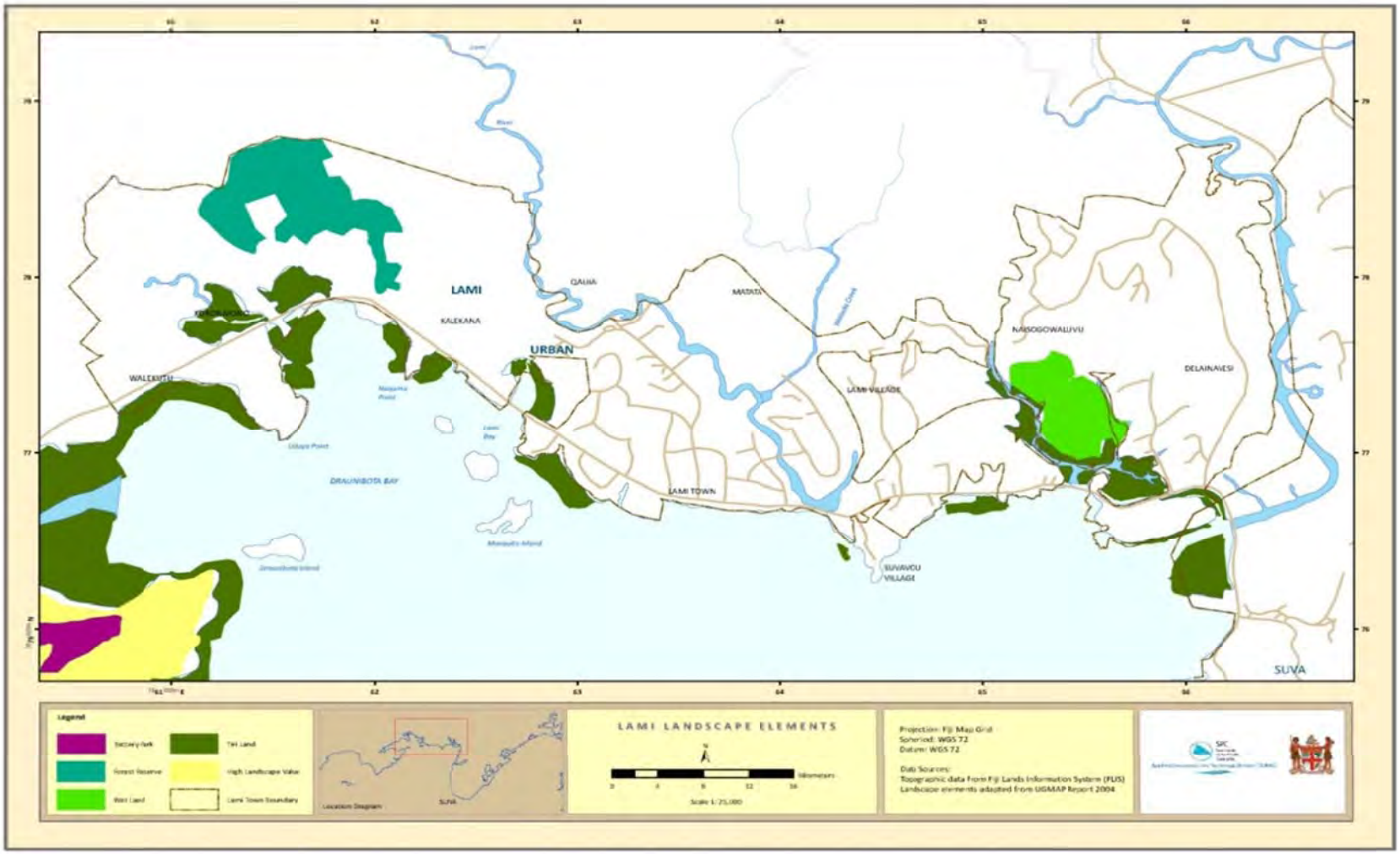
| Lami Health Centres | | |
|---|---|---|
| Name | | Location |
| 1 | Lami Health Centre | Lami Village Road, Lami Village |
| 2 | Grace Medical Centre | Marine Drive, CBD |
| 3 | Lami Medical Centre | Marine Drive, CBD |

Health centres provide vital medical services for Lami and need to be relatively accessible, particularly in the event of a natural disaster and other emergency events. The coastal location of the two private medical centres places them at risk of adverse impacts from climate change events like sea level rise, extreme events like storm surges and natural disasters like tsunamis. The Lami Health Centre is located on higher ground though access is difficult from other areas within Lami as people would be required to travel along the Suva-Nadi Highway and several bridges to get to the medical centre for assistance.

### 3.4.4 Nature Reserves, Foreshore and Mangrove (*Tiri*) Areas

There are three islands within Draunibota Bay; *Labiko* (Snake Island), *Vatutaya* (Admiralty Island) and *Nukumaronika* (Mosquito Island) (see Figure 24). These islands were declared as forest reserves in a bid to protect and preserve the islands' natural vegetation and wildlife habitats. The wildlife on these islands mainly comprise of native birds. The State owned islands cover a total area of 40 acres.

**Figure 24 Areas of High Natural Importance, including *Tiri* Areas (highlighted in Olive Green)**




*Source: SOPAC, 2011*

There are mangrove areas within Draunibota Bay, along the Delainavesi side of Tamavua River and some other coastal areas in Lami which is in parts depicted in Figure 24. The Lami Town Planning Scheme Report of Survey (1998) identified approximately 141.6 acres of standing *tiri* areas that were significant to Lami. Although *tiri* areas are situated below the high water mark and technically outside of Lami Town's boundaries, they have been included in the V&AA study because of their importance in stabilizing Lami's coastlines and as a barrier against strong wave action. Further, their capacities to work as natural carbon sinks, if new seedlings are planted (having the ability to absorb $CO_2$ from the atmosphere into the soil) and as important breeding grounds and nurseries for coastal fisheries which are a source of livelihood within settlement areas.

The Department of Lands, Ministry of Lands, Mineral Resources and Environment is the approving authority for all applications proposing development of foreshore area; consequently the Lami Town Council has no jurisdiction over the foreshore areas, other than as a stakeholder who may be consulted as part of the assessment process of foreshore development applications for a state development lease. To date the Department of Lands has received several proposals for the development of foreshore areas in Lami ranging from small areas comprising of one to six lot subdivision proposals to large expanses of foreshore for residential, special use marina and commercial areas. If approved, this could result in the clearance and destruction of mangrove areas with potential irreversible changes to the coastal process within the Bay causing detrimental effect on Lami's coastal fisheries and coastlines.

Lami Town Council together with the Department of Town and Country Planning should take an active role in the decision making on the use of these abutting foreshore areas. Lami Town Council should take the lead role in developing a long term foreshore master plan, in consultation with the traditional qoliqoli owners, to identify restricted foreshore areas for future development but more importantly, future areas for protection and better management taking into consideration climate change impacts such as coast erosion, sea level rise and inundation during storm surge events.

## 3.5 Infrastructure, Public Utilities and Waste Services

Lami Town Council is responsible for a number of infrastructure and utility services, and waste collection services. These services include bridges, roads, streetlights, stormwater drainage and side road drains. Note that these services are often not restricted to those ratepayers of Lami but to others who live within the peri-urban areas of Lami as well as to workers and road users that commute either to or through Lami. The only two services which Council is fully in charge of delivering are waste collection services and street lighting services.

The challenge for Lami Town Council is to ensure that all properties within their boundaries are well serviced by appropriate urban infrastructure, a large proportion of the infrastructure services are provided by other stakeholders which include, Water Authority of Fiji (water and sewer), Department of National Roads (roads and bridges), Fiji Electricity Authority (electricity) and Telecom Fiji (telecommunications).

The provision and coordination of these services by the various agencies is an extremely challenging task for Lami Town Council as each of these agencies have different budgets, priorities and objectives to achieve for different part of Fiji.

### 3.5.1 Bridges

There are 7 bridges within Lami (listed in Table 20 below); 5 of these bridges belong to the State and administered by the Department of National Roads, Ministry of Works, Transport and Public Utilities while 2 are under the jurisdiction of the Lami Town Council (refer to previous Figure for locations of bridges within Lami). Maintenance of the bridges is carried out as according to ownership.

**Table 20 List of Bridges in Lami**

| | Bridge Name | Ownership | Length of Bridge (m) | Width (m) | Area ($m^2$) | Footpath Width (m) |
|---|---|---|---|---|---|---|
| 1 | Delainavesi | Department of National Roads | 89.6 | 7.4 | 663.04 | 1.2 |
| 2 | Vugalei | Department of National Roads | 51.3 | 7.4 | 379.62 | 1.2 |
| 3 | Suvavou | Department of National Roads | 52.1 | 6.1 | 317.81 | 0.77 |
| 4 | Wailada | Lami Town Council | 37.45 | 7.4 | 277.13 | 1.5 |
| 5 | Fiji Industries Ltd | Lami Town Council | 57.1 | 7.55 | 431.105 | 1 |
| 6 | Samoa | Department of National Roads | 43.8 | 7.4 | 324.12 | 0.9 |
| 7 | Wailekutu | Department of National Roads | 22.3 | 7.4 | 165.02 | 0.95 |

### 3.4.2 Roads

There are 47 roads within Lami, 30 of which are State-owned and 17 under the jurisdiction of the Lami Town Council. Maintenance of the roads is carried out as according to ownership. A list of the road register is attached as Appendix I.

The main Suva-Nadi highway (Queens Road) traverses Lami town and is connected to the capital city by Marine Drive (the main highway for traffic to/from the Central and Western Divisions and is the main traffic route in town.

As the main highway linking Suva to the western division, the Queens Road is maintained by the [11]Department of National Roads (DNR), which conducts annual traffic counts to ascertain the volume of traffic that uses the national highway. Traffic data obtained from DNR for the stretch of the main highway before Lami's CBD and industrial sectors for the years 2007 – 2009 indicates that approximately 11,524 vehicles travel to and from Suva daily. However the volume of traffic decreases to approximately 7,506 vehicles past Lami's CBD and Nukuwatu/Wailada industrial subdivisions, which indicates that approximately 4,018 vehicles move within Lami's central commercial and industrial areas daily.

The most common types of vehicles are cars and taxis, followed by vans and small utility vehicles (SUVs). Other vehicles that also regularly traverse the Queens Road and CBD (including industrial

[11] Department of National Roads (DNR) under the Ministry of Works, Transport and Public Utilities.

subdivisions) are goods haulers (light goods, medium goods and heavy goods), buses and motor cycles.

Feeder roads connected to Marine Drive include Delainavesi Road (main road in the Eastern ward, and Nasevou, Solomoni and Mawi streets in the Central ward. Settled areas in the Western ward are directly linked to and dependent on the Suva-Nadi highway for travel and transportation. Data collected from surveyed areas in all three of Lami's wards as well as the CBD and central industrial sectors indicate that public transportation in the form of buses, mini-buses and taxis are the main mode of transportation for many.

Substandard or second-rate roads are common in unsubdivided or informal settlements; consequently vehicular access is required in most settlements. Most of these roads were constructed through national government's help or funding from self-help projects, and are mostly graveled instead of tar-sealed. Therefore with the exception of Nadonumai settlement, bus transport is commonly not provided within these roads due to the poor condition of the roads. And though the settlements are situated within Lami's town boundaries, the Council is not responsible for their maintenance.

### 3.4.4 Drainage

Lami has poor drainage capacity, which makes flooding a common problem. Poor engineering and design of drains, siltation of drains, coupled with the problem of pollution of waterways with solid and green waste, are the main causes of blockage of the drains. These blockages result in the flooding of the drains and adjacent low-lying areas during heavy rainfall events.

### 3.4.5 Water Supply

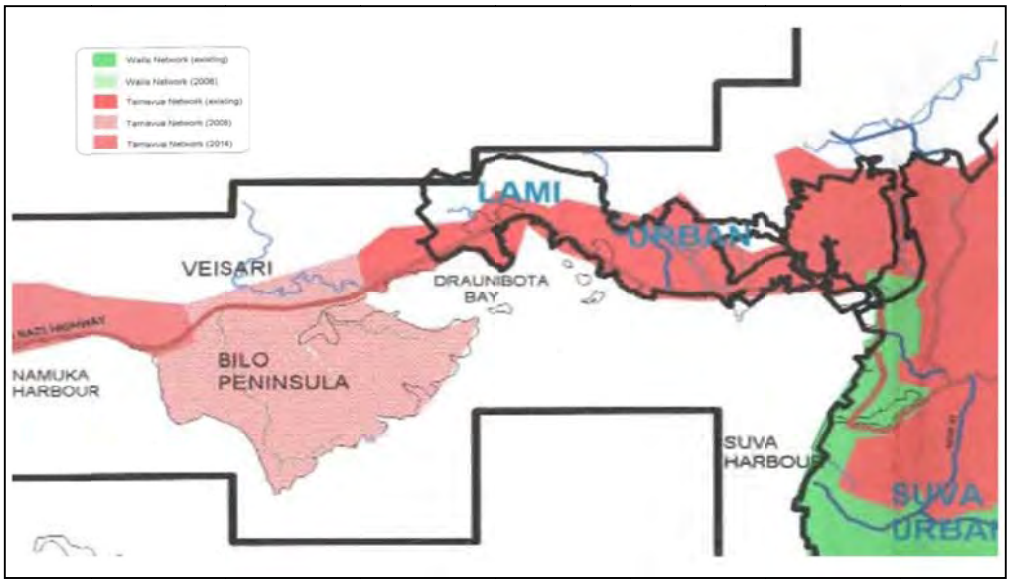
The whole of Lami is currently reticulated by the Water Authority of Fiji supplied by the Tamavua Network from Wailoku catchment (Figure 25). The water supply system is generally good although a major problem affecting the reticulated network is the frequency of water cuts as the current network has difficulty supplying the population compounded by and old pipe network.

Consequently most of Lami's residents store water for use during times of water cuts. The peri-urban location of some settlements like Matata and the scattered residences on the backland of Kalekana and Wailekutu that are situated at quite a distance from the reticulated system, on steep topography in some areas, has resulted in the use of other water sources like rainwater collection, boreholes, rivers and creeks.

Water is stored in storage tanks, drums, buckets, bottles, and some settlements like Matata also have underground wells that store rainwater and/or tap water. WAF supplies carted water by water tank trunks during water cuts. However these trucks are considered unreliable by many as they only supply water to some areas, and rarely service settlements due to the poor condition of the roads.

At present Lami's peri-urban areas of Veisari and Bilo are not reticulated; however there are plans by WAF to include these areas by 2014. WAF is also involved in various water upgrading projects within Lami (from Delainavesi to Kalekana and Veisari) and the rest of the Greater Suva area.

Figure 25 Lami Water Supply Network by Water Authority of Fiji

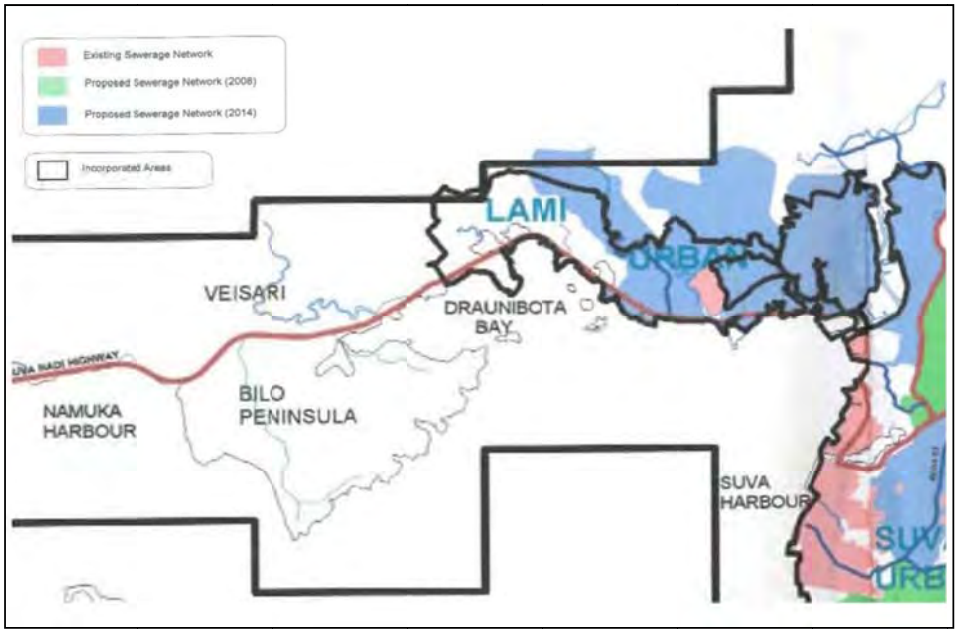



*(Source: UGMAP: Department of Town and Country Planning, 2004)*

### 3.4.6 Sewerage Disposal

A reticulated sewerage system is only provided in the Wailada industrial subdivision (a sewerage treatment plant that services the subdivision) and the Novotel hotel has a private sewerage treatment plant that caters for its operations. Plans to have Lami area connected to a reticulated sewerage network have been in place since 2004 with connection to be made by 2014 (see Figure 26 below), though WAF have yet to confirm if/when these works are likely to take place as a significant amount of infrastructure and budget is required to have these works implemented.

Figure 26 Lami Existing and Proposed Sewerage Networks for 2014




*(Source: UGMAP: Department of Town and Country Planning, 2004)*

At present, the most common method of sewage disposal is septic tanks in subdivided areas and the informal settlements both in town and in the peri-urban areas. Other methods of sewage disposal also include the use of water-sealed toilets and pit latrines that discharge waste into in-ground pits. When the pits are full they are sealed/filled with soil and new locations for pits are established. Although these practices are not recommended or encouraged by the Ministry of Health due to health and environmental concerns, they are more affordable options for some residents in informal settlements.

The type of sewage disposal within an area determines the density and lot sizes likely to be approved by the Director of Town & Country Planning as specified under the Town Planning General Provisions for all subdivisions. For Lami Town, the absence of a reticulated sewerage system has contributed to all the residential areas being zoned Residential B for low density whereby the minimum site area for each residential lot is 800m² and each of these residential lots are restricted to the development of a maximum floor area of 20% of the site area (ie. plot ratio of 0.2:1). For example, for a site of 800sqm, the floor area of the residential building cannot be greater than 160sqm. The topographical constraints of most of the residential land in Lami also restrict the development capacity for higher densities. For the settlements, land per household is limited so if they are using a septic tank it is likely to be communal system shared by a number of households or they are using alternative low costs system such as pit latrines and bucket flush.

Of the industrial areas surveyed, 30% stated that liquid wastes are discharged directly into the premises' septic tank; 15% discharge into waste traps, 13% discharge directly into nearby drains and waterways, 11% discharge to the Wailada Sewerage Treatment Plant (STP) and nearby drains and waterways, and 4% discharge directly to the STP. Liquid wastes discharged from companies' premises include washing and kitchen waste water, liquid detergents, acids, oil/diesel waste and others (usually into the sewage system). 2% stated no discharge of any liquid waste.

Wastewater generated by households is greywater – kitchen, bathing and laundry water. Because Lami is unsewered, greywater is normally disposed off directly into nearby drains or waterways, in gardens alongside homes, on hillsides, or is discharged into septic tanks.

### 3.4.7 Electricity

Electricity is available in most areas of Lami although not all households in informal settlements are connected due to financial constraints, the state of some houses (e.g. broken down houses), or topographical locations that make access difficult as observed in some households in Kalekana, Matata and Naisogowaluvu.

The majority of residents interviewed (48%) in formal residential areas spend either $50 - $70 or less than $50 on electricity per month; 11% pay $70 - $100 for their use of electricity and a further 11% pay more than $100. About 3% pay approximately $500 per month for their use of electricity.

Within the surveyed settlement areas, 76% - 86% have access to electricity; with the majority of households indicated an approximate $20 - $100 per month for electricity costs. Those without electricity depend on kerosene lamps, lanterns, candles, chargeable or solar lights and batteries for lighting purposes. In some cases, as in Kalekana, several households source electricity from one household's power line and the monthly electricity bill is split between the households involved in the power/electricity- sharing.

96% of companies interviewed had access to electricity - the majority spending less than $200 on monthly electricity bills. 23% pay $200 - $500 for electricity, 11% pay $500 - $1000, and 19% pay more than $1000 per month on electricity.

53% of those surveyed stated that they are not aware of the energy audits and schemes advertised by the Department of Energy, as part of the efforts to assist companies in reducing energy consumption and emission levels. Of this figure, 34% stated that they would be interested in knowing more about and participating in the energy audits schemes while 9% stated that they were not interested.

### 3.4.3 Streetlights

There are approximately 300 streetlights in Lami for which Lami Town Council is responsible for. Streetlights currently use sodium lamps; however the Council is hoping to switch to solar (street) lights in the near future. The draft GHG profile of Lami Town Council's operations highlights a significant amount of Council's annual expenditure spent on the electricity to power street lights in Lami including in some of the informal settlement and peri-urban areas.

### 3.4.8 Solid Waste

Garbage is collected twice a week by the Council, with regular pickup of garden and other household refuse from developed areas with proper roads maintained by the Council. The Council collects solid waste from informal settlements within town boundaries, with the exception of Matata and Naisogowaluvu whose topographical location limits road access; individual households that wish to have their rubbish collected (from designated collection areas) by the Council pay annual garbage fees of $80 which is collected on a quarterly basis by Council to make it more affordable for these communities.

Solid wastes generated by households include kitchen waste and vegetable peelings, paper, plastics, and tin cans/metals. Households in the informal settlements, burn paper and plastic rubbish, and vegetable peelings and food waste are recycled in gardens or fed to pigs. Metals (commonly tin cans), are usually collected by the Council provided waste collection services. Where this service is unavailable e.g. Matata settlement (due to lack of road access) into the settlement, households have allocated areas near their houses where rubbish is heaped. Some households dispose of their rubbish in nearby rivers and creeks.

Naisogowaluvu in the upper regions of Delainavesi does not have access to the Council collection service due to an absence of access roads. Residents trek to the nearest access road and place their rubbish by the road-side, which is problematic as stray dogs strew the contents all along the road-sides. Those that opt not to leave the settlement to dispose of their rubbish recycle green waste in gardens or feed these to pigs. Metal wastes are buried in ground pits.

In the commercial and industrial sectors, solid wastes generated on premises consist of papers and plastics, kitchen waste, green waste and metals. Industrial and commercial wastes normally comprise of by-product waste, rubber, scrap metals, waste concrete and vehicle parts, while solid waste in areas other than commercial and industrial centres comprises green waste and others. 62% of those interviewed rely on the Council-provided waste collection services while 23% rely on Waste Care Services, a company that provides large rubbish skips for residents that are willing to pay them, and disposes of the rubbish after a certain amount of time e.g. after 6 months, depending on how

long it takes for the skips to get full. Some waste is recycled (6%), sold (2%) or taken to the Naboro landfill (2%). Some companies have other means of disposal for their solid waste (6%).

The EU under the 9th EDF – Project 9 ACP FIJ 5 and 6 is undertaking "Fiji Solid Waste – Lami Dump Rehabilitation" which commenced in 2010. The ex-Lami dump sits on Crown land under the administration of the [12]Department of Lands and Survey. The Lami dump opened in 1954 and by its closure in 2005, waste layers had reached a height of up to 17 metres above the surrounding terrain. The dump site covers an area of about 75,000$m^2$ and borders the Tamavua River and Queens Road. At the time of its closure, the dump had recorded an annual waste deposit of 40,000-50,000 tonnes and the total quantity of waste in the dump amounted to approximately 800,000 tonnes. A topographic survey completed in 2009 (EU/DoE project) illustrated that the total volume of waste (4 years after the closure of the dump) was about 735,000$m^3$.

The base of the rehabilitated Lami dump is approximately at mean sea level, exposing the site to variations of sea levels and potential tsunamis. Although outer reefs reduce waves, the tide is powerful and the ex-dump site is at risk for tsunamis. The EU's Project Formulation Mission report, however, advised that securing the site against a tsunami would be too costly.

The key activities for restoring the Lami dump included covering the waste body with a landfill gas drainage layer and a layer of relatively impermeable topsoil, landscaping, and an erosion protection structure along the Tamavua River. A proposed installation of landfill gas flaring equipment and gas utilisation equipment did not come to fruition. Initial studies found that the quantities of methane gas emitted from the old Lami dump were estimated at 1.1 million $m^3$ in 2009, with a predicted slow decrease to 576,000 $m^3$ by the year 2020 (Hydea & Tavolini, 2009).

According to EU's Report there are environmental risks still at the Lami dump; these include the discharge of leachate, the emission of gas, and the risk of fire (as was experienced in 2005) or tidal waves. The EU Project Formulation Mission reported that environmental impacts from leachate discharge are minimal as there are no ground water wells in close proximity of the ex-dump, and chemical analyses of samples obtained from around and within the site indicate minimal contamination as well as no heavy metal contamination of sediments close to the dump site.

**Picture 20 Old Lami Dump Prior to Rehabilitation**

Observations of the site indicate that rubbish situated along the coastal peripheries is falling into the sea due to tidal and wave action (see Picture 20 below). This may have detrimental effects for coastal fisheries and nearby mangrove areas that also act as a nursery and breeding ground for fish, as well as decrease the aesthetic values of nearby

[12] Department of Lands and Survey comes under the jurisdiction of the Ministry of Lands, Mineral Resources and Environment.

coastal areas where waves may end up depositing rubbish.

The shorelines around the harbour are relatively stable or influenced only by very low rates of erosion. The offshore barrier reef protects part of the Lami shoreline, including the ex-dump, from ocean swells. An EIA conducted for the nearby Rokobili site noted a low-energy hydrodynamic regime characterising both the Rokobili site and the ex-dump site. The assessment noted that the ex-dump site is surrounded by mangrove swamps and flooding would increase the water level in the swamp, but not substantially increase the water level and velocity at the Tamavua river mouth, where the dump is located. The Rokobili EIA estimates that a 100-year return period flood flow of 370 $m^3$/s for Tamavua River would create a backwater effect of 40 cm at the river mouth and 6 cm at the road bridge. In practice, the velocities that would occur across the delta are high enough to mobilise the sand bed and form a new channel along the side of the reclamation, thus reducing the actual backwater effect.

# 4 Identifying Key Adaption Options for Lami

Climate-related changes and anthropogenic-induced changes observed include changes in air temperature; hot weather seems to be getting hotter and cold weather seems to be getting colder. Other notable impacts are landslides and flooding especially during heavy rainfall, vulnerable infrastructure especially during storm-induced strong winds and heavy rain, soil erosion in sloping areas that have been cleared of vegetation and along cliff-side areas, storm surges, sea level rise and coastal erosion for those households situated along Lami's coastlines, destabilization of building foundations, uncontrolled clearance of vegetation leaving bare patches in some areas, and changes in vegetation resulting from changes in weather patterns.

The following findings were identified as part of the V&AA:

- Households are situated along steep slopes prone to landslides and erosion and in low-lying areas susceptible to flooding during high rainfall events.
- Consequently some residents have had to relocate or adjust homes to adapt to climate-related changes e.g. increased flooding.
- Lami's foreshore and low-lying coastal communities, its CBD and industrial sectors and associated infrastructure and utilities are the most vulnerable to impacts of climate change, as are communities and industry situated near or on floodplains and flood-prone areas; and locations prone to landslides and/or soil erosion;
- Certain bridges are considered as hazardous areas that require careful planning because during high rainfall events and associated flooding human lives are placed at risk when rivers flood. One resident mentioned that parents normally carry their children on their backs and carry them across bridges during flooding events.
- The majority of the residential, commercial and industrial sectors interviewed stated their support for Lami Town Council's initiative to undertake a Vulnerability and Adaptation Assessment because it would; educate people and create awareness about climate change and its impacts, living standards and infrastructure could be improved, outline options for better management of solid waste, that people would be able to voice their opinions and concerns about climate change, ensure safety for company premises and employees, and that successful implementation of the adaptation options highlighted in the V&AA could help to improve and ensure the protection of the environment.
- The commercial and industrial sectors stated that the V&AA would help create awareness on appropriate measures to be taken by the community during the event of a natural disaster. Other benefits of the V&AA envisaged by these two sectors were that the adaptation options highlighted would help prevent or reduce mishaps and would help communities to identify the types and levels of risks as well as ways to overcome or adapt to these risks. Other benefits highlighted included the decrease in pollution and increase in recyclable materials, assistance to build more resilient communities that are better prepared to face the impacts of climate change, and assistance to improve the circumstances of community members and would pin-point critical issues within the community that need to be seen to.

- Current mitigation measures by community members include reduced energy consumption and reduced carbon emissions. Residents do not burn rubbish, and only burn papers and plastics on a monthly basis. Other measures include the relocation of homes situated near hazard areas, better management of solid waste disposal, planting of more trees, reducing the number of trees cut down, alternative water sources and better storage, and adapting housing and living conditions e.g. some households have reconstructed homes on wooden/ concrete piles to prevent floodwaters from entering their homes.
- The main concerns and issues highlighted by households were the need for improvement of infrastructure e.g. flood-prone bridges and absence of streetlights along some roads which poses a danger for children and female residents using the roads at night, as well as the need of proper footpaths and walkways within settlements. Other issues include the current methods of solid waste disposal, flooding of nearby rivers, creeks and low lying areas, the increasing frequency of water cuts by WAF, and poor construction of houses in steep areas.
- High concern for the erosion of hillsides and riverbanks during high rainfall events, causing water to divert into some settlements, and the occurrence of landslides following extreme rainfall events. Residents stated that proper revetment walls are needed along rivers and creeks to prevent further riverbank erosion.
- Some settlements are seeking assistance for community water storage tanks for use during times of water cuts.
- The need for a community skip for rubbish disposal, and the construction of roads into settlement areas e.g. Naisogowaluvu and the higher Samoan settlement areas where majority of households are situated.
- Companies highlighted the overflowing and blocked drains that cause or exacerbate flooding as a priority concern. Other issues included, the deteriorating state of roads, the littering and polluting of Lami River, the harvesting of coral, disposal of oil wastes into the environment, and the dangers speeding vehicles pose to pedestrians and other vehicles.
- The need for the installation of early warning systems in and around Lami to warn people of impending disasters.

The key impacts that have been identified include flooding and erosion of inland and coastal areas, which assert additional pressure on already compromised infrastructure and utility services struggling to meet increasing population and service demands.

Recommended adaptation options therefore tend towards improved planning and land management, construction of seawalls/rock revetments and mangrove rehabilitation, awareness raising and community programs, livelihoods training and skills upgrading, relocation of settlements and creation of evacuation centres, and improvement of existing infrastructure and utilities.

## 4.1 Surface Flooding

| Impacts | Key Areas/Assets | Adaptation Options |
|---|---|---|
| Surface Flooding | Residential<br>- Qauia<br>- Nukuwatu<br>Settlements<br>- Naisogowaluvu<br>Commercial<br>- CBD<br>Industrial<br>- Wailada<br>- Wailekutu<br>Civic and Recreational<br>- Johnny Singh Park<br>Foreshore areas<br>- Tikaram Park<br>Infrastructure<br>- Stormwater Drains<br>- Road drains<br>- Septic tanks | • Installation of proper drainage systems<br>• Ensure drains are well maintained and free from green and solid waste<br>• Use of plants with high absorption rates i.e. bananas, species of ginger flowers and dalo<br>• Use of appropriate fill and landscaping material to assist with infiltration<br>• Install and maintain roof catchment devices for rainwater harvesting<br>• Avoid surface drainage into reaching nearby rivers and waterways if hazardous chemical substances are being used<br>• All hazardous chemicals and substances should be raised above the ground to avoid contamination of soils and groundwater<br>• Minimal clearance of vegetation<br>• Minimize areas that encourage ponding and stagnation of water to avoid mosquito breeding and spread of disease<br>• Regular collection of solid waste and industrial waste<br>• Encourage mulching and composting of green waste<br>• Upgrading of gravel roads<br>• Raising of road levels and/or aligning roads in low lying areas<br>• Need to connect Lami to reticulated sewerage treatment system<br>• All new development applications for flood prone areas should be required to raise ground or floor levels for all new structure<br>• Re-assessment of drainage options being proposed as part of new development proposals which shall take into consideration flooding level, sea level rise and increase river flows as a result of high precipitation |

## 4.2 River Flooding

| | | |
|---|---|---|
| River Flooding | Residential<br>- Qauia<br>- Lovers Lane<br>Settlements<br>- Naisogowaluvu<br>- Qauia<br>- Matata<br>- Samoan<br>- Nadonumai<br>Civic and Recreation<br>- Johnny Singh Park<br>River bank reserves<br>- Qauia<br>- Navesi<br><br>Infrastructure<br>- All bridges<br>- Gravel roads i.e. Matata Road<br>- Pedestrian walkways | • Detailed River Hydraulics Assessment of Lami, Navesi, Wailekutu and Veisari Rivers to determine changes in river flows and flood risks along these rivers<br>• Mapping of all the built forms that are likely be affected by flooding<br>• Prepare a hazard risk map for Lami including peri-urban areas<br>• Better management of the upper river catchment activities by developing a river catchment management plan with all relevant stakeholders including native land owners and Department of Forestry<br>• Stabilizing of river banks through planting vetiver grass<br>• Construction gabion basket bank protection or rock/concrete walls<br>• Dredging of the rivers<br>• Diversion of the Lami river<br>• Re-enforcement of river banks with gabion baskets or retaining walls<br>• Engineering review of all bridge structures in Lami<br>• Cost benefit analysis of raising or repairing bridges ie. Qauia, Vugalei,<br>• Establishment of appropriate disaster management plans and evacuation areas<br>• Building construction shall be appropriately setback from the river bank<br>• Relocation of highly vulnerable settlements and homes<br>• Need for all new building applications along the river bank to provide river bank protection measures and appropriate drainage provisions<br>• That LTC take a more active role in landuse management and development of peri-urban areas and the upper river catchment areas |

## 4.3 Coastal Flooding

| | | |
|---|---|---|
| Coastal Flooding<br>- Storm surges<br>- Inundation | Residential<br>- Nukuwatu<br>Settlements | • Coastal Processes Assessment of the Suva Bay to understand the coastal dynamics, wave energy and foreshore morphology for decision making purposes |

| | | |
|---|---|---|
| - Sea level rise | - Kalekana Coastal<br>- Wailekutu<br>- Koronivono<br>Commercial<br>- CBD<br>Civic and Recreation<br>- Tikaram Park<br>- Mangrove areas<br>Infrastructure<br>- Bridges<br>- Gravel Roads i.e. Wailekutu and Uduya Point | • Undertake a Mangrove Assessment of all mangroves in the Lami area<br>• Preparation of a Lami Foreshore Master Plan to guide the future development and protection of the foreshore area including the islands and mangrove areas<br>• Mapping of all built forms that are likely be affected by flooding<br>• Prepare a hazard risk map for all areas in Lami including peri-urban areas<br>• Coral replanting<br>• Banning the extraction and sale of coral from the fringing reef in Lami<br>• Mangrove replanting to provide natural coastal protection<br>• Construction of seawalls or engineered bunding to address wave overtopping and sea level rise<br>• Relocation of settlements and/or homes inland i.e. Kalekana coastal to a more formalized subdivision to provide security of tenure<br>• Rezoning of areas to zones that enable uses that are less vulnerable<br>• Raising the ground level of existing settlement above mean sea level to avoid flooding i.e. Koronivono and Wailekutu<br>• Vegetating land with salt and wind tolerant plant species<br>• Need for all new building applications along the coastline to provide appropriate coastal protection measures and appropriate drainage provisions |

## 4.4 Inland Terrestrial Erosion

| | | |
|---|---|---|
| Terrestrial Erosion/ Landslides<br>- Extensive precipitation | Residential<br>- Panoramic<br>- Uduya Point<br>- Delainavesi<br>- Naqumu Point<br>Settlements<br>- Naisogowaluvu<br>- Kalekana Inland | • Installation of proper drainage systems ie. Replace earth drains with concrete drains<br>• Ensure drains are well maintained and free from green and solid waste<br>• Install and maintain roof guttering and tanks for rainwater harvesting<br>• Minimal clearance of vegetation during the wet and rainy periods<br>• Upgrading of gravel roads<br>• Raising of road levels and/or realigning roads in low lying areas<br>• Connect Lami to reticulated sewerage treatment system |

| | | |
|---|---|---|
| | - Wailekutu<br>- Naivikinikini<br>- Samoan<br>Industrial<br>- Wailada<br>- Wailekutu<br>Infrastructure<br>- Gravel access roads i.e. Wailekutu Road<br>- Septic tanks | • Rezoning of areas to zones that enable uses that are less vulnerable<br>• Building construction appropriately setback from unstable slopes and hills<br>• Relocation of households and structures away from steep slopes and hilly terrain<br>• Planting of vetiver grass along edges of slopes where exposes<br>• Enforcement slopes with gabion baskets to protect the embankments from slippage<br>• That LTC take a more active role in landuse management and development of peri-urban areas and the upper river catchment areas |

## 4.5 Riverbank Erosion

| | | |
|---|---|---|
| River Bank Erosion | Residential<br>- Qauia<br>- Lovers Lane<br>Settlements<br>- Qauia<br>- Matata<br>- Samoan<br>- Naisogowaluvu<br>- Nadonumai<br>Industrial<br>- Wailada<br>Infrastructure<br>- Bridges i.e. Qauia, Vugalei, Suvavou, Tamavua-i-wai, Navesi | • Detailed River Hydraulics Assessment of Lami, Navesi, Wailekutu and Veisari Rivers to determine changes in river flows and flood risks along these rivers<br>• Mapping of all the built forms that are likely be affected by flooding<br>• Prepare a hazard risk map for Lami including peri-urban areas<br>• Better management of the upper river catchment activities by development a river catchment management plan with all relevant stakeholders including native land owners and Department of Forestry<br>• Stabilizing of river banks through planting vetiver grass<br>• Construction gabion basket bank protection or rock/concrete walls<br>• Dredging of the rivers<br>• Explore the possibility of diverting the Lami river<br>• Re-enforcement of river banks with gabion baskets or retaining walls<br>• Engineering review of all bridge structures in Lami<br>• Cost benefit analysis of raising or repairing bridges ie. Qauia, Vugalei,<br>• Develop disaster management plans and evacuation areas<br>Building construction shall be appropriately setback from the river bank<br>• That LTC take a more active role in landuse management and development of peri-urban areas and the upper river catchment areas |

## 4.6 Coastal Erosion

| | | |
|---|---|---|
| Coastal Erosion<br>- High wave energy<br>- Storm surges | Residential<br>- Nukuwatu<br>- Uduya Point<br>- Naqumu Point<br>- Vatuvia<br>- Raghunath Singh<br>Settlements<br>- Kalekana Coastal<br>- Wailekutu<br>Commercial<br>- CBD<br>Industrial<br>- Baro<br>Civic and Recreation<br>- Tikaram Park<br>- Mangrove areas<br>- Snake Island<br>- Admiralty Island<br>- Mosquito Island<br>- Colin Park<br>- Bay of Islands Park<br>Infrastructure<br>- Bridges<br>- Gravel Roads i.e. Wailekutu and Uduya Point | • Coastal Processes Assessment of Suva Bay to understand coastal dynamics, wave energy and foreshore morphology for decision making purposes<br>• Undertake a mangrove assessment in the Lami area<br>• Undertake a marine and coral assessment of Suva Harbour and reef system<br>• Preparation of a Lami Foreshore Master Plan to guide future development and protection of the foreshore area (including islands and mangrove areas)<br>• Future developments on the foreshore including all seawall constructions, rock revetment and geo-textile protection, reclamation, rock groyne, jetties, marinas etc shall require a coastal processes assessment to assess the impact on the existing coastline<br>• Mapping of built forms that are likely be affected by eroding banks<br>• Prepare a hazard risk map for Lami including peri-urban areas highlighting coastal erosion hotspots<br>• Coral replanting<br>• Banning the extraction and sale of coral from the fringing reef in Lami<br>• Mangrove replanting to provide natural coastal protection in front of the CBD, Wailekutu bridge and river mouth<br>• Enforce mangrove protection areas i.e. within Kalekana Coastal and Wailekutu settlements and in front of Vatuvia and Naqumu Point residential areas, Suvavou village and Baro Industrial<br>• Construction of seawalls or engineered bunding to address wave overtopping and sea level rise<br>• Relocation of settlements inland i.e. Kalekana coastal to a more formalized subdivision to provide security of tenure<br>• Rezoning of areas to zones that enable uses that are less vulnerable<br>• Raising existing settlement above mean sea level to avoid flooding ie. Koronivono and Wailekutu<br>• Vegetation of land with salt and wind tolerant plant species |

# 5 Critical Strategic Action Areas

Critical actions for Lami are based on the vulnerabilities of identified hotspot areas and are proposed to help Lami adapt to the impacts of climate change and build its resilience to climate change and its associated impacts in future.

The following areas have been identified as needing critical action areas for Lami Town Council to focus on and to include these actions into their Annual Plans and 5 Year Strategic Corporate Plans to further encourage the mainstreaming of adaptation and mitigation options for climate change into their daily operations:

- Coastal zones
- Flood-prone areas
- Human settlement
- Public Utilities and Infrastructure
- Water resources
- Health
- Disaster preparedness
- Greenhouse gas emissions

## 5.1 Coastal zones

Lami's coastal zones are at risk from cyclones, tsunamis, sea level rise, storm surges, and coastal erosion and inundation. Cyclone-induced wave action and storm surges coupled with coral extraction from Suva's barrier reefs are triggering the rapidly increasing erosion of Lami's coastlines, which in turn affects settlements, commercial and industrial areas, infrastructure, and areas of civic and recreational use. Many sectors will be affected because Lami is a coastal town. Recommended critical actions to counter and/or adapt to predicted impacts and disasters include:

- Development of a cyclone storm-surge prediction and warning system and of an effective disaster-mitigation program
- Coastal Processes Assessment of the Suva Bay to understand the coastal dynamics, wave energy and foreshore morphology for decision making purposes
- Undertake a Mangrove Assessment of all mangrove stands in the Lami area
- Undertake a Marine and Coral Assessment of the Suva Harbour and reef system
- Preparation of a long term Foreshore Master Plan by LTC as the lead in consultation with the traditional qoliqoli owners to identify restricted foreshore areas for future development, future areas for protection and better management taking into consideration climate change impacts such as coastal erosion, seal level rise and inundation during storm surge events
- Need to work together with Lands Department to ensure that all foreshore development proposals applied adjacent to Lami Town boundary is referred to LTC for their consideration in relation to their future plans for the area (ie. Foreshore Master Plan)
- Preparation of a Foreshore Management Plan for Lami including mangrove protection zones to control development in the foreshore area
- Installation of tidal gauges to monitor sea level rise and tidal change
- Repairing and maintaining existing shore protection through mangrove planting
- Construction of proper evacuation centres within Lami

- Monitoring reef health and growth to determine whether it will be able to keep up with projected sea level rise
- Investigating and monitoring the role of mangroves in stabilizing coastlines and maintaining healthy fish stocks
- Reducing reclamation of mangrove areas for residential purposes and discouraging cutting of mangroves for other purposes
- Requirement by Council/Department of Lands for environmental impact assessments of foreshore development plans and city-sponsored reclamations
- Zoning foreshore and low elevation areas based on level of protection required against storm surges
- Ensuring that river retaining schemes have addressed sea-level rise in the engineering design
- Implementing building recommendations with regard to climate change during construction of new buildings
- Creation of an offshore breakwater that will allow sand deposition on current 'beaches' instead of movement up shore to land areas and roads
- Implementation of land-use policies that encourage settlement away from low-lying coastal areas
- Implementation of control measures on pollution from residential, tourism, commercial and industrial areas
- People empowerment in the management of coastal resources e.g. the creation of marine sanctuaries for preservation of coastal resources
- Community education and awareness programs on pollution of the aquatic/marine environment and its effects and on its effects on climate change
- Encouraging the use of alternative sources of construction aggregate rather than coral

## 5.2 Flood-prone Areas

Flooding is a major problem in the Lami area, following surveys and recorded observations. Increased rainfall events have resulted in more frequent flooding in Lami, which has been exacerbated by poor drainage capacities especially along Lami's main watercourses - Navesi, Wailekutu and Veisari rivers. Other problems associated with flooding include riverbank erosion, littering of drains and waterways, and increased risks to human health from seepage of effluents from septic systems. Recommended critical actions to counter and/or adapt to flooding-related issues include:

- Request Fiji Meteorology Department to replace the rainfall gauge at the Cement Factory or to reinstall it at Lami Town Council Chambers and to possibly look at having a temperature gauge placed in this location as well for more reliable Lami specific climate data.
- LTC to explore the option of entering into an MOU with Fiji Met office so enable LTC to assist with monitoring and recording the rainfall and temperature data on a daily basis
- Request SOPAC to identify and map all flood prone and risk areas as prepared for Nadi Town
- Identify flood prone areas with appropriate signage and markings
- Ensure records of flood events and markings of flood levels for future assessment by Council
- Design and installation of proper flood gate (if necessary)
- Design of proper drainage systems and their maintenance programmes

- Development of evacuation centre and installation of early warning system for flash floods following extreme rainfall events
- Installation of gabion basket (chicken wire filled with rocks) for riverbank reinforcement
- Dredging of rivers
- Re-vegetation with vetiver grass to strengthen riparian vegetation
- Combination of rock reinforcement and re-vegetation with vetiver grass
- Implementing building recommendations that account for river flooding during construction of new buildings
- Improvements to existing buildings and infrastructure
- Relocation of affected households to safer sites or raised areas
- Installation of proper rainwater harvesting system
- Implementation of proper rubbish disposal systems and improved management of liquid and solid wastes
- Using plants to absorb effluents/nutrients and prevent from reaching rivers and waterways by planting around septic tanks
- Regulating development on flood plains

## 5.3 Human Settlements & Livelihoods

Approximately 74% of land use in Lami is residential and includes both formal subdivisions and informal settlements. Informal settlements are situated in areas outside of town planning provisions and normally accommodate low-income earners. Houses within informal settlements are usually located in areas that are at a higher risk from natural disasters and projected climate change impacts than those situated in formal residential subdivisions. Housing materials are often constructed of cheaper materials. Informal settlements within Lami are situated in areas prone to coastal inundation, river flooding, and coastline or riverbank erosion. Recommended critical actions to counter/adapt to settlement issues include:

- Preparation of Local Community Action and Support Plans for each settlement - Assist and support settlements with the preparation of local community plans to enable each community to prioritize and address key issues relating to climate change impacts to ensure that these communities are able to improve their adaptive capacities and implement long term mitigate actions and cultural changes to minimize their vulnerability
- Undertake regular detailed settlement/community profiling exercises to understand the situational issues, demographics, up-to-date household incomes within each of the settlement/communities
- Land-use policies encouraging settlement away from low-lying coastal areas
- Employment and alleviation of poverty through livelihoods training and skills upgrading
- Local community empowerment to manage and use coastal resources sustainably should be encouraged
- Diversification of livelihood sources - developed through in-depth study of community livelihood patterns
- Identify employment and training opportunities for youths and women
- Introducing inter-cropping farming methods to get the best use out of the land and also to be able to plant a variety of produced based on seasons and climate

- Increase awareness on farming methods
- Education and awareness on the impacts of deforestation and the need for reforestation
- Skills upgrading and encouragement of self-employment activities
- Encouragement of women to engage in alternative livelihood activities
- Encouragement of the protection of the ecology and enhancement of land productivity
- Provision of proper and healthy standards of housing for all
- Implementation of a national sustainable development policy that promotes sustainable settlements, both urban and rural, sustainable coastal-zone management and sustainable agriculture
- Building of public awareness on the effects of urbanization on climate change and the creation of climate change awareness programs for communities
- Incorporating climate change into curriculum for primary and secondary education
- Relocation of settlements situated within high risk areas

## 5.4 Public utilities and infrastructure

Public utilities and infrastructure are two areas that are currently bearing the brunt of weather events, climate change impacts, and the rapidly increasing population that has led to a strain on services. Recommended critical actions to counter/adapt to issues related to public utilities and infrastructure include:

- Provision of safe and adequate water supply and improved sanitation especially for those in peri-urban settlements
- Proper design of bridges to allow for elevation (raise bridges)
- Reinforcement of riverbank and re-vegetation
- Dredging of rivers
- Addition of large boulders around base of pylons
- Maintenance and increased adjustment of bridge structures
- Reinforcement and upgrading of bridges (many heavy vehicles use bridge to access industrial zone)
- Reinforcement of areas around bridges through planting of mangroves
- Relocation of utilities like electrical substations that are situated in areas at high risk of flooding or coastal inundation
- Improvement of water storage systems; use of communal water storage tanks in settlements
- Increasing capacity of stormwater systems
- Connection to sewerage reticulation network for Lami and its peri-urban areas
- Introduction and installation of composting toilets in informal settlements?
- Installation of proper waste management system

## 5.5 Water resources

As mentioned in Section 5.2, areas around major waterways in Lami are prone to flooding, and this is exacerbated by the discharge of solid wastes into waterways that lead to blockages and water diversion from waterways resulting in flooding. This is a major issue because the waterways are also a source of livelihood for people many within settlement areas especially during times of water cuts.

Pollution of water resources leads to increased risk to human health and environmental degradation. Recommended critical actions to counter/adapt to issues of water resources include:

- Development of water-catchments and associated management of water catchments
- Implementation of soil-conservation measures to reduce erosion and sedimentation e.g. strengthening of riparian vegetation by planting vetiver grass on river banks and waterways
- Flood-control measures to cope with extreme high-rainfall events including the construction of diversion channels, weirs, cut-off channels, retarding basins and dams
- River-improvement activities such as channel widening, dyke construction or river-bed excavation (dredging)
- Implementation of drought-alleviation measures including water legislation, development of alternative water resources such as groundwater and the use of roof catchments, and increasing awareness on methods to save water or reduce water usage during times of drought
- Installation of proper rainwater harvesting systems
- Saving water by changing gardens to plants that require less water
- Adding vegetation with high fluid absorbency capabilities around septic tanks to absorb effluents/nutrients to prevent from reaching waterways e.g. ginger plants
- Catchment management including reforestation, land-use controls, protection of wetlands and soil conservation

## 5.6 Health

Common health issues related to disruptions to water and sanitation services and increased climate-related incidents include the outbreak of skin infections and diarrhoeal diseases. Recommended critical actions to counter/adapt to health issues include:

- Improved access to quality primary health care for Lami's urban and peri-urban areas
- Improved reliability and safety of water supply
- Improved sanitation
- Improved refrigeration and storage of perishable foods
- Preparation of emergency strategies to cope with the effects of floods and droughts and improved emergency response
- Development of an Urban Growth Management Plan specific to Lami to curb demands for water resources, food, construction materials and space for settlement, as well as address issues of urbanization and the high population density in coastal areas

## 5.7 Disaster Risk Preparedness and Reduction

The National Disaster Management Office (NDMO) operates on a national level, and commences operations only when a disaster strikes. It does not have specific disaster management plans for individual cities and towns like Lami. The need for better disaster preparedness and risk reduction/management are key issues that the Lami Town Council has incorporated into the Council's 5-year Strategic Plan (2010 – 2014). The Council was the first Pacific Island Town to sign up for the "Making Cities Resilient" campaign (UNISDR) and is in the process of preparing an evacuation plan for the whole township in the event of impending natural disasters. The Council has also been

lobbying for the provision of a Fire Department by the National Fire Authority (NFA) in Lami which will greatly assist the Council in its disaster preparedness plans.

Recommended critical actions to counter/adapt to issues of disaster preparedness include key activities from the SOPAC Framework for Action 2005 – 2015, and include:

- Strengthening training programmes for assigned Council members and stakeholders to enhance professional development in disaster risk reduction and disaster management amongst all stakeholders
- The formulation of an evacuation plan for the town of Lami
- Installation of early warning systems to warn of impending disasters like cyclones, tsunamis, flash floods, etc
- Expanding and focusing public awareness and education programmes to improve community understanding and the development of local resilience plans
- Strengthening links between the Council and the national Government to improve information management, public awareness and education
- Conducting hazard and vulnerability assessments and mapping including the collection of required baseline data
- Collecting and analyzing broad data on the direct and indirect impacts of disasters to determine future implications for Lami
- LTC adopting and applying the Comprehensive Hazard and Risk Management (CHARM) process to assist decision making in disaster risk reduction and disaster management planning
- Ensuring that Lami's disaster management organizational structure comprises a sufficiently resourced disaster office, a functional emergency operations centre and other infrastructure
- Developing and implementing a disaster management training programme that includes community-based disaster risk management
- Implementation and maintenance of effective and sustainable emergency communications systems
- Effective communication and awareness raising with communities as part of community-focused early warning systems
- Promotion of risk-sensitive resource-use policies and practices and ensuring compliance
- Implementation of appropriate building codes to enhance buildings resilience to disasters
- Promotion of food security to ensure the resilience of communities during disaster

## 5.8 Lami GHG Emissions

A Greenhouse Gas emission report has been undertaken for Lami Town Council to assess the emission levels of Council's operations. The GHG profile only covers certain aspects of the energy sector e.g. transport, council properties/assets and certain infrastructure services, as well as the solid waste collected from local communities and business operations. The GHG report presents the findings of the study as well as mitigation measures towards reduced emissions.

The analysis found that the three highest emitters from the stationary energy sector under are the Lami market (16t$CO_2$-e), Council building (69t$CO_2$-e) and streetlights. The linear trend shows that emission released from Lami market increased from 2006-2010 and could still be increasing in future. The council building shows a steady growth whereas streetlight indicated a decrease in

emissions; these are collectively known as indirect emissions. The major emitters identified were the street lights at approximately 227t$CO_2$-e (2006 IPCC Guideline).

The Council owns eight vehicles that run on diesel fuel. Use of the two emission factors outlined in IPCC 1996 and 2006 guidelines indicated a negligible difference in emissions. However, the periods 2006-2010 indicate emissions of approximately 39-43t$CO_2$-e; this is quite high and requires consideration by the Council to reduce its emissions.

The Council is converting from diesel to bio-diesel for Council vehicles as a positive approach towards minimizing emissions. 5 Council staff own vehicles, four of which use unleaded fuel and one that uses diesel. The highest t$CO_2$-e content released by the use of unleaded fuel is 0.8t$CO_2$-e and 0.2t$CO_2$-e by the use of diesel. Lami's public transportation sector was examined. Taxi operators comprise 132 taxi drivers operating from 39 bases. The taxis use unleaded fuel, diesel, LPG and bio-fuel; diesel was found to have the highest emission factor of approximately 12t$CO_2$-e.

Overall, the emissions released by the Council are relatively low and can be controlled and managed. This GHG inventory initiative by LTC can be shared with other municipal councils in Fiji to demonstrate simple yet practical measures to adopt more sustainable use of energy and working towards reducing consumption levels. Refer to Lami's Greenhouse Gas (GHG) Emissions report for a more detailed and comprehensive in-depth study of Lami's GHG Inventory.

# 6 Conclusion

The Vulnerability and Adaptation Assessment focused on the vulnerability of residential, commercial, industrial and special use areas and sectors within Lami to identify the impacts of climate change and adaptation mechanisms to these impacts. It uses the three dimensions of *exposure, sensitivity* and *adaptive capacity* to outline the vulnerability of areas within Lami, the level of exposure to climate change impacts for these areas, and their ability to adapt to and possibly become resilient to these impacts.

This V&AA report is a flexible document to be used to be practical measures in place to ensure that there is an on-going evaluation of the impacts of climate change and to ensure that there is a mechanism in place to record events and impacts as well as identify ways in which these impacts can be minimize and most importantly how day to day operations and cultural behaviours and lifestyles can be adapted to the changing climate and its impacts to ensure that we can minimise peoples vulnerability to these changes over time.

This assessment is a starting point for Lami Town Council together with its key stakeholders to collaborate efforts to making Lami Town resilient to the effects of climate change through a coordinated and strategic approach rather than being reactive and disjointed. This V&AA has brought about the realization that climate change is not just a global or national issue but an important local issue for those living and working in Lami. The impacts of climate change knows no boundaries and therefore, it is critical for Lami Town Council to ensure that the key impacts are continuously evaluated and adaptation options implemented for better preparedness and risk minimization.

# 7 References


1. Atkinson, J.E. and Collen, J.D. 2000. Environmental Setting of Namuka Reef, Suva Fiji Islands – SOPAC Technical Report 324 [online]. http://www.sopac.int/data/virlib/TR/TR0324.pdf [accessed May 2011]

2. Barstow, S. and Haug, O. 1994. SOPAC Technical Report 205. Wave Climate of Fiji [online]. http://dev.sopac.org.fj/VirLib/TR0205.pdf [accessed 22 September 2011]

3. Beca Pty Limited. 2005. Rokobili Port Development – Suva Harbour Hydraulics Study as part of the Environmental Impact Assessment Report. December, 2005.

4. Camargo *et. al.* 2007. The Influence of Natural Climate Variability on Tropical Cyclones, and Seasonal Forecasts of Tropical Cyclone Activity [online]. http://www.bama.ua.edu/~jcsenkbeil/gy4570/camargo%20et%20al%20natural.pdf [accessed 23 September 2011]

*5.* Chand *et. al.* 2010. A Bayesian Regression Approach to Seasonal Prediction of Tropical Cyclones Affecting the Fiji Region. In: Journal of Climate, Vol. 23 [online]. www.cityu.edu.hk/gcacic/Chand_Walsh_Chan_10_JC.pdf *[accessed May 2011]*

6. Corerega, L. 2010. Environmental Impact Assessment for the Rehabilitation of the Lami Dump – HYDEA Consulting Ltd

7. Department of Fisheries. 2011. Dead Coral Assessment Report: Current Status of the Dead Coral Trade at Suvavou village, Suva, Fiji Islands – Fisheries Research Technical Report No. 3. Fisheries Resource Inventory Survey, Department of Fisheries, Ministry of Primary Industries

8. Fiji Islands Bureau of Statistics. 2008. Census 2007 Results: Population, Size, Growth Structure and Distribution. No. 45, 2008. Suva, Fiji Islands

9. Fiji Meteorological Services. 2001. Climate Data [online]. http://www.met.gov.fj/ [accessed May 2011]

10. Fiji Meteorological Services. 2011. Climate Data [online]. http://www.met.gov.fj/ [accessed May 2011]

11. Graham Shorten, Avi Shapira, Marc Regnier, Geraldine Teakle, Litea Biukoto, Monika Swamy and Lasarusa Vuetibau. February 2001. Site-specific Earthquake Hazard Determinations in Capital Cities in the South Pacific – SOPAC Technical Report 300, 2nd Edition

12. Kailola, *et al.* 2005. Environmental Impact Assessment for the Fisheries Lami Jetty Redevelopment Project. Department of Fisheries, Ministry of Fisheries and Forests, Government of Fiji

13. Kench, P. 2005. Coastal Impact Assessment of Rokobili Port Development, Suva Harbour, Fiji. Auckland Uniservices Limited as part of University of Auckland, November 2005.

*14.* Kellog, Brown and Root Pty Ltd. 2011. Strengthening the Capacity of Developing Member Countries to Respond to Climate Change – Inception/First Progress Report – ADB Technical Assistance Consultant's Report.

15. Khan, N. 1998. Lami Town Planning Scheme Report of Survey Planning Proposals. Department of Town and Country Planning, Ministry of Local Government, Urban Development, Housing and Environment.

16. Koshy, K. 2009. Modelling Climate Change Impacts on Viti Levu (Fiji) and Aiututaki (Cook Islands)

17. Lami Town Council. Lami Town Council Strategic Plan 2010 – 2014.

18. Leslie, D. & Seru. M. 1998. Fiji Soil Taxonomic Unit Description Handbook. Canterbury, New Zealand. Manaaki Whenua Press.

19. Malo *et al.* 2009. Kalekana Action Plan. College of Medicine, Nursing and Health Sciences, Fiji National University.

20. Malo *et al.* 2009. Kalekana Profile. College of Medicine, Nursing and Health Sciences, Fiji National University.

21. McKenzie *et al.* 2005. Economic Impact of Natural Disasters on Development in the Pacific – Vol. 1. Australian Agency for International Development [online]. www.spc.int/lrd/index.php?option=com_docman&task=doc... *[accessed May 2011]*

22. National Disaster Management Council. 1995. Fiji National Disaster Management Plan. Government of Fiji and the Australian Government.

23. Nisha *et al.* 2009. Matata Community Profile. College of Medicine, Nursing and Health Sciences, Fiji National University.

24. Pacific Islands Climate Change Assistance Programme (PICCAP) & Fiji Country Team & Department of Environment. 2005. Climate Change - The Fiji Islands Response – Fiji's Initial National Communication under the United Nations Framework Convention on Climate Change.

25. Solomon, S. & Kruger, J. 1996. Vulnerability and Adaptation Assessment Suva and Vicinity, Viti Levu, Fiji Islands Coastal Impact of Sea Level Change – SOPAC Technical Report 242 [online]. http://dev.sopac.org.fj/VirLib/TR0242.pdf [accessed May 2011]

26. United Nations Human Settlements Programme. 2008. Sorsogon City Climate Change Vulnerability and Adaptation Assessment

27. United Nations Human Settlements Programme. 2011. Cities and Climate Change Initiative – Lami Town Fiji [online]. http://www.fukuoka.unhabitat.org/programmes/ccci/pdf/Lami_CCCI_April_2011.pdf [accessed May 2011]

28. Urban Policy Action Plan (UPAP) – Draft for DSC/Cabinet Consideration. 2004. Ministry of Local Government, Urban Development, Housing, Squatter Settlement and Environment

29. Secretariat of the Pacific Community Applied Geoscience and Technology Division. 2005. Framework for Action 2005 – 2015 Building the Resilience of Nations and Communities to Disasters

30. Fiji Initial National Communications (2005) Department of Environment, Government of Fiji

# 8 List of Appendices

A CCCI Terms of Reference

B Presentation for Global Disaster Risk Management Platform by Lami Town Council

C Presentation for the Pacific Regional Disaster Risk Management Platform Meeting by Lami Town Council in Auckland, New Zealand

D Lami Town Planning Scheme

E List of Major Disasters in Fiji – 1985 to 2010

F Community Presentation (Fijian)

G Community Survey Questionnaire Sample

H Community Profiles

- Naisogowaluvu
- Matata
- Samoan
- Kalekana

# Appendix A

# Appendix B

# Appendix C

# Appendix D

# Appendix E

# Appendix F

# Appendix G

# Appendix H

# Appendix I