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THE VALUE OF LOCAL KNOWLEDGE FOR CLIMATE CHANGE ADAPTATION PLANNING: CASE STUDIES FROM FIJI AND VANUATU

by

Shirleen Shomila Prasad

A thesis submitted in fulfillment of the requirements for the degree of Master of Science

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Pacific Centre for Environment and Sustainable Development
Faculty of Science Technology and Environment
The University of the South Pacific

February 2013
DECLARATION

Statement by Author

I, Shirleen Shomila Prasad, declare that this thesis is my own work and that, to the best of my knowledge, it contains no material previously published, or substantially overlapping, with material submitted for the award for any other degree at any institution, except where due acknowledgement is made in the text.

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Statement by Supervisor

The research in this thesis was performed under my supervision and to my knowledge is the sole work of Mrs. Shirleen Shomila Prasad.

Signature: D Date: 12/03/2013
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Designation: Primary Supervisor
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Acknowledgement

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Lastly, I would like to convey my thanks to my family and friends for their love and encouragement. Their prayers and blessings gave me strength and aspiration to endure all hard times.
Abstract

Pacific Island communities are heavily reliant on natural resources for their livelihoods. These communities have been using their knowledge of their land and sea to monitor changes in their local environment, manage resources and secure their livelihoods. In doing so, they have developed an intimate understanding of patterns relating to winds, seasonal cycles, flowering and fruiting patterns and changes in the behaviour of animals including bird nesting and migration. This locally-sustained knowledge has been passed down through generations and is widely applied in agriculture, food preservation, natural resource management and adaptation to extreme weather events. For decades now, there has been a growing concern that climate change will have severe and far-reaching impacts on communities throughout the Pacific region. In recent years, it has been recognised that local knowledge can: enhance the understanding of climate change impacts; assist in identifying successful coping strategies used currently or those practiced in the past; and facilitate the planning of appropriate mitigation measures.

This study involved forty in-depth interviews in six communities in Fiji and Vanuatu. The six communities involved in this study included Qeleni village, Naselesele village and Yanuca village in Fiji; and Piliura village, Tasirriki village and Lonamilo village in Vanuatu. The research focused on the premise that we must learn from past practices to plan for appropriate climate change adaptation measures in the future. This thesis presents analysis of various indicators in nature that indicate the onset of extreme weather events and documents valuable coping strategies utilised by communities to adapt to the impacts of extreme weather conditions. Some of the coping strategies employed by locals include: re-planting trees on coastal foreshores; securing houses and plantations prior to cyclones and floods; using sustainable water storage practices during droughts; and using food preservation techniques during cyclones and droughts. The findings of this research intend to build an understanding of the types of local knowledge and sustainable local adaptation practices that can be utilised for community-based climate change planning. This can provide a more sustainable and effective manner upon which decision-making about climate change adaptation can transpire.
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<tr>
<td>AIPP</td>
<td>Asia Indigenous Peoples Pact</td>
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<td>COP</td>
<td>Conference of Parties</td>
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<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
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<td>EU-GCCA</td>
<td>European Union Global Climate Change Adaptation</td>
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<td>ENSO</td>
<td>El Niño Southern Oscillation</td>
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<td>FAO</td>
<td>Food and Agricultural Organisation of the United Nations</td>
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<tr>
<td>GHGs</td>
<td>Green House Gasses</td>
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<td>GIZ</td>
<td>Deutsche Gesellschaft für Technische Zusammenarbeit</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<td>ICC</td>
<td>In Country Coordinator</td>
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<td>IPCC</td>
<td>Intergovernmental Convention on Climate Change</td>
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<td>MPA</td>
<td>Marine Protected Area</td>
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<td>NAPA</td>
<td>National Adaptation Programme of Action</td>
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<td>PACE-SD</td>
<td>Pacific Centre for Environment and Sustainable Development</td>
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<td>PICCAP</td>
<td>Pacific Islands Climate Change Assistance Programme</td>
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<td>PICs</td>
<td>Pacific Island Countries</td>
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<td>SOI</td>
<td>Southern Oscillation Index</td>
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<td>SOPAC</td>
<td>Pacific Islands Applied Geoscience Commission</td>
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<td>SPC</td>
<td>Secretariat of the Pacific Community</td>
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<td>SPSS</td>
<td>Statistical Programme for Social Sciences</td>
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<td>TEK</td>
<td>Traditional Ecological Knowledge</td>
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<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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Chapter 1: Introduction

1.1 Chapter Introduction
This first chapter provides a background to the overall study. The chapter begins with an overview of climate change issues at the global and regional levels, and moves into a discussion of the projected impacts of climate change on Pacific Island Countries (PICs). A brief background on Fiji and Vanuatu is also presented. This chapter also explains the overall objectives and the aims of this thesis. It then provides information on the key priorities of the research and explains the rationale for this study. Finally, this chapter reflects on the role of local knowledge in climate change adaptation planning, and provides details on the general structure of this thesis.

1.2 Overview of Climate Change Issues
Recently, climate change has been recognised as one of the major environmental issues likely to impose serious socio-cultural, economic and environmental concerns across the globe. Various drivers affect the earth’s climate. Anthropogenic activities, through the emissions of greenhouse gases (GHGs) have been attributed to be one of the leading causes of climate change. McMullen (2009) argues that GHGs may remain in the atmosphere for many decades and hinder the long wave radiation from leaving the earth’s atmosphere. This results in the warming of the earth’s climate system. This warming cause an increase in ocean temperatures, which leads to the thermal expansion of our oceans, enhanced melting of glaciers and sea ice, and changes in ocean circulation, ocean acidification and sea level rise (United Nations Framework Convention on Climate Change (UNFCCC) 2007). The major impacts and threats caused by changes in the earth’s atmosphere and the climate system include changes in the frequency and intensity of extreme weather events (Food and Agriculture Organisation (FAO) 2010).

The Intergovernmental Panel on Climate Change (IPCC) uses a Serial Report on Emissions Scenarios to provide climatic projections for the future that show emissions of “baseline global greenhouse gases are likely to increase by a range of 25 to 90%” (IPCC
2007, p. 44). This projection indicates that the emissions of GHGs will continue to increase which may lead to increases in global temperatures where “projected global average warming and associated sea level rise by the 21st century” would fall in a range of 1.8-4.0°C and 0.18m to 0.59m (this excludes sea level rise from changes in ice flow) respectively (IPCC 2007, p. 45). This may pose considerable damage to biodiversity, increase pressures on vulnerable societies and enhance the risk of small island nations to extreme weather events.

The changes in rainfall patterns are likely to increase risks of water shortages; flooding incidences; riverbank or coastal erosion; increases in temperature will cause shifts in cropping and fruiting seasons that may affect food production; temperature rises are expected to increase disease vectors affecting health, coral and forest ecosystems, and cause the extinction of various species and sea level rise may induce greater hazards from storm surges, inundation and coastal erosion (UNFCCC 2007). These extreme conditions may bring major environmental and climatic challenges at local, regional and global scales, which will pose significant implications on sustainable development and livelihoods for communities across the globe (Jones et al. 2010). There have been concerns that the changing climate can lead to crossing of the tipping points which are “critical thresholds that can alter the state of a system” and cause dangerous climate change that will entail catastrophic impacts on natural resources, ecosystems and on the climate system (McMullen 2009, p. 9).

1.3 Impact of Climate Change on PICs
Lately, it has been recognised that PICs are amongst the most vulnerable countries to the impacts of global climate change (Hay et al. 2003). According to Maclellan (2009), extreme weather events already pose serious threats to livelihood resources, infrastructure and economy of many PICs. The projected levels of warming, accelerated sea level rise and future increases in the frequency and/or intensity of extreme events will possibly intensify these problems.
A number of PICs are exposed to risks from changes in climatic patterns such as variations in precipitation, storm surges, king tides, sea level rise and salt water intrusion that impedes access to food, freshwater supplies and constrains sustainable livelihoods (Maclellan 2009). According to Mimura et al. (2007, p. 693), such risks pose a serious threat to country’s “vital socio-economic infrastructure including housing, utilities, tourism related facilities and subsistence and commercial agricultural production that requires time to recover”. Nunn (2007) asserts that an increase in temperature will largely impact crop yields and may imperil the health of coral reef ecosystems jeopardising the livelihoods of many Pacific Islanders who are largely dependent on the ocean for their own subsistence and/or commercial purposes. Under future climatic change, the frequency and intensity of extreme events is expected to become more extreme and destructive.

There is evidence that the climate of PICs is changing. For instance, Bettencourt et al. (2006) highlights that the normal climate of PICs is already changing with the Southern Pacific experiencing dryer (by 15%) and warmer (by 0.8°C) climates, the Equatorial Pacific receiving more rainfall (approximately changed by 30%) and sea surface temperature rise in the Southern and Equatorial Pacific by approximately 0.4°C. Hay et al. (2003) emphasises that the increased levels of GHGs in the atmosphere is expected to warm the Pacific Region by 0.6°C to 3.5°C. The climate is expected to become similar to El Niño type conditions for the Pacific Region where the “sea surface temperature for the central and eastern equatorial Pacific” is projected to be warmer than the sea surface temperatures of the western equatorial Pacific while precipitation is expected to shift towards the east (Hay et al. 2003, p. vi). Sea level rise is expected to be most prominent in the eastern Pacific (Bettencourt et al. 2006).

1.4 Background: Fiji and Vanuatu
This research focuses on three communities in Fiji and three communities in Vanuatu. Fiji is located 175° longitude and 18° latitude, with a total of 332 islands and a population of 832,494, based on 2000 estimates (Encyclopedia of Nations 2012). Majority of the population reside near coastal areas, which is also the predominant site
for community infrastructure, and socio-economic and agricultural activities. The capital city of Fiji is Suva while tourism activities, sugarcane production, and garment and mining industries are amongst the major economic activities. Fiji is a tropical country with south easterly trade winds and distinct dry and wet seasons that are controlled by the South Pacific Convergence Zone (Mataki et al. 2006). Figure 1.1 shows its location and vast number of islands.

![Map of Fiji Islands](http://www.mapsofworld.com/lat_long/maps/Fiji-lat-long.jpg)

**Figure 1.1**: Map of Fiji Islands
(Source: http://www.mapsofworld.com/lat_long/maps/Fiji-lat-long.jpg)

Fiji experiences tropical cyclones from November to April, which bring heavy rainfall and flooding in “low-lying areas” (Mataki et al. 2006, p. 50). The Fiji Islands are also exposed to the impacts of the El Niño and La Niña events (PICCAP & Fiji Country Team 2005). According to Fiji’s National Communication in 2005 (a requirement for UNFCCC members), climate change is projected to impose significant challenges for Fiji, particularly on coastal resources (due to rise in sea level, washing away of coastlines and inundation); water resources (from droughts and changes in rainfall patterns); agricultural sectors (where El Niño events and more intense cyclones may cause considerable damage to the agricultural produce) and deter the health status of people probably because of nutritional deficiencies.
(from damages incurred to the agricultural sector) and increase in disease outbreaks (due to warmer temperatures and increase in the numbers of disease carrying vectors) (PICCAP and Fiji Country Team 2005).

Vanuatu is situated in the Western Pacific Region and is located between 12° and 23° latitude and 166° and 173° longitude (FAO 2008). Vanuatu is categorised by the United Nations as a ‘least developed country’ and a ‘small island developing state’, and is particularly vulnerable to the risks of climate change (Lorentz 2011). The Vanuatu communities are highly dependent on agriculture and fishing as their major industries (Lorentz 2011). According to the Vanuatu Government (2007, p. 11), the climate of Vanuatu is “wet tropical” in the islands on the northern side and drier in the islands on the southern side with November and April being the seasons for cyclones. Here changes in rainfall, particularly the projected decline in rainfall is likely to affect rain-fed agricultural crops and impair food security while high intensity cyclones and pests and diseases are likely to arise from future increases in temperature (Republic of Vanuatu 1999).

Vanuatu is vulnerable to long dry conditions during El Niño warm phases and La Niña cool phases due to the El Niño Southern Oscillation (ENSO) phenomenon and is also prone to storm surges, coastal erosion, landslides, earthquakes and hailstorms (Vanuatu Government 2007). The Australian Bureau of Meteorology and CSIRO (2011) have indicated a series of future projections for climate change in Vanuatu including increase in wet season rainfall, decrease in dry season rainfall, continuing sea level rise and decline in the number of tropical cyclones. Vanuatu has a National Plan of Action (NAPA), which is a requirement of least developed countries under the UNFCCC (Lorentz 2011). The NAPA identified priorities for adaptation in the agricultural sector to promote food security, water management initiatives and policies, low-impact tourism, community-based marine and fisheries management programmes, and sustainable forestry management (Lorentz 2011). Figure 1.2 provides a map of Vanuatu, illustrating the numerous island and capital, Port Vila.
There are a number of concerns that climate change is likely to impose greater challenges for the sustainable development of many PICs. This is particularly so because many urban centres and economic activities are concentrated near the coastal zone for many PICs. With the increasing pressures of climate change, it is crucial that reliable adaptation techniques developed by locals to respond to the past environmental hazards are identified and strengthened so that it can be applied to respond to the detrimental impacts of future climate change. Similar concerns have been raised by PICCAP and the Fiji Country Team (2005, p. 7) that “the capacity of PICs to use economic, scientific and traditional knowledge to monitor, assess and predict environmental, social and economic risks and effects of climate change needs strengthening”. The high dependence of Pacific Islanders on their ocean, seasonal and traditional food crops and limited livelihood resources makes planning for their adaptation, diversifying food crops and search for alternatives, a priority concern.
1.5 Research Objectives and Aims

The main objective of this research is to enhance our understanding of the role and value of local knowledge in adapting to the impacts of climate change, drawing on fieldwork in six diverse communities in two countries across the Pacific region. A number of subset aims drive the agenda of this research. These four aims include the following:

i) To identify past and present adaptation strategies used by locals to adapt to environmental change and events more broadly;

ii) To collate and analyse the tools used by local communities to make local observations of the climate and local landscape, to further develop our understanding of local changes;

iii) To document the environmental changes (local changes and events) of these six local environments, as observed by communities themselves; and

iv) To provide a summary document to each of the six communities on the information and findings gathered.

The thesis presents the results of deliberations on past coping strategies, provide an analysis of various local tools for observation of local changes, record evidences of local environmental changes and present a feedback of the research findings to the communities involved.

1.6 Implications of this Research

Dealing with the impacts of climate change has become a priority for many PICs. Recently, several studies are being conducted involving climate change issues that have mainly focused on assessing the exposure and vulnerabilities of local communities (for e.g. Yakub et al. 2011; Nakalevu 2006). The purposes of these studies are generally to evaluate the potential risks of climate change on the environment and livelihoods of vulnerable communities and to provide possible adaptation options to manage the risks. However, it is important that studies reflect on the local perceptions and experiences of people to better understand the consequences of climate change on local communities in the Pacific. Considering local views and experiences not only provides opportunities for better understanding localised climate change, it can also provide chances for building
mutual trust and good relationships with the communities and relating their locals knowledge and sustainable practices that will promote successful research outcomes (Dumaru 2010).

Recently, there are plans that local and Indigenous people will be heard and included in the international climate change negotiations. For instance, representatives from the Indigenous Rights Organisation were allowed to share their views of climate change at the Conference of the Parties (COP) of the UNFCCC 18th negotiations in Qatar, Doha. Here issues were discussed on the need to acknowledge traditional knowledge and for Indigenous people to effectively participate in climate change programs (Natural Justice 2012). Local communities are increasingly being faced with the consequences of climate change, which jeopardises their capacity to make a living. As such, they should be given a platform to raise their concerns during climate change negotiations. This would provide opportunities for Indigenous people to fight against policies and anthropogenic activities that threaten their local environment and existence.

Furthermore, local and Indigenous people have been described as people that hold rich knowledge on the preservation and restoration of natural resources to achieve ecological balance who can also offer the best alternative for countering climate change impacts (United Nations Economic and Social Council 2008). The Cancun Adaptation Framework states that adaptation needs to be based on and directed with best scientific knowledge systems, and through incorporation of appropriate local knowledge and consideration of vulnerable communities and ecosystems (United Nations University 2012). This is particularly important because local people can contribute significantly in climate change adaptation planning and decision-making due to their vast experiences in actively coping with unstable environmental conditions (Nakashima et al. 2012).

It is argued that “indigenous people are particularly vulnerable to climate change; however, they can also offer valuable contributions as solutions to climate change” (International Union for Conservation of Nature 2010, p. 5). The remote location of many Indigenous communities and their high dependence on limited natural resources
and basic services, make them particularly vulnerable to the impacts of climate change (Macchi 2008). Yet, local people who are the owners of local knowledge have been able to effectively utilise their valuable knowledge systems and modify their coping strategies to manage the impacts of extreme events to protect their livelihoods.

The adoption of local knowledge in dealing with climate change impacts is recognised as a critical component to promote local adaptation (Ogalleh 2012). The UNFCCC has made attempts to include local’s views through active involvement of local and Indigenous people in COP of the UNFCCC (AIPP 2012). In the Indigenous People’s Global Submit on Climate Change held in Anchorage Alaska, the participants called for action upon the Parities of UNFCCC to recognise the importance of traditional knowledge and practices in developing strategies to address climate change (Indigenous Peoples’ Global Submit on Climate Change 2009). The IPCC Fourth Assessment Report (2007) acknowledges traditional knowledge of local communities and recognises that local knowledge and practices of dealing with climate disasters such as droughts, floods and health crises can facilitate in the formulation of culturally appropriate coping strategies for local communities that are largely depended on their oral traditions. In further efforts to accomplish this, the Fifth Assessment Report of the IPCC aims to provide chapters that include case studies on least developed countries, Indigenous people and vulnerable communities to enhance our understanding of climate change impacts, vulnerabilities and adaptation (United Nations University 2012).

Local communities across the Pacific region are heavily dependent on their land and ocean resources to sustain their livelihoods. By working and managing their environment, local communities have learnt to conserve their resources and respond to various environmental stressors. Many communities have developed various mechanisms to adapt to local environmental conditions and extreme events and these practices have often been passed down through generations and modified to adapt to their current environmental conditions (Salick and Ross 2009). As emphasised in the report by AIPP (2012, p. 3), local people should not just be considered vulnerable to the impacts of climate change but also be recognised as “ecosystem people” who hold vast
knowledge of their local environment and have experiences in coping, managing and responding to environmental stressors.

One of the main messages of the Anchorage declaration is to include local knowledge of environment and forest management, agriculture, farming and medicines to formulate effective adaptation strategies in order to sustain food and secure local livelihoods (Indigenous Peoples’ Global Submit on Climate Change 2009). However, only a few studies conducted in the PICs have acknowledged and documented local knowledge (Lefale 2010; Bridges and McClatchey 2009). It is important that sustainable local knowledge is incorporated into community-based climate change planning for the development of locally-appropriate adaptation strategies.

Researchers often have various perceptions of the valuable knowledge held by local people. Many academics term this knowledge as either traditional, Indigenous or local knowledge. Berkes (1998, p. 8) regards this knowledge as traditional knowledge and describes it as “a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission”. Hodgson (2007) defines traditional knowledge as the local perception of procedures and practices pursued by a community. Nichols et al. (2004, p. 69) debates that traditional knowledge is dynamic and can be “modified by its holders to reflect changes in the environment” and as it gets passed down through generations, “each new generation incorporates its own empirical knowledge and observations”. This research will use the term local knowledge to refer to the valuable knowledge held by people of a particular area that are not necessarily Indigenous. This knowledge is ever changing and being reconstituted as it is passed down from one generation to another. This system of knowledge is transferred through each new generation in the forms of “oral history, stories, myths, song, lessons and more recently in written forms” (Nichols et al. 2004, p. 69).

I will be using local knowledge instead of traditional or Indigenous knowledge in this research. My first argument is that traditional knowledge implies that knowledge is fixed
and static and fails to recognise that knowledge can be built upon and reconstituted (Prasad et al. 2012). Indigenous knowledge only speaks to those who are Indigenous and as such can fail to recognise that valuable knowledge can also be held by ‘locals’ (who aren’t Indigenous) but have valuable knowledge of land, seasons, climate, and the environment constituted from living and working on a particular land. For instance, a local resident who has lived in the same locale for years and has worked and managed the local environment all his/her life will develop valuable knowledge about that particular locale with important tracks and experiences of dealing with localised impacts and extreme events. Hence, local knowledge is more encompassing and takes into consideration those who may hold valuable knowledge about particular locales but they are not Indigenous. Moreover, by using the term local knowledge, I am flexible to exploring knowledge that is ever-changing and being reconstituted (as opposed to using the term traditional which implies knowledge as fixed and cannot change).

I appreciate that there are three main tiers of ‘local knowledge’. One tier is sacred or closed knowledge and holds spiritual importance that is passed down through generations to particular gatekeepers who earn this privilege (Hansen and Fleet 2007). The second tier is negotiated knowledge. The final tier is open or common knowledge – which is shared knowledge. Locals may be able to cross over all these tiers of knowledge to manage their resources and respond to changing environmental conditions (Whap 2001). These three tiers of “local knowledge” do not take account of the restrictions that may be place in relation to gender, culture, age, membership of land-holding groups, seniority and other cultural restrictions. This is because it is complex to completely understand these dynamics and it was beyond the scope of this study.

However, for this specific research, it is not my intention to ‘tap into’ sacred or negotiated knowledge but focus on the shared/ common/ open knowledge held by locals that can be used to complement western science and provide locally and culturally appropriate ideas about adaptation for the community. This ‘shared, open knowledge’ can be applied in resource management and in community-based adaptation planning.
There were people who held seniority in the village and they were interviewed assuming they would hold high levels of local knowledge.

Local knowledge held by people on their local culture and environment can be accessed using qualitative interview based methodology. This study uses qualitative social research approach to represent the importance of incorporating local knowledge in community-based climate change adaptation planning. The research intends to document local knowledge held by the communities in Fiji and Vanuatu in adapting to extreme weather events and impacts of environmental changes. The results of this study would set grounds for future research to incorporate local knowledge systems when planning for community-based climate change adaptation to increase the adaptive capacity and resilience of vulnerable communities to future environmental perturbations.

As climate change takes up its roots, it should become a primary concern for nations to formulate and implement effective environmental policies to encourage the sustainable development of resources. It is necessary that adaptation programmes and decision makers explore the successful practices adopted by locals in preparing and adapting to extreme weather events that can assist in the formulation of effective adaptation strategies at local levels. Adaptation practices of local people can provide valuable information on current environmental situations, offer information to address gaps in regional/local data to complement scientific models and satellite data sets and provide basis for identification and formulation of effective adaptation and mitigation measures (United Nations University 2012). Therefore, government departments, non-governmental organisations and researchers from a variety of disciplines should consider the valuable learnings that local knowledge systems can offer in addressing future climate change threats.

1.7 Thesis Structure
This thesis examined the significance of local knowledge in coping with the impacts of environmental changes and extreme weather events in the Pacific using case studies from Fiji and Vanuatu. The thesis is presented in seven chapters. The first chapter
provides a brief overview of PICs and presents a fundamental purpose and organisation of the study. Chapter 2 reviews relevant literature and provides an overview of the work done by other authors using local knowledge. It offers the relevance of local knowledge in climate change planning and illustrates the use of local knowledge in climate observation, environmental management and in planning for adaptation. Chapter 3 provides a brief background on the study sites. It provides information on the geographical setting and socio-economic characteristics of the study sites. Chapter 4 provides detailed information on the processes and techniques involved in conducting fieldwork and analysing the results of this study. Chapter 5 is the first results chapter. This chapter presents the outcomes of the data collected during field work and provides information on how local people utilise their local knowledge to predict extreme weather events and consequently devise strategies to prepare for them. Chapter 6 is the second results chapter. It details the results of the research and reflects on the use of local knowledge to adapt to different environment conditions and extreme events. This chapter also demonstrates the different levels of knowledge held by locals of Fiji and Vanuatu in adapting to various climatic events. Chapter 7 provides a conclusion to this thesis. This chapter discusses the findings of this research and compares it with the findings of other similar studies conducted in a different setting. It also summarises the major themes and outcomes of this research.

1.8 Chapter Conclusion
This chapter indicates that climate change is expected to cause severe consequences on many Pacific communities. Fiji and Vanuatu, like other vulnerable PICs, are prone to the detrimental impacts of climate change. Climate change and extreme weather events are likely to cause deviations in the climate system that will cause destruction of various ecosystems and affect biodiversity. This is expected to impair agricultural produce, disrupt food chains, affect tourism activities, cause freshwater shortages, and create more health problems and damage to natural resources. It is evident through the arguments presented in this chapter that incorporating local knowledge in climate change research can provide feasible options for the successful identification of locally and culturally appropriate adaptation measures to respond to the impacts of climate change.
Locals can provide baseline information on their local environment that would serve as a foundation to make comparisons against current and projected climatic conditions. The following chapters of this thesis demonstrate the application of local knowledge in environmental management and adaptation using case studies for Fiji and Vanuatu.
Chapter 2: Review of Relevant Literature

2.1 Chapter Introduction
The following literature review is intended to provide a background on the value of local knowledge in better understanding climate change in the Pacific. The literature review begins with an exploration of the theories and practices of local knowledge in understanding climate change impacts, coping strategies and mitigation measures. This chapter also includes a review of studies that utilise local knowledge in: understanding environmental change, natural resource management and conservation. This is followed by an exploration of studies focused on the use of local knowledge to monitor changes to local environment. The next section explains the relationship between communities, their environment and how they address the consequences of climate change. It also elaborates on the importance of local knowledge for adaptation to changing local climatic conditions. Finally, the consideration of a research framework on the role of local knowledge is provided.

2.2 Overview of Local Knowledge
Local knowledge and Traditional Ecological Knowledge (TEK) are important tools in the exploration of changes to local environments. TEK is being broadly used in resource management and biodiversity conservation. The contribution of local knowledge in climate change adaptation planning has been limited, however, the application of local knowledge in understanding ecosystem functions and environmental processes has been widely acknowledged (see Orcherton 2012; Green et al. 2010a; Silvano and Valbo-Jorgensen 2008). For instance, Kimmerer (2002, p. 432) highlights how local knowledge is being extensively used by “academics, agency scientists and policy makers as potential sources of ideas for ecosystem management, conservation biology and ecological restoration”.

Local people interact with their environment, monitor their ecosystems and manage their biodiversity to sustain their livelihoods. In the course of such interactions with nature, local people have built a unique set of environmental knowledge (see Weatherhead et al.
2007; Turner and Clifton 2009). Brodnig (2000, p. 4) believes that local knowledge is not “static” as the information contained in this knowledge system is continuously “renewed and revised” as it is passed on from one generation to the next. Each generation “incorporates” its own set of local knowledge, observations and environmental change into the existing TEK systems (Nicols et al. 2004, p. 69).

Local communities apply their local knowledge and practices in planning their daily activities. For example, local knowledge is applied in farming practices to increase food production, to plan cultural and social activities such as hunting and feasting, to understand local medicines and improve health, in natural resource management, to improve education, to forecast weather and climate and generally to sustain their livelihoods (see The World Bank 2004; Barnhardt and Kawagley 2005). Nakashima and Roue (2002) acknowledge the significance of local knowledge in local food production and healthcare.

Recent study by McDowell and Hess (2012) demonstrate local practices of Palca communities in crop diversification and food storage methods for food security during extreme weather conditions. Similarly, local knowledge system is used to guide small-scale farmers to select appropriate crops per seasons, maintain soil fertility and identify plants with insecticidal or medicinal properties (Nakashima and Roue 2002). Nakashima and Roue (2002) argue that communities also rely on local knowledge for food security where fisher people and hunters use local knowledge and skills to mark landscape, locate fish and navigate safely at sea.

In some communities, local people particularly depend on the ecosystem for their livelihood. Consequently, these people have built valuable knowledge of the environment, its ecological processes and knowledge of species behaviour and breeding patterns based on their observations. Berkes (2009) describes local knowledge as the collective set of knowledge, practice and beliefs of a group of people regarding the relationship of all living things with each other and their environment which are passed on from one generation to another. Duerden (2004) believes local knowledge can provide
baseline information to monitor changes occurring to the land and sea due to climate change. On the other hand, Hill (2008, p. 2) defines local knowledge as “the total understanding by Indigenous people of their relationship to the earth and the universe, and the knowledge inherent within the relationship”. Local knowledge encompasses changes occurring to the land and natural resources and the approaches utilised by locals to manage those changes to achieve sustainable productivity in the future.

Local people have developed a range of management techniques that are practiced locally to identify, understand and respond to changes in the local environment. Huntington (2000) believes that local knowledge is being applied in many scientific publications and used in impact assessments to enhance the understandings of local ecology and environmental settings. For example, Mallory et al. (2006) demonstrates the use of marine bird as an indicator for marine ecosystem health and changes taking place in the Arctic environments. Local knowledge is also being used to observe changes in weather patterns, seasons, ecosystem changes and changes in species distribution (Salick and Byg 2007).

The majority of research on local knowledge is related to environmental management. Edwards and Heinrich (2006) highlight the use of local ecological knowledge by Australian Aboriginal communities in land management, burning regimes and use of “calendar” plants to determine suitable times to burn and collect particular species for food. Likewise, Silvano and Valbo-Jorgensen (2008) underline the use of local ecological knowledge in fisheries management where detailed knowledge possessed by fisher people on fish behaviour and abundance trends is used to monitor the effects of local ecological changes on fish and marine species. Hun et al. (2003) explains the use of local ecological knowledge by the communities in Alaska to promote the use of sustainable sea gull egg harvesting techniques.

Moreover, Tamuno et al. (2009) reports on the use of TEK in water resource management and in understanding fishing pattern across five seasons in Central Niger Delta where local knowledge has been found to be consistent in providing reliable
information for sustainable management of natural resources. Similarly, Raymond et al. (2010) describes the use of local knowledge in forest management in Kenya where locals have limited right to collect building materials, fuel-wood, fruits and impose restrictions on livestock to graze in the managed forest area. Such approaches prevent over exploitation of natural resources that are available locally.

The insights from local knowledge can be integrated into other streams of knowledge to enhance our understanding of nature in the changing world of today. Kimmerer (2002) draws attention to the importance of incorporating local knowledge in biological education to enhance the understanding of the approaches necessary to maintain adequate diversity and environmental sustainability. Orcherton (2011) views collaborative learning as an important measure for natural resource management authorities to incorporate local level understandings of cultural diversity with scientific knowledge systems to manage natural resources. However, Rist and Dahdouh-Guebas (2006, p. 488) explain that sustainable development cannot be achieved through scientific disciplines only but requires the incorporation of local knowledge that provides practical issues relating to “agriculture, livestock keeping and forestry”. Sustainable development becomes more productive through the integration of the local management practices of communities along with scientific processes.

Moreover, Turner and Clifton (2009) demonstrate the importance of traditional phenological knowledge in assessing and responding to climate change issues particularly using environmental indicators to monitor changes in the environment. Local people hold important knowledge about weather and climate as a result of their complete dependence on their land, water and seasonal food resources (Turner and Clifton 2009). Riedlinger (1999) indicates that locals (Elders and hunters) observe and report changes in the environment and this knowledge can be used to complement western science to improve resource management and environmental protection. Likewise, Lefale (2010) elaborates on the use of local knowledge by the Samoans in weather and climate forecasting using a seasonal calendar. The Samoan seasonal calendar is based on local environmental changes such as changes in cloud cover, wind
direction and animal behaviour. Knowing these intricate details of the local climate and environment determines the hunting and fishing activities of locals.

There are arguments that not all the traditional practices of locals are ecologically wise but many local knowledge practices do have useful lessons to offer (see Berkes 2004). Huntington et al. (2000) argues that local knowledge like other knowledge systems is susceptible to errors may be due to the misinterpretations made by the observers or the knowledge collectors. Yet, there are concerns that local knowledge is being lost and this may be contributing towards ecosystem decline (Edwards and Heinrich 2006). It is evident through the literature that local knowledge does present valuable information on local resource management and environmental protection. There is a growing need to document local knowledge as many forms of this knowledge are transferred orally. A recent investigation by Orcherton (2011) indicates that documenting local knowledge requires ethical consideration of knowledge holders and acceptable data collecting techniques.

2.3 Using Local Knowledge to Observe Local Environmental Change

The intensive dependence on their land and sea has led local people to develop comprehensive knowledge of their environment. Consequently, local communities make observations of their surroundings, build their understanding of local climatic conditions and observe the responses of living things to various climatic events. Local people observe changes in plant and animal behaviour and use it as indicators to predict changes in environmental conditions (Lefale et al. 2010). Green et al. (2010a) states that local observations made by Indigenous communities can serve as an important source for providing environmental data in climatological studies.

Drawing on a study of Inuit communities, Gearhead et al. (2010) demonstrates the value of local knowledge that has been orally passed down through generations and is used to make climatic observations crucial for planning daily activities. Here locals observe wind patterns, cloud cover and snowfall to predict weather conditions and plan activities such as hunting, fishing and travel accordingly. However, the Inuit communities’ have
observed changes in wind speed and directions, which has impacted their daily activities (Gearhead et al. 2010). Likewise, Weatherhead et al. (2010, p. 524) exhibits a variety of indicators including “wind direction and wind speed, cloud formation, animal behaviour and stars, sun and the moon” used by the Inuit communities to forecast weather which is being influenced by the changing climate and traditions of people. Weatherhead et al. (2010) uses scientific methods to examine observed changes in the climate and emphasises the importance of bridging local knowledge and science to identify impacts of climate change. Hence, considering local environmental knowledge of communities can help better understand changes in local climate.

In the same way, Nichols et al. (2004, p. 71) highlights the importance of local observations of the Inuvialuit population to assess changes in the characteristics of sea ice due to climate change such as changes in the “amounts of multiyear ice, changes to pressure ridge abundance, sea ice thinning and marked changes in the seasonal timing of sea ice breakup and freeze-up” that can serve as baseline information for scientific assessments of localised changes on Arctic ecosystems. Such approaches can be effective in studies of climate change whereby scientific analysis can be used to verify localised changes observed by local communities. Nichols et al. (2004, p. 78) also emphasises the need to incorporate both local and scientific systems of knowledge to identify localised changes and states that challenges still remain in using local knowledge with western science especially with the translation of “technical terms and concepts” when local knowledge is documented in native language.

Local communities have developed intense local knowledge gained over centuries that constitutes knowledge systems based on cultural and traditional practices of managing resources, conserving biodiversity, making local observations and adapting to environmental perturbations to achieve sustainable livelihoods. This knowledge has been acquired from ancestors and is passed down between generations through oral means. This knowledge system is based more on local experiences compared to theoretical/scientific knowledge systems that are based on inductive or deductive reasoning (Mazzocchi 2006). Nonetheless, combining local knowledge rich in local
observations and trends can be used to fill in gaps in the scientific data and enhance our understanding of changes in local conditions and peoples responses to manage these changes (Mackinson 2001).

Moreover, Lefale (2010) illustrates the use of a seasonal calendar by Samoans, which is based on environmental indicators and climatic events. Samoans read the sky (using the sun, moon and stars), observe cloud formation and movement, monitor wind type and direction and observe changes in animal behaviour to orient their activities such as farming, fishing, hunting and social activities (Lefale, 2010). Green et al. (2010a) highlights a similar approach employed by Torres Strait Islanders who use seasonal weather calendars that are based on environmental indicators such as seasons, clouds, rain, movement patterns of stars and animal and plant behaviour to plan social and cultural activities. This study documented local observations to assess environmental changes arising from the impacts of climate change in the Torres Strait Islands including changes in the breeding seasons of turtles and fish that affect local food supply as fishing season is delayed, increased shoreline erosion (from king tides and storms surges); and fruits not ready on time. These local observations serve as a foundation for further assessments of climate change impacts on local environments. Local people can provide researchers with useful information about localised changes to their environment for the identification and implementation of effective adaptation measures.

Likewise, King et al. (2008) demonstrates various environmental indicators used by the Māori community to forecast weather and climate principally through the observations of clouds, waves sounds, flowering patterns, position of the moon, and the plume from the volcano. The locals use these indicators to forecast weather and direct activities, for instance, the “flowering of trees and ripening of fruits are used to direct planting of sweet potato and even their roots are dug out in times of heavy rain and frost to prevent them from rotting” (King et al. 2008, p. 400-401). This community has observed recent decreases in the number of frost, “increase in the frequency and severity of storms in recent decades” and severe flooding episodes that indicates changes in local weather and
can be significant in providing baseline data for scientific assessment to compare changes in their environment (King et al. 2008, p. 396).

Correspondingly, a study on interior Alaska conducted by McNeelay and Shulski (2011) describes the use of local observations to identify recent changes in the climate of Alaska. The study records local observations made by the Elders in Alaska which depicts a warming trend during the hunting season that delays the “fall season” and causes “temperature extremes” that significantly affects moose harvesting and impacts subsistence food sources (McNeelay and Shulski 2011, p. 470). Likewise, Vednam and Rhoades (2001, p. 113) illustrate how apple farmers of Western Himalaya (India) use their local knowledge to monitor the amounts of snowfall, rainfall and temperature ranges and compare it with their “traditional weather calendar” to describe changes in the climate. These Elders observed that decrease in the amounts of snowfall; changes in rainfall and increase in temperature and rainstorm affects apple production (Vednam and Rhoades 2001). Such observations of local climate change and its effect on food production can be utilised in agricultural science to facilitate decision-making to promote food security.

2.4 Relevance of Local Knowledge for Climate Change Planning

Anthropogenic activities have caused a significant increase in the emissions of GHGs since the pre-industrial times (IPCC 2007). The emissions of GHGs from fossil fuel burning and changes in land use patterns have resulted in an enhanced greenhouse effect and the warming of the earth’s surface. This additional warming is likely to cause disastrous impacts to earth’s diverse ecosystems. The United Nations have set up the Kyoto Protocol as an attempt to reduce current levels of emissions in the atmosphere (United Nations Environment Program 2002). However, as argued by Nyong et al. (2007), sea level and global warming will continue to rise for several centuries even after GHGs and temperature stabilises due to the large amounts of GHGs built up in the atmosphere from past and present anthropogenic emissions. There are various adaptation and mitigation options being put forward to reduce the vulnerability associated with climate change. However, further adaptation measures are crucial to reduce the adverse
impacts of climate change despite the extent to which mitigation measures are taken in the near future (IPCC, 2007).

Modelling activities and scientific studies have largely been used in past years to observe climatic changes, make future projections and plan adaptation and mitigation measures (Oreskes 2004; Hay et al. 2003; IPCC 2007). Green and Raydorodentsky (2010) draw our attention to the Indigenous people who live on their traditional land and are responsible for almost negligible amounts of GHG emissions but are likely to suffer greatly from the impacts of climate change. Local people have been using their local knowledge of landscapes and managing their natural resources for centuries. These people have been making local observations, monitoring changes in their environment and responding to localised changes (see Nichols et al. 2004; Green et al. 2010b). In doing so, they have “traditionally acquired” local knowledge of their environment which is “based on experience and adaptation to a local culture and environment, that has developed overtime” (Barnhardt and Kawagley 2005, p. 11).

Recently, there have been concerns that climate change is likely to pose great challenges for local communities (Duerdon 2004; Ford et al. 2006). Macchi (2008) reports that many local people living on traditional lands are highly dependent on their natural resources to sustain their livelihoods and they are particularly vulnerable to the impacts of climate change. There is evidence of localised changes in climate as local communities observe, understand, experience and report climate variability and climate change (see Petheram et al. 2010; Weatherhead et al. 2010; Hinzman et al. 2005). Locals and their ancestors have been exposed to many types of localised environmental changes that impacted their lives and forced them to devise ways to respond, manage and adapt to those changes (Turner and Clifton 2009). However, the study by Petheram et al. (2010 p. 689) highlights that local people were more concerned about non climatic issues that affect the community welfare rather that climate change issues and improving the general community vulnerability would be “a valuable approach in strengthening adaptation to climate change”.

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It has been acknowledged in recent times that locals heavily linked to their surrounding environments have developed a sophisticated level of understanding and knowledge of such, which can provide valuable information in understanding environmental change more broadly (see McNamara and Westoby 2011; Orcherton 2012; Lefale 2010). Wildcat (2009, p. 17) offers insight into saving the planet with local knowledge as a critical ingredient in doing so, as it holds with it “customs, habits, behaviours, material and symbolic features of culture emergent from the land and sea”. It is particularly important that people’s local knowledge is given recognition when planning for effective community-based adaptation strategies in response to future climatic changes. Those successful practices and procedures adopted in the past can be applied with more robust approaches to increase resilience of local communities.

Modern societies are extensively dependent on recent technologies and scientific ways of solving environmental issues. It has also been noted that the current knowledge on climate change has largely been initiated by scientific findings from modelling, climatology and biological studies (Reidlinger 1999). Limited acknowledgement is given to the existing strategies practiced by the locals in response to localised changes and extreme events. For instance, Lefale (2010) emphasises that local people in Samoa have been using their local knowledge to monitor changes in their environment to predict their weather and climatic conditions even before the introduction of climate models. However, with advancing technology, scientists are becoming more reliant on climate models and science based approaches to respond to “global challenges” and have “neglected” the resourceful knowledge and “local ways of solving problems” actively employed by the local communities for centuries (The World Bank 2004, p. 1). Even so, there are arguments that the “current climate models do not accurately represent the climate system” because of the “incomplete scientific understanding of the climatic processes” (O’Keefe and Kueter 2004, p. 9). This creates uncertainty in the climatic simulations and projections.

In addition to this, Duerden (2004, p. 204) highlights that further uncertainty arises because of the “large scales” at which “physical data” is collected for climate change
simulations and projections. Reidlinger (1999) elaborates that this data is often limited by lack of historical baseline information and emphasises the need to engross local knowledge systems to address such limitations. Duerden (2004) suggests that the scale of change experienced by the diverse and geographically isolated communities varies with their distinct environments. Local people who live and work on their environment everyday observe initial changes in the landscape. These people then respond to the changes by modifying their activities in accordance to the changing environment. Berkes et al. (2000, p. 1260) emphasises that the local knowledge of local people is a critical component in developing adaptation actions as it acknowledges that environmental conditions will always change “requiring societies to respond by adjusting and evolving”. Such actions have useful lessons to offer about the “successful and unsuccessful coping strategies for environmental and climate change” (O’Neil 2009, p. 5). Therefore, local knowledge of people can be used as a means to address such gaps.

Moreover, local observations can provide information on any local changes in their environment and landscape (Gil-Romera et al. 2010). Such observations of localised changes would provide place based information that can complement scientific understanding of local climate change (see Nichols et al. 2004; Duerden 2004). Berkes et al. (1995, p. 283) elaborates that local knowledge holds “long time series” of observations about a particular location compared to the “synchronic data” produced by western science that is based on “short time series over a large area”. Thus, the limitations of western science approaches can be harmonised using the valuable knowledge held by locals.

Local communities have created special bonds with their land, culture and natural resources that can provide records of seasonal observations and their coping mechanisms in response to environmental changes, which can enhance adaptive capacity and resilience to climate change (Salick and Ross, 2009). Integrating local knowledge into climate change adaptation planning can promote community-based participatory approaches and the formulation of culturally relevant and sustainable adaptation strategies to enhance the resilience of vulnerable communities (see McNamara and
Such an approach would encourage changes that come from communities themselves and help locals build confidence as they learn from themselves while being a part of the adaptation program (McNamara and Westoby 2011). It is evident from the theories and practices of local knowledge that locals and Indigenous populations can offer valuable ways of planning sustainable community-based climate change adaptation initiatives.

2.5 Using Local knowledge for Climate Change Adaptation

Adaptation is regarded as a means of managing climate change. Local people have been using their local knowledge to develop ways to adjust to different environmental conditions (see Stigter et al. 2005; Macchi, 2008). For instance, Salick and Ross (2009, p. 137) explain that locals have “faced climate change and adapted to it” for centuries. Smith and Wandel (2006, p. 289) considers adaptation as “local or community based adjustments” in response to changing environmental conditions. Nakalevu (2006, p. 9) defines adaptation as “the adjustment in natural or human systems to a new or changing environment”. Adjustment is the process of altering behaviour to adapt to the changing environment (Psychology Glossary 2013). Mathew et al. (2012) expresses that adaptation strategies can be made effective if it is implemented based on the communities’ priorities and concerns on sectors that they consider most vulnerable to climate change risks.

Local people have had to endure various environmental changes and modify their activities accordingly in order to survive in the changing environments. Ford et al. (2006, p. 148) refers to the ability of communities to “address, plan for or adapt” to changing conditions as “adaptive capacity”. Marshall and Smajgl (2013 p. 88) highlight that “adaptive capacity can be evaluated along four essential dimensions: (1) the management of risk and uncertainty, (2) skills in planning, learning and reorganising, (3) financial and emotional flexibility, and (4) interest in adapting”. The study by Marshall et al. (2013 p. 30) showed that people who have “higher climate change awareness have greater capacity to adapt to at least three dimensions of adaptive capacity”.

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Moreover, adaptive capacity is influenced by poor communication between locals and decision makers who fail to acknowledge the value of local practices and knowledge when planning for community-based adaptation measures (Petheram et al. 2010). Recent studies by Kurrupu and Liverman (2011) and Kpadonou et al. (2012) indicate that the adaptive capacity of a community is particularly dependent on the availability of resources for adaptation and the ability of communities to use the available resources effectively for adaptation. Petheram et al. (2010, p. 687) recognises that “locals prefer adaptive capacity that involves greater self-sufficiency, independence, empowerment, resilience and close contact with the natural environment” to enhance their ability to adapt to extreme environmental conditions.

Adger et al. (2003) reflects on the coping ability of the locals in developing world which is mostly based on the use of past strategies. Adger et al. (2003, p. 192) explains that “adaptation by farmers, fishers, coastal dwellers and residents of large cities” will mostly be self-directed and appropriate adaptation measures developed based on the availability of “social capital and resources”. It can be concluded that the ability of societies to cope up with changing climatic conditions largely depends on the extent of their exposure to extreme conditions and the availability of resources to facilitate adaptation.

Chapin et al. (2004), demonstrates strong interactions between local people and their environment that can lead to enhanced adaptive capacity. Effective adaptation decisions can be shaped with learning’s from the past and present practices used by locals to adapt to changes. In doing so, actions and subsequent behaviours have been discovered as successful. Adaptive capacity can be enhanced through knowledge sharing (Fabricius et al. 2007) and through the inclusion of sustainable past and current adaptive strategies used (Tschakert and Dietrich 2010). Local communities have adapted to various environmental “hazards” and such “adaptation practices” can possibly be used to reduce the “adverse impacts” of future climatic changes (Macchi 2008, p. 5).
Adger et al. (2003) exemplifies the use of migration techniques as a common adaptation measure practiced in the past by local societies in the developing world to respond to climate variability and in resource management to avoid overexploitation of resources in a particular area. Bridges and McClatchey (2009) demonstrate the efforts made by the dwellers of the Rongelap Atoll in Marshall Islands to cope with the impacts of climate change using their local knowledge to: identify ground water wells and shading from the sun to prevent the lens from drying; using tidal movement to access freshwater; utilising local plants (coconuts) for drinking during freshwater shortages; and growing food crops that can tolerate extreme conditions. Hence, local knowledge systems do hold unique set of ideas that can be applied in dealing with extreme environmental conditions.

The study on Inuit community by Ford et al. (2006) highlights the impacts of changing environment conditions on accessibility to resources where changes in environmental conditions impede precise prediction of winds that makes activities like hunting, fishing and travel unsafe (Ford et al. 2006). However, Inuit communities have learnt to cope up with such risks where hunters and fisher people manage risk by: “taking extra food and supplies; knowing what equipment to take along; navigating using traditional means; and those families that are financially secured have also employed technological adjustments such as the use of GPS to detect ice movement, radios to contact families in times of disaster and powerful boat engines to ease travel (Ford et al. 2006, p. 151-152).

Local knowledge is developed through experiences from past, technological advancements and generally transmitted through learning’s from Elders. McNamara and Westoby (2011) explored the use of local knowledge by the locals of Erub Island in the Torres Strait region of Australia to build community-based adaptive capacity in response to changing environmental conditions. McNamara and Westoby (2011, p. 891) identified the approaches used by locals in response to environmental change that includes “building of rock walls and wind breaks” to minimise coastal erosion, “using native species to re-vegetate sand cays and the coastal foreshore” and setting up fish traps and home gardens to secure food resources. These adaptation strategies are passed down
through generations and modified by its users to respond to their current environment conditions, therefore enhancing their adaptive capacity.

Correspondingly, Nyong et al. (2007, p. 7927) portrays the significance of local knowledge in reducing vulnerability of people to droughts in Sahel in Africa where locals practice zero tilling, mulching, “fallow systems of cultivation”, agro-forestry, organic farming and preservation of biodiversity as ways to increase carbon sequestration and maintain carbon sinks. The adaptation responses of the Sahel people to drought conditions include the use of emergency food items, harvesting of weak livestock during extreme drought conditions, raising a variety of domestic animals, switching from sheep, cows and goat depending on the availability of animal feed, changing the grazing grounds of herd to reduce overexploitation of a particular area and using local knowledge to predict weather that serves as an early warning to plan cropping (Nyong et al. 2007). Similarly, Newsham and Thomas (2011, p. 765) explore the benefits of using local knowledge in North Central Namibia where farmers practiced the planting of “early maturing varieties of staple crops” during drought conditions as it produced good yield even in low rainfall and exchanged livestock farming to avoid over grazing in a particular area. These approaches assist farmers in building resilience and securing food in times of extreme dry conditions.

Moreover, Berkes and Jolly (2001) explore the coping strategies of locals in Sach’s Harbour in Canada that includes changing the time, location and patterns of fishing and hunting, locals go out hunting before the extreme weathers approach and diversify their catch by hunting for different types of animals in season, fishing in areas close to the community and using the traditional practice of food sharing amongst fisher people, hunters and village Elders. Hodgson (2008, p. 1) reflects on the need for Australian Red Cross and the Pacific national societies to incorporate local knowledge in organising disaster management plan and argues that the “existing disaster management techniques could be made more effective if it is used together with traditional knowledge”. The local techniques of providing: early warning systems through, weather forecasts, food preservation, securing thatched and wooden houses, local knowledge of seasonal food
crops and farming techniques to increase yield, and local systems of managing natural resources were identified to be useful in planning for disaster preparedness to reduce the vulnerability of local communities (Hodgson 2008).

On the contrary, there are arguments that reliance on local knowledge that depends on various environmental factors can be modified under climate change. For instance, Speranza et al. (2010) reflects the local knowledge of agro-pastoralists of the Makueni District in Kenya that is particularly dependent on local plant and animal behaviour to distinguish seasons and predict changes in the climate. However, these indicators may be constrained under future climatic changes because the plant and animal behaviour may be modified due to the changing environmental conditions (Speranza et al. 2010). Yet, Brodnig (2000, p. 9) evaluates the need to integrate local knowledge with western science using technologies such as “public participatory and community integrated Geographical Information System” that recognises local knowledge as a valuable knowledge source and encourages community-based adaptation and resource management approaches. Local knowledge systems offer useful learning’s on “environmental cues”, local calendars, environmental indicators that specify planting and spawning cycles, demonstrate successful adaptation strategies and sustainable hunting and farming practices that can be applied to secure food resources and protect local livelihoods under future climate change (Vanuatu Cultural Centre 2005, p. 1).

2.6 Towards a Research Framework

The remoteness of local and Indigenous communities and their intimate dependence on local environments for their livelihoods makes them more vulnerable to climate change (Australian Human Rights Commission, 2008). Local knowledge systems provide vast information on how locals modify their life-styles and activities to buffer the impacts of changing climatic conditions for centuries. This local knowledge system can provide practical understanding of the environment, its ecosystems, the weather conditions and the responses of living things to climatic stressors. Subramanian and Pisupati (2010) indicate that local knowledge is continuously evolving as each new generation adds on
their own set of knowledge and experiences while adapting to changing environmental conditions to build their resilience.

Climate change imposes pressure on the earth’s systems. It is vital to incorporate local knowledge to facilitate the scientific understanding of the climate change processes and impacts and identify ways to mitigate or adapt to those impacts. Subramanian and Pisupati (2010, p. 4) emphasise the need to develop “appropriate methodologies to understand and assess” local knowledge and integrate it with scientific perspectives to enhance better understanding of climate change.

Policy makers play a major role in the implementation of adaptation and mitigation measures. Srinivasan (2004) recognises the need for the policy makers to take into consideration the local knowledge of communities when formulating community-based adaptation strategies. In a case study on Bangladesh, it was found that local knowledge was rarely taken into account by policy makers, which impeded the effective implementation of adaptation strategies (Srinivasan 2004). Denton (2002) reveals that only modest efforts have been made to incorporate local knowledge into environmental policy.

Local institutions play vital role in the development of national adaptation plans in the country. Agrawal (2008, p. 44) outlines the limitations in the production of the National Adaptation Programmes of Action (NAPA) that failed to effectively incorporate “historical experiences”, vulnerabilities and adaptation practices of local people. Under such circumstances, “local people may feel powerless and not responsible for combating climate changes, despite their own vivid experiences of climate change” (Salick and Byg 2007, p. 18). Thus, there is need for greater involvement of local concerns and recognition of the local ways of coping with environmental changes along with modern scientific findings in the development of climate change adaptation initiatives. Including local knowledge systems in climate change adaptation planning and decision-making process can help address “gender related inequalities” as it provides opportunities for the
inclusion of men’s and women’s contribution and participation in resource management and sustainable development (Denton 2002, p. 10).

Additionally, Kirkland (2012) highlights the two specific importance of local knowledge. Kirkland (2012, p. 4) states that local knowledge can “help scientists understand current and expected climate change impacts”. This argument is supported by Green and Raygorodetsky (2010) who state that western scientists can use local knowledge of people to gain area specific information on weather and details on observations of environmental change to fill in the gaps in scientific data. Kirkland (2012, p. 4) points out the second importance of local knowledge “in providing tools for managing climate change” and exemplifies the use of local knowledge in forecasting weather and preparing for it in advance, using local skills of farming to secure food in times of extreme conditions, local ways of harvesting water and constructing/securing buildings so that it can withstand extreme weather conditions. Local people have wide-ranging experiences of adaptation to natural disasters and are continuously employing various local practices that may enhance resilience of local communities to climatic changes (Macchi 2008). These local techniques can be used with modern adaptation strategies to help locals cope up with the impacts of climate change.

Similarly, Salick and Byg (2007, p. 18) emphasise the need to recognise local observations and experiences of people that provide concrete evidences of environmental change unlike the scientific explanations of climate change that is based on “invisible things put into the atmosphere” by anthropogenic activities. However, Dumaru (2010) argues that even though locals have broad understanding of their local environment, they have limited understanding of the causes and consequences of climate change. In this situation, community-based adaptation programmes should encourage collaborative learning that encourages knowledge sharing between scientific knowledge and local people (Dumaru 2010; Strigl 2003).

Community involvement in resource management is necessary for sustainable development as it helps to identify locally based anthropogenic activities that degrades
the environment and involves the active participation of locals to help moderate those actions and control resource use (Kumasi et al. 2010). Local knowledge can facilitate scientific and native learning to enhance adaptive capacity (Simonelli 2008). Effective adaptation and coping strategies could be developed by incorporating local knowledge and scientific learning’s “mainly in developing countries where technology is least developed” (Gyampor 2009, p. 70).

Furthermore, local people are known to be able to sustain their livelihoods and secure their major resources for centuries despite the major changes and climatic challenges on their local environment. Barnhardt and Kawagley (2005, p. 20) focus on the need to incorporate native learning’s in the education systems to encourage local activities such as “learning to hunt by observation”, resource management and environmental protection strategies. In an effort to address issues associated with climate change, it is vital to evaluate the techniques used by locals that facilitated them in dealing with the past extreme events.

The assessment of a community’s vulnerability and the development of adaptive measures can only be productive with the rapid engagement of the locals and incorporation of their local observations and practices to cope with changes (Cameron 2012). There is a need for direct involvement of local people when formulating adaptation strategies and developing resource management measures to deal with climate change related issues at a local level. For instance, Ogunseitan (2003, p. 107) exposes that “the valuation of climate change impacts has a subjective dimension that can only be captured through local experience and an understanding of the values associated with life-saving intervention programs”. Hence, climate change can be better understood and planned for with an appropriate understanding of: past environmental conditions, observations of local changes and community oriented responses developed to cope with such environmental changes.
2.7 Chapter Conclusion

The studies used in this literature review have demonstrated that local communities respond dynamically to the changing environmental conditions and extreme events. Local communities use their local knowledge to manage resources, forecast weather, switch crops, diversify cultivation and make adjustments in their fishing and hunting patterns. The case studies discussed does portray that local knowledge can provide valuable information on climate change, and represents reliable mechanisms to adapt to the challenges posed by climate change. Yet, there is a growing need to broaden the understanding of local knowledge systems and integrate it with scientific research to facilitate the formulation of measures that can help reduce vulnerability, enhance community resilience and promote sustainability to safeguard local livelihoods under future climate change. It is certainly crucial to formulate ways in which useful learning’s from local knowledge systems can be used to respond to climate change challenges. The local knowledge systems necessitate studies and methodologies that can help to document and safeguard local knowledge. This research seeks to explore how locals of Fiji and Vanuatu utilise their local knowledge to prepare and adapt to local environmental changes. It will also assess ways through which those actions and adaptation practices could be effectively applied to facilitate community-based adaptation.
Chapter 3: Study Sites

3.1 Chapter Introduction
This chapter reviews the background of the six research sites. The following sections in this chapter examine the locale of Fiji and Vanuatu to present a background on the study sites. The chapter discusses the geographical location, climatic conditions, population, socio-economic and environmental context of these research sites. This is followed by a presentation of the current and projected future impacts of climate change in Fiji and Vanuatu. After this, a discussion on the study sample is presented. Various pictures and maps have been provided to represent a better understanding of the villages under study.

3.2 Fiji Sites
The island of Taveuni is the third largest island in Fiji situated in the Cakaudrove Province. Taveuni is located 16.82° latitude and 179.97° longitude (Yakub et al. 2011) (see Plate 3.1). The approximate land area in Taveuni is 435km² with a length of 42 km and a width of 10.2 km (Yakub et al. 2011). The weather in Taveuni is mostly humid with easterly trade winds and distinct dry and wet seasons (Taveuni Adventures, 2011). Taveuni is a volcanic island with fertile soils and is commonly known as the garden island of Fiji. Taveuni has a population of approximately 14,500 people (Cronin 1999).

The locals of Taveuni mostly engage in agriculture, small-scale tourism and fishing to earn income. The staple crops mainly grown include dalo, cassava, coconuts, yqona, pineapples, banana, pawpaw, seasonal vegetables and coconut trees. A few others are employed in hotels and resorts, or other services including the Matei airport, hospital, Waiyevu jetty or in Naqara, which in the main business centre in Taveuni. The island has waterfalls, extensive coral reef systems, heritage parks, forest reserves, bird watching sites, the endemic tagimoucia flowers and the international dateline that runs through the island (Paradise Taveuni- Fiji 2012).

There are four districts in Taveuni. These are Cakaudrove I Wai, Wainikeli, Laucala and Vuna (Yakub et al. 2011). Taveuni has 23 villages, 18 primary and three secondary
schools, one government hospital, three nursing stations and a government agriculture research station (Yakub et al. 2011). The sources of water on the island are springs, boreholes, Mua water catchment, streams, rivers and rainwater. The residents of Taveuni provide for their own power, which includes using their own generator or that of the village. Some use diesel, while a few depend on solar panels to collect electricity (Taveuni States, Fiji 2005). The University of the South Pacific’s Pacific Centre for Environment and Sustainable Development (PACE-SD) has conducted vulnerability and adaptation assessment on two sites on Taveuni (Naselesele and Qeleni villages) and one site in Yanuca Island (Yanuca village). This research uses the same study sites so that the information collected in this research can be used to feed into future research of the European Union Global Climate Change Adaptation (EU-GCCA) project.

3.2.1 Naselesele Village (Taveuni Island)
Naselesele village is located on the Northern side of Taveuni close to the Matei airport and overlooks Qamea Island which lies close to Taveuni (Taveuni Adventures 2011). Naselesele village consists of 49 households and 370 people (Yakub et al. 2011). The main source of income for these people is agriculture but a few women make handicrafts and sell them to the visitors who come in the Captain Cook Cruises. The women’s hold weekly meetings where they hold important discussions and engage in activities such as making handicrafts and weaving mats (see Plate 3.1). There is one primary school in Naselesele village and those students attending secondary schools have to travel to any of the three secondary schools in Taveuni which are Niusawa Secondary School, Bucalevu Secondary school and Holy Cross High School.

Male and female who belong to any of the five Mataqali (land owning units in Fiji) in Naselesele have access to their own areas of Matqali land, and utilise ocean resources and the fishing grounds (fishing ground is locally called the “Qoliqoli”) areas. The fishing ground area is shared with Qeleni village. The high Chief of Naselele Village controls the Mataqali land and 11,000 acres of state land. The ownership of the ocean resources is with the Fiji Government, however, the village high Chief decides when to open and close part of the fishing grounds as a traditional “taboo” or for managing ocean
resources. Naselesele village has numerous water sources but the main water supply is from the Mua water catchment located 20 km from the village (Yakub et al. 2011). The Mua water catchment has rainwater. Rainwater is collected in concrete tanks and piped to all the households in Naselesele village. The Mua catchment is managed by the Water Authority of Fiji (Yakub et al. 2011). Other common sources of water include the stream water and spring located along the coastlines that locals rely on when the water supply from the Mua catchment has been disrupted.

The main source of electricity in Naselesele village is from the village generator that supplies electricity to the households from 6pm to 9pm. Each household has to pay a certain amount of money (FJ$5/week) to compensate for the fuel and the maintenance costs of the generator. There is a dispensary situated as part of the village community hall where the village nurse deals with minor health problems. The patients may be taken to the Waiyevu public hospital in Taveuni if the need arises. The community hall is used to conduct church services, hold community functions and become an evacuation centre in times of extreme weather. All environmental problems in the village are discussed by the Elders and are addressed using the necessary measures.

Plate 3.1: Map of Taveuni (left), Weekly ladies meeting in the community house in Naselesele village (right) (Photos: Google Earth 2013; Karen McNamara)

3.2.2 Qeleni Village (Taveuni Island)
Qeleni village is located further down the road from Naselelele village. There are 75 households and 425 people living in Qeleni village (Yakub et al. 2011). The main sources of income for the community are farming (mainly dalo (*Colocasia esculenta*) and yaqona (*Piper methysticum*)), handicraft and fishing. Plate 3.2 illustrates the various activities conducted in Qeleni village that includes the export promotion programme conducted in partnership with the Ministry of Agriculture and the kava drying process. Qeleni village is famous for its bird watching site. There is one primary school and no secondary schools in Qeleni village. The Mataqali land is more than 700 acres and the “Qoliqoli” are shared with the locals of Naselelele village and Qamea Islanders. Men and women, have access to different areas of land and ocean resources. The village Chief of Qeleni controls the resources and makes decision on the conservation of natural resources, including when to impose a “taboo”.

The main source of water in Qeleni village is the local river. However, after the 1998 drought the water level in the river dropped so the villagers now depend on the Unitarawa and the Cawaki spring to collect water for drinking and cooking. The river that runs through the village is used for bathing, washing and sometimes for cooking. A few households own water tanks in which they collect rainwater during rainy seasons that is mostly used for drinking and cooking. The village also has a dispensary that is used to treat minor sickness and also act as an evacuation centre if necessary. The mangroves growing along the beach are being extensively used for fuel wood, making dye for “tapa”. “Tapa” is a customary cloth (Fijian name “masi”) made from the bark of the tree that is worn in Fijian ceremonies (Vaka’uta 2013). The village generator provides electricity to the households but fuel costs are incurred by families. All environmental problems raised by individuals are discussed at a community level and the Chief makes the final decision on what actions to pursue.
3.2.3 Yanuca Village (Yanuca Island)

Yanuca Island is a small island with one village, Yanuca (refer to Plate 3.3). The island is located at 16.50234° latitude and 179.69157° longitude with 19 households and a population of approximately 115 (Yakub et al. 2011). The main sources of income for the locals include fishing, the sale of beche-de-mer and handicraft with a small-scale tourism activity (Yakub et al. 2011). Men and women have access to land and ocean resources. The village Chief makes decisions on access to the fishing grounds. Farming is mostly done on a subsistence scale. There is one primary school on the island; however, students have to then travel to Taveuni or to the mainland for secondary and tertiary education. Open fiber boats are mostly used for transportation. There is one canteen on the island, but locals have to travel to Taveuni to buy majority of their packaged food goods. There is no hospital in Yanuca so people have to travel to the Waiyevu government hospital or any health clinics in Taveuni.

Rainwater is collected in big containers and tanks and is used for drinking. When it does not rain, the community uses the ground water and spring water for cooking, washing and bathing. Locals travel to the other side of the island to collect water from the spring. The current borehole system supplies only 400 litres of water at any one time, which is not enough to cater for the whole village. This borehole was operated using solar energy, however, the solar panels were damaged during Cyclone Tomas in 2010 and have not been repaired since then. When there is little rainfall, locals manually use their hands to...
pump water from the borehole. For electricity and light, the community uses generators, lamps, hurricane lanterns and solar panels. Village environmental problems are discussed at village meetings or in the evenings during kava drinking sessions. The village Chief makes the final decision on appropriate measures to be taken to address the issue.

**Plate 3.3**: Yanuca Island (left), houses in Yanuca village (middle) showing their location close to the coast (right) (Photos: Google Earth 2013; Karen McNamara)

### 3.3 Vanuatu

Vanuatu has a tropical climate with south east trade winds (Briney 2012). Vanuatu is situated in the Oceania group of the South Pacific with a total land area of 12,189km² (Briney 2010) and a population of 234,023 based on the 2009 census (Vanuatu Government 2009). Port Vila is the capital of Vanuatu. The main agricultural activities in Vanuatu include copra, cocoa, coffee, kava, taro, yams, fruits and vegetables, cattle and livestock farming and fisheries (Napat 2012). Fishing, tourism, wood processing, meat canning and mining industries also contribute towards Vanuatu’s economy (Briney 2012). There are active volcanoes in the country, and those that are accessible are major tourist attractions.
The sustainability of the education system in Vanuatu is littered with challenges. One major difficulty is that many children stop their education after primary school due to financial constraints and low household incomes, despite there being secondary schools in Port Vila and outer villages (Levec 2012). Students who complete secondary education attend college in Port Vila or Universities in other PICs through government scholarships. Efate Island has a good water supply; however, many people in other islands of Vanuatu have limited access to freshwater supply and are particularly dependent on the ground water, streams, rivers or springs. Diesel generator is used as the main source of energy for generating electricity (Weaver et al. 2007), yet some communities depend on solar energy and lanterns for light.

Natural hazards such as tropical cyclones, storm surge, coastal and river floods, droughts, tsunamis, earthquake and volcanic eruptions affect the communities of Vanuatu (UNFCCC 2005). Vira (2011) indicates that the communities of Vanuatu have suffered approximately 100 tropical cyclones in the past 40 years, almost ten active volcanoes and 22 major earthquakes in past 27 years and have experienced many floods and drought conditions in past years from the Southern Oscillation Index (SOI). Flooding is common in low lying areas of Vanuatu during tropical cyclones or prolonged rainfall in La Niña years while droughts are common in El Niño years when the SOI is negative (Kiste 2009). Vanuatu is considered to be extremely vulnerable to natural disasters and has been ranked the world’s most vulnerable country from the 111 countries that were assessed (Napat 2012). The connection of people with their ancestral beliefs, lands, culture and traditional practices are extensive, and their daily activities are mostly planned based on the local knowledge and behaviours practiced in the past.

3.3.1 Piliura Village (Pele Island)

Pele Island is located 7km north of Efate, the main island that has the capital Port Vila (Vanuatu Tourism Office 2011). Pele Island is a small volcanic island with rich coral reef systems that fall in the Shefa Province (Vanuatu Government 2009). There are four villages in Pele namely Launamoa, Piliura, Worearu and Worasiviu that collectively have a total of 62 households and 330 people (Vanuatu Government 2009). Piliura
village that has 22 households and 136 people is one of the study sites for this project (see Plate 3.4). Fishing, agriculture and rearing local livestock are major subsistence activities practiced by the locals (Nguna-Pele MPA 2012). The main source of income for locals are making and selling handicrafts, farming and remittances.

The main crops grown in the village are cassava, yams, taro, varieties of banana and island cabbage (bele). A small-scale eco-tourism industry operates in the village and contributes towards funds for the management of the guest house and the Marine Protected Area (MPA). The MPA in Pele serves to protect and conserve marine resources (Getaway 2012). The children attend the primary school located close to the neighboring village on Pele Island – a few kilometres from Piliura village. The students travel to the mainland for their secondary education. Men and women in the village have access to different areas of land and ocean resources and pay respect to the “taboo” and the conservation area imposed by the village Chief. Locals in the village depend on rainwater for drinking. In dry seasons, locals collect drinking water from the spring located in the hills. The ground water wells are used for washing, cooking and flushing toilets.

The locals use their household generators, solar panels (used by only a few) and lanterns as source of lightening and electricity. Any environmental problems in the village are raised by individuals and dealt with in the weekly village meetings. Studies show that Pele Island is vulnerable to the impacts of climate change particularly sea level rise, coastal inundation, inconsistency in rainfall, low soil fertility due to nutrient loss and coastal erosion (Bartlett 2007). A recent climate change project in Piliura, implemented by SPC/GIZ, has initiated community-based adaptation activities to bolster adaptive capacity in the community (refer to Plate 3.4). The project has set up a nursery that grows many coastal and forest plants to reduce coastal erosion and deforestation and a food drier that is operated using solar panels for food preservation. The SPC/GIZ project works with the locals of Pele Island and takes up adaptation programmes so that they are able to cope up with extreme events under future climate change (Land Resources News 2011).
3.3.2 Tassiriki Village (Moso Island)

Moso Island is located close to the Efate and also falls in the Shefa Province (Vanuatu Government 2009). There are two villages on Moso Island – Tassiriki village and Sunae village with a total of 48 households and 237 people (Vanuatu Government 2009). Tassiriki village is used as the study site for this project. The main source of income for the locals of Tassiriki village is farming and making charcoal. The charcoal and vegetables are sold at the market in Port Vila. A few locals also engage in fishing, handicrafts and small-scale tourism activities. There is one primary school in the village and those students who wish to further their education travel to schools on the mainland and mostly reside there with families and relatives. There are no hospitals on Moso Island so the locals travel to the hospital in Efate. Males and females have access to different areas of land and ocean resources. The village Chief usually makes decisions on the management and conservation of resources.

Groundwater wells are mostly used for washing, cooking, bathing and flushing toilets. The locals collect drinking water in village cement tanks that is shared between households while a few locals have their own tanks. Most of the families do their farming on Efate that has a river for easy water access and good fertile soil. Many households use their own generators to provide electricity, a few locals use solar energy while others rely on lanterns. Boats are used as the only means of transportation on the

Plate 3.4: Piliura village on Pele Island (left), solar dryer for food preservation and sale provided by SPC/GIZ (right) (Photos: Google Earth 2013; Karen McNamara)
island. The village frontage is covered with an extensive mangrove system through which the locals have made passages for the boats to pass through to enter the village and the tourist bungalow (Plate 3.5). The environmental problems are resolved in village meetings. The village has imposed the MPA as an initiative to conserve and promote sustainable harvesting of marine resources.

Plate 3.5: Tassiriki village on Moso Island (labeled Sunae in the Map), extensive mangrove systems in Tassiriki village (right) (Photos: Google Earth 2013; Karen McNamara)

3.3.3 Lonamilo Village (Tanna Island)

Tanna Island is located in the Tafea Province in Vanuatu (Stit 2005). Tanna Island has 5,155 households and a population of 28,799 people (Vanuatu Government 2009). Lonamilo village is a small traditional village on Tanna Island which is used as a study site in this research project. According to a focus group meeting conducted with the women in the village by McNamara, there are seven households and a total of eight women, ten men and 40 children living in Lonamilo village. Lonamilo village has traditionally thatched houses (Plate 3.6) and the locals mainly engage in farming activities, making coffee or raising cattle and livestock. These locals mostly practice subsistence living and are heavily depended on their local fruits and vegetables for food. There is a kindergarten in the village and children attend the nearby schools for their primary education. Men and women have access to different areas of land and ocean
resources. The village Chief controls these resources. Mount Yasur, located on Tanna Island, is an accessible active volcano that attracts many tourists to the island (see Plate 3.6).

Accessing freshwater is one of problems for the locals of Lonamilo village. The main source of drinking water in Lonamilo village is rainwater. Otherwise, locals depend on the water from a small stream located near the village for drinking, cooking and washing. Locals place a lot of importance in passing their local knowledge to younger generation. Village Elders (males) and fathers teach boys the cultural ways in the “nakamal” (a small house for males where no females are allowed) while girls learn from their mothers and village ladies at home. Locals access the hospital on Tanna Island. Motor vehicles are used as common means of transportation in the village. Environmental problems are discussed and resolved in village meetings.

Plate 3.6: Houses in Lonamilo Village (left) and Mount Yasur volcano on Tanna Island that is a major tourist attraction (right) (Photos: Karen McNamara)

3.4 Study Sample

Sampling was done using snowballing techniques to identify locals who held rich local knowledge and experiences to adapt to extreme weather events. The sample sites for this study are Taveuni and Yanuca Islands in Fiji, and Pele, Moso and Tanna Islands in Vanuatu. The three study sites in Fiji as discussed above are Naselesele village (Taveuni Island), Qeleni village (Taveuni Island) and Yanuca village (Yanuca Island). The three
sites in Vanuatu are Piliura village (Pele Island), Tassiriki village (Moso Island) and Lonamilo village (Tanna Island). The study sample included 40 participants – 18 from the three study sites in Fiji and 22 from the three study sites in Vanuatu. The study emphasised gender equality therefore; the study sample consisted of both male and female participants. This was done to ensure that the local knowledge, experiences and adaptation actions adopted by both the local men and women in preparing and coping with extreme events are included and documented in this study. Table 3.1 below provides a summary of the number of male and female participants interviewed for this study.

**Table 3.1**: Number of males and females interviewed, according to location (n=40)

<table>
<thead>
<tr>
<th>Village</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naselesele</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Qeleni</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Yanuca</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Piliura</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Tassiriki</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Lonamilo</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>

More women were interviewed in Piliura and Lonamilo villages because men were mostly out in fields or at workplace during the time the interviews were held. The interview questions were kept the same for all the sample sites. The sample size was chosen to be representative of the local knowledge of the entire village at each site and the participants were selected and interviewed until saturation point was reached where participants started providing the same information. Most of the respondents in the study attended primary school with only a few with secondary and tertiary qualifications. Table 3.2 illustrates the qualifications of the respondents and Table 3.3 indicates the age range of the respondents.
Table 3.2: Summary of the level of education of the respondents (n=40)

<table>
<thead>
<tr>
<th>Village</th>
<th>Primary school</th>
<th>Secondary school</th>
<th>Trade</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naselele</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Qeleni</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Yanuca</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Piliura</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Tassiriki</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lonamilo</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3.3: Summary of the age of the respondents (n=40)

<table>
<thead>
<tr>
<th>Village</th>
<th>&lt;30</th>
<th>31-59</th>
<th>&gt;60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naselele</td>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Qeleni</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Yanuca</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Piliura</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Tassiriki</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Lonamilo</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

The sample consisted of middle aged (between 31 to 59 years of age) and old aged (above 60 years of age) locals who have lived in these villages for years and have responded to local environment changes and extreme weather events. The study sample chosen for this research was effective in providing information on past environmental impacts and also reflected on the potential knowledge held by locals in preparing and adapting to extreme events.

3.5 Chapter Conclusion

Due to their location, remoteness and high dependence on ocean and land resources, the six communities chosen for this study are particularly vulnerable to the impacts of
localised environmental changes. There are concerns that the impacts of climate change will impose significant challenges on the livelihoods of these vulnerable communities. Therefore it is crucial to formulate adaptation actions that can strengthen the coping abilities of these vulnerable communities. The local knowledge documented in this study can be utilised to find innovative ways to adapt to future climate change. Involving local communities from Fiji and Vanuatu provided opportunities for the documentation of local observations of localised environmental, investigate the impacts of climate change experienced by locals and identify local techniques of coping with these changes. The next chapter provides the methodological approach used in this study.
4.1 Chapter Introduction
This chapter presents the general overview of the qualitative social research approaches. Following this, the process of conducting in-depth interviews is discussed, including details on snowballing techniques and data collection procedures. This is followed by a description of the techniques used for data analysis. Linked with data collection and analysis, the issue of and concern about positionality are critically discussed. Finally, the limitations of this research methodology are put forward.

4.2 Overview of Qualitative Social Research Approaches
As discussed in Chapter 2, various literatures have shown that local people hold valuable sources of knowledge for monitoring, managing and adapting to environmental change (Green et al. 2010a; Salick and Ross 2009; Berkes 1998). More recently, knowledge systems of local people have been recognised as an important resource for providing an alternative source of ‘knowing’ in relation to community-based climate change adaptation and mitigation actions. For instance, literature indicates that local knowledge can provide significant information on changes occurring to land and sea including changes in seasonal cycles, weather patterns, flowering patterns, breeding and migration patterns of animals and the consequent impacts of these changes on natural resources and local livelihoods (Duerden 2004; Salick and Byg 2007).

There are various ways to document and utilise valuable local knowledge for community decision-making, planning for climate change adaptation and resource management processes. For this research project, a qualitative interview-based research methodology was used. Crouch (2006) indicates that interview-based quality research can produce desirable meaning in research studies when applied effectively where the researcher is directly involved with the participants in the research field. Interviews can either be structured (involving structured questionnaire); semi-structured (includes open-ended questions) or in-depth interviews (that covers one or two issues in great details) (Britten 1995). In this research, using in-depth interview allowed for a more nuanced two-way
dialogue to flow between the ‘participants’ and the researcher in order to understand local environmental knowledge and observations of climate change in detail. This methodology enabled the researcher to collect local views and experiences on the impacts of extreme weather events on local livelihoods and identify successful adaptation measures undertaken to respond to those impacts.

Furthermore, qualitative research involves the collection and analysis of data based on perception, viewpoint and experiences of the people involved that can be useful in understanding local issues and phenomenon (Pope et al. 2002). This research approach is therefore appropriate for this study as it allows for the direct involvement of locals who are actually experiencing the pressures of extreme weather events and climate change. Vishwanathan et al. (2004) strongly asserts that community-based research approaches can enhance the formulation of effective measures that makes research outcomes more appropriate and valuable. Kesby (2000) affirms that such approaches can identify, focus on and facilitate the activities of participants and generate rigorous research outcomes.

Engaging local people in research enhances the effectiveness of the research outcomes as their involvement ensures that local priorities and perspectives are incorporated (Cornwall and Jewkes 1995). Such an approach that incorporates local views does not only acquire local ways of managing climatic impacts but also explores the challenges faced by locals in addressing the environmental dilemmas arising from changing environmental conditions. According to Braun (2010, p.783) “cultural and behavioural” features of local communities and the “views of most vulnerable people should be heard through local participatory schemes such as public forums, interviews and community based events” to ensure that research projects are more effective and sustainable.

Moreover, Riedlinger (1999, p.431) believes that involving local participants in discussions accurately represents the “viewpoints, observations and traditions” of locals, which can enhance reliability. In the same way, Bergold and Thomas (2012) highlight that methods of data collection must be designed in ways that reflects the participants’
experiences so that they can understand the research procedures better. According to Nichols et al. (2004, p. 69) participatory research and “semi directed interviews” can be considered appropriate approaches for climate change studies as they facilitate an understanding of the “dynamic interaction between nature and society” and requires “case studies situated in particular places and cultures” to enhance our collective understanding of climate change.

Ford et al. (2006), uses semi-structured interviews as a means to gather information from the Indigenous communities on their vulnerabilities and adaptation. “Interviews and focus groups, questionnaire, photography projects, blogs, diaries and mapping processes” can be used to generate data (Bergold and Thomas 2012, p. 1). Adopting a qualitative interview-based methodology approach was a crucial component in conducting this study. The approach involved comprehensive engagement of the participants as they were encouraged to participate in as many stages of this project as possible, including preparing for interviews, collecting and analysing data and in producing outcomes.

4.3 Data Collection Techniques

One of the most important factors shaping the success of any research project is the methodological approach used to collect and interpret data. This research project uses a non-experimental research design that utilises in-depth interviews. Advice was taken from the In-Country Coordinator (ICC) for Fiji and Vanuatu and the community engagement team from the European Union funded Global Climate Change Alliance (EU-GCCA) project, which is being implemented by PACE-SD, on most appropriate and suitable sites for this research. Three of us (me, my primary supervisor and a research assistant on the EU-GCCA) visited the three sites in Fiji to assist with translation and initial introductions with community leaders. The ICC (Vanuatu) for the EU-GCCA project accompanied my primary supervisor and I to the three villages in Vanuatu and helped to organise meetings with the Vanuatu Cultural Centre and village leaders for all the three research sites.
Research permits were granted to undertake this study in Fiji and Vanuatu. The research permits were taken from the Permanent Secretary for Education in Fiji to conduct research in Taveuni and Yanuca Island. The research permit to conduct research in Vanuatu was taken from the Director of the Vanuatu Cultural Center. The research permit request letter included Ethical Considerations of the research and Ethics approval was granted. Relevant research authorities in both countries were advised on this study. Following this, the ICC for Fiji, EU-GCCA research assistant and ICC for Vanuatu introduced the researcher to the community leaders (‘gatekeepers’) or spokesperson who recommended community participants and in some instances organised community members for interviews. The community leaders directed the spokesperson to assist the researcher in identifying relevant locals in the community who could participate in the study and each participant then referred the researcher to the next appropriate person in the community who could be interviewed.

4.3.1 Gatekeepers and Snowballing Technique
During our visit to each community site, meetings were organised with the community leaders, considered by the researcher as ‘gatekeepers’, to seek permission to undertake this research first. Upon this confirmation, these gatekeepers were asked to identify the most appropriate community member for this research- those who hold this alternative source of knowledge. Participants were therefore initially selected based on their experiences in using local knowledge to either adapt to environmental changes (past and present) or monitor changes in their landscape and seasons, based on the recommendations of the community leaders.

Alongside the recommendations of the community leaders on the most appropriate community members to include in this study, the snowballing technique was also utilised. Atkinson and Flint (2001) define snowball sampling as a technique for identifying research participants through social networks whereby one of the participants identifies the next participant and so on. Snowballing techniques was utilised in this research, allowing the researcher to link with appropriate people in the six communities who held rich knowledge about the community’s social and cultural systems. Groger et
al. (1999) implies that people in positions of authority in a community can provide opportunities for the researcher to enter into the required population. For instance, in this research, the village Chief, the village Turaga-ni-koro and the village pastor are people in positions of authority in the village and they assisted in identifying Elders who could direct me to knowledge holders in the community.

During interviews, participants were asked to identify any other community members who would be relevant to interview. These participants could then direct the researcher to other relevant people in their community that were known to hold potential valuable local knowledge on adapting to extreme events and could contribute effectively to the study. The researcher interviewed the recommended community members until a ‘saturation point’ was reached, whereby participants provided the same set of knowledge discussed by other participants. Atkinson and Flint (2001) describe this process of finding respondents using snowballing technique as chain referrals. Davis and Wagner (2003) highlight the use of “saturation point” in research to determine the sample size when collecting local knowledge. According to Glaser and Strauss (1967, p. 61) researchers should continue data collection until saturation is reached when the researcher can find no new information significant to the research topic.

In contrast, Abdul-Quader et al. (2006) argue that snowballing techniques can create bias because the participants are not selected on a random basis but mostly chosen based on the individual preferences of the initial participants. Therefore, it does not provide an accurate representation of the community. According to Sica (2006), research bias is inevitable but it can be avoided with proper research design. It is important to recognise the characteristics and skills of the participants as valuable contributions. Faugier and Sargeant (1997, p. 792) suggest that snowballing techniques could possibly be the “only feasible methods available in attempting to study hidden populations for whom adequate lists and consequently sampling frames are not readily available”.

Moreover, all initial participants identified ‘new’ community members to be involved due to their strong community social networks or “existence of some kinds of linkages
or bonds” at the local community level (Faugier and Sargeant 1997, p. 792). According to Streeton *et al.* (nd), the snowballing technique is applicable for studies that are based on sensitive issues and relate to ‘insider knowledge’ of local community members. The snowballing technique is applicable for this study as collecting knowledge of people on their past experiences can be considered a sensitive issue since it deals with emotions and experiences of people in adjusting to extreme weather events, including their ability to cope with devastating impacts.

*4.3.2 In-Depth Interviews*

At each of the six community sites, approximately eight to ten in-depth interviews were undertaken. These interviews documented the local changes witnessed by the knowledge holders, and the mechanisms by which they have adapted to past and ongoing climate extremes and changes to the local climate and the broader local environment. Insights were ascertained from these interviews, which included how local knowledge can facilitate actions that reduce vulnerability, improve resilience and promote effectual community-based climate change adaptation initiatives. I conducted 40 in-depth interviews in total with the assistance of translators (the EU-GCCA research assistant in Fiji and ICC in Vanuatu). Table 4.1 provides a summary of the number of interviews conducted including the timeframe and the list of gatekeepers in each sites.

An interview guide was used to conduct in-depth interviews (please refer to the interview guide in Appendix A). The interview guide included open-ended questions that permitted conversational dialogue and knowledge sharing between the researcher and the knowledge holder. The interview guide also included a mix of structured and close-ended questions that allowed for statistical analysis of data to identify trends and comparisons. Using in-depth interviews also increases the opportunity to collect useful information shared by the participants.

Moreover, the interviews were conducted in an informal setting to encourage a relaxed environment and opportunities for storytelling to evolve based on the knowledge holders’ experiences in dealing with extremes events, observations of local changes and
understanding of climate related issues and relating its impact on their livelihood. McNamara and Westoby (2011, p. 890) inform that this approach allows the researcher to “capture various interpretations of a range of opinions, memories and experiences” and maintain good research relationships. The interviews were organised with a particular consideration of the “location and time” so that it was convenient for participants and there was sufficient time for discussions to take place (Krishnaswamy 2004, p. 21). After permission was gained from the interviewees, I took both verbatim and thematic notes. Throughout the thesis, italics has been used to highlight verbatim notes from the interviews while the non verbatim notes are presented with in-text referencing to show that the information discerned from the interviews but are not direct quotes from the respondents.

The information discerned from the interviews was used to identify the pressures of past and present extreme climate conditions and environmental changes on the livelihoods of the locals of these six communities. The information gathered also gave insights into various local practices and adaptation actions employed by the locals to cope up past extreme weather events and environmental changes. Secondary data was collected from journal articles, the Vanuatu Research Centre Library and other Internet sources to add to the debate and discussions on the historic and contemporary use of local knowledge in adapting to local environment and climatic changes. The secondary data sources were used to analyse the environmental events that impact Fiji and Vanuatu and to interpret and show reflections of primary data with scientific literature for validity.

To take into consideration ethical issues, the project will return all knowledge collected to the community to avoid the one-way extraction of knowledge. All cultural, gender and religious obligations before, during and after the interviews were fully respected. Confidentiality, privileged ownership and sharing will be strictly maintained as directed by the owner or caretaker of the information. It was crucial to maintain ethical codes throughout the research to encourage courteous behaviour, allow good research conduct based on trust, respect and appreciation and minimise harm to participants (Sultana 2007). Verbal consent was sought from the participants nominated by the “gatekeepers”.

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Prior to the commencement of the research, information about the purpose of the study, the methods involved and the potential risks and benefits of the research was explained to the people nominated by the “gatekeepers” in their own language with the assistance of the translators. Based on this information, participants were allowed to either participate or oppose their participation in the research. Consent was sought from those who agreed to participate in the research and they were interviewed. The names of individuals was not revealed when reporting the information gathered from the interviews and any direct association made is only through the consent of the participants.

Table 4.1: Summary of the number of interviews and timeframe in each site (n=40)

<table>
<thead>
<tr>
<th>Research Sites</th>
<th>Timeframe</th>
<th>Total number of interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naselesele village (Fiji)</td>
<td>26/07/2012 to 27/06/2012</td>
<td>8</td>
</tr>
<tr>
<td>Qeleni village (Fiji)</td>
<td>30/07/2012 to 31/07/2012</td>
<td>5</td>
</tr>
<tr>
<td>Yanuca village (Fiji)</td>
<td>03/08/2012 to 04/08/2012</td>
<td>5</td>
</tr>
<tr>
<td>Piliura village (Pele)</td>
<td>13/08/2012 to 14/08/2012</td>
<td>8</td>
</tr>
<tr>
<td>Tassiriki village (Moso)</td>
<td>20/08/2012 to 21/08/2012</td>
<td>8</td>
</tr>
<tr>
<td>Lonamilo village (Tanna)</td>
<td>23/08/2012 to 24/08/2012</td>
<td>6</td>
</tr>
<tr>
<td>Total number of interviews</td>
<td>26/07/2012 to 24/08/2012</td>
<td>40</td>
</tr>
</tbody>
</table>

4.4 Data Analysis

The knowledge that was gathered from the interviews was developed into themes that were then identified from the interview materials to develop appropriate stories and subsequent thesis chapters. The socio-economic characteristics served to provide baseline information on the study sample. The information was used to develop an overall understanding of local knowledge and its application to resource management and adaption to environmental changes. The content analysis of the qualitative data obtained was used to reflect on the past environmental change events and on the practical responses of locals to extreme events.
The quantitative data obtained through the in-depth interview was analysed using the Statistical Program for Social Sciences (SPSS, version 16.0). All close-ended questions in the interviews were coded, inputted and analysed using SPSS. Basic frequencies and means were produced, followed by cross tabs and comparisons of means to assess if any (statistical or not) relationships existed between socio-economic variables and other participant responses, which could assist in mapping trends. The results of such analysis are presented in Chapters 5 and 6. In concluding, the findings of this research will feed into the ongoing climate change adaptation initiatives (under the EU-GCCA project) at these six sites. All knowledge collected in this project will be returned to the community as a depository in the library or school for use by the community in future climate change adaptation or sustainable development planning for their local community.

4.5 Positionality

The interactions and relationships between the researcher and participant can affect the ways in which participants respond. Many studies have developed a growing interest in assessing the consequences of positionality on research (see Sultana 2007; St. Louis and Barton 2002). St. Louis and Barton (2002) define positionality as the identity of an individual as positioned by others that is often defined in a social context such as race, gender, class and roles. Elwood and Martin (2000, p. 649), in a study on assessing how varied interview site affect qualitative research, argue that interview sites represent “multiple scales of spatial relations and meanings” that can influence the “power and positionality of participants in relation to people, places and interactions discussed in the interview”. The extent to which female views are considered in environmental decision-making, the influence of local’s traditions and customs to orient a society’s ways of living and the differences between groups of people within a community can produce subjective responses. As such, we need to be mindful that the gender, ethnicity, class and other personal attributes of the researcher may have influenced how local community members answered and responded to questions in interviews.

The social interactions made during the interview are also influenced by the position of the researcher. Often, differences in class, gender, nationality ethnicity, education and
lifestyle can put the researcher in a different position as they are from diverse backgrounds (Sultana 2007). However, in this study, some of these differences were minimised by following the Fijian village protocols whereby the researcher wore a ‘sulu’ as the rest of the women in the village. The researcher also observed cultural practices to prevent any behaviour that would offend anyone and to minimise the difference between the researcher and locals. This creates a comfortable atmosphere between the researcher, participants and broader community members (Mero-Jaffe 2011). According to Elwood and Martin (2000, p. 652), researchers can observe “artifacts, posters and decorations” at the interview sites to increase their understanding of community priorities and observe peoples interaction with each other to understand the experiences of people in that locality. This also allows the researcher to feel more comfortable when interacting with participants and be able to talk freely and not feel entirely as an ‘outsider’.

The positionality of the researcher, as viewed by the participants, could influence the participant’s interest in participating in the interview. During the fieldwork, it was noticed on a few occasions that the Elders were reluctant to participate in the interview. When the family members explained the Elder’s behaviour, they mostly reasoned it to be because the interviews would be in English, which would require formal knowledge and that interacting with the researcher would be difficult because the researcher is formally educated and belongs to a different ethnicity (but same nationality), class and gender.

4.6 Research Limitations
There were a few unavoidable constraints experienced in carrying out this research even though care was taken in successfully achieving the objectives of this study. First, only a single visit was made to each of the study sites because of the time limit and one year provision of the scholarship to complete the Masters program. However, when documenting knowledge from a community it is important to build mutual trust with the communities to be able to successfully understand and describe the local ways and actions. Therefore, the study should have involved a few more visits to the research sites. The priority was to investigate the research problem, assess localised changes and document the local strategies used to cope with past changes within the available
timeframe. Nonetheless, the research will document the learning’s from this study and make the research outcomes available for the local communities so that the participants and younger generation can benefit from it and strengthen their locally-based adaptation practices under future climate change. A further benefit of this would be that locals feel part of the project outcomes and the relationships of trust and respect are maintained between the researcher and locals.

Another constraint of this research study was due to the language barrier between the researcher and the locals who were interviewed. Since most of the participants were Elderly and preferred their mother tongue as a language to be used for the interview, it became quite difficult for the researcher to effectively communicate during the interviews. This language barrier was addressed through the use of translators. The translators translated the interview questions to the participants and then translated the responses to the researcher to be recorded in the interview materials. The translators were selected by primary supervisor and the ICC for Fiji and Vanuatu. The translator for the three communities in Fiji was the EU-GCCA research assistant. There were two translators for three communities in Vanuatu. The ICC in Vanuatu assisted with the translations in Piliura and Qeleni villages and a local from Tanna Island (who works for the Ministry of Agriculture in Tanna) helped in translation in Lonamilo village.

Furthermore, it was found out during the interviews that some of the local knowledge of people has been lost. This is particularly because local knowledge was not formally recorded and the early Christian Missionaries forbid songs and dances which were the most common ways of recording and transferring local knowledge. Therefore, important local knowledge and ways of dealing with environmental problems, extreme events and food preservation techniques have been lost. This history has limited the collection of data to some extent and influenced the effective assessment of past local knowledge and experiences of people that had been constructed and reconstituted throughout centuries. However, there was still a vast range of adaptation measures and local knowledge shared by participants (discussed in Chapters 5 and 6), which provides a valuable foundation to
base future decisions when planning community-based climate change adaptation strategies.

4.7 Chapter Conclusion

Qualitative interview-based methodology has been considered an appropriate framework to document local perceptions of climate change. The interview guide used in this research was effective in collecting valuable local knowledge through informal discussions and storytelling. The knowledge produced using this research methodology encouraged a better understanding of the community’s social structure, their cultural norms, and identification of local practices to respond to changing environmental conditions. As discussed above, there were a few unavoidable limitations in conducting this research however, ethical considerations were considered and local customs and traditions were respected at all times. This research framework documented various applications of local knowledge in predicting, preparing and adapting to extreme weather events that is discussed further in the upcoming chapters.
Chapter 5: Predicting and Preparing for Extreme Weather Events

5.1 Chapter Introduction
This chapter presents the first set of research results. The chapter is organised based on valuable knowledge of locals in predicting and preparing for extreme weather events. The first section describes local methods of recording and imparting local knowledge. The next section focuses on the procedures used by the locals to prepare for extreme weather events. The following section presents the use of local knowledge to predict extreme weather events. Subsequently, the sustainable local practices of managing natural resources are provided. Finally, discussions on local ways of securing food through various planting and preservation techniques are provided.

5.2 Recording and Transferring Local Knowledge
The local communities in Fiji and Vanuatu have developed intricate techniques to prepare for extreme weather events. To understand how communities cope with these environmental changes, particularly extreme weather events, it is important to assess the adaptation approaches employed by the locals in the past. Local communities have developed immense knowledge about their environment and often depend on this knowledge system to sustain livelihoods, manage or reduce environment risks, plan daily activities and adjust to climate related changes. Consequently, the interviews undertaken for this research focused on the adaptation strategies and skills used by locals of the six communities to cope up with the consequences of extreme weather conditions.

Prior to documenting and assessing these adaptation strategies, which will be analysed in more detail in Chapter 6, respondents were asked to identify who they gained their local knowledge from. Common ways of gaining this knowledge include story-telling and demonstrations from grandparents, parents and village leaders. Parents, grandparents and village leaders pass their knowledge of the traditional ways of living, farming techniques and village protocols to their children. For example, one of the Elders from Naselesele village (Fiji) illustrated the ancestral ways of knowing:
Our ancestors are good at knowing the time to plant. Like now July, good time to plant. They use months as indicators for planting season; we get land ready in July for planting in July and August. We get this information from our parents who got it from their parents so information comes down from ancestors (#3 pers. comm., 2012).

The citation style “(#3 pers. comm., 2012)” indicates the verbatim quote from the third interview. These stories and techniques are then put into practice and at times the Elders demonstrated while the younger generations copied and performed actions themselves. Figure 5.1 highlights the key ‘gatekeepers’ of this knowledge and allow for it to be transmitted to the younger generation.

![Figure 5.1: The transmission sources of local knowledge (n=40)](image)

The main sources of transmission of local knowledge are through grandparents and parents. Respondents could select as many relevant variables as possible on possible sources of local knowledge mindful of the fact that knowledge can stand from various sources. All locals from Vanuatu indicated that they gained their local knowledge from grandparents (100%), 72.7% of the respondents acquired their local knowledge from parents, and village leaders provided local knowledge to 45.5% of the respondents. Just 4.5% of the respondents from Vanuatu gained their local knowledge from relatives and friends presented in the ‘Other’ category. In contrast, Fiji results show that only 27.8 % of the participants acquired their local knowledge from grandparents, 50% from their
parents, 11.1% participants gained local knowledge from their neighbours while 16.7% gained their local knowledge from relatives and friends presented in the ‘Other’ category. The village leaders play an important role in transmitting local knowledge to the younger generation especially during afternoon grog sessions or in village gatherings.

Furthermore, cross tabulations were done to find trends in transmission sources comparing the two countries. It was found that all the respondents in Vanuatu gained their local knowledge from their grandparents (100%) when compared to Fiji (27.8%) while only 50% of the locals in Fiji obtained their local knowledge from their parents compared to 72.7% of locals in Vanuatu who gained their local knowledge from their parents. This can be explained in relation to the Vanuatu customs that has compulsory requirements for children to learn their local ways. The boys accompany their fathers to the “nakamal” and learn local ways from their grandfathers, fathers and village leaders while females learn from their grandmothers, mothers and village ladies.

However, acquiring local knowledge from neighbours is common in Fiji compared to Vanuatu. The respondents from Fiji indicated that they often learnt local ways of planting and constructing locally made thatched houses, weaving mats or making handicrafts while helping their neighbours or from their relatives and friends that the respondents included in the “Other” category. Also, knowledge in preparing and adapting to extreme weather events and learning sustainable ways to secure food and natural resources is mostly learnt while helping in preparing for extreme weather events. This was common amongst the Fijian communities. As it is Fijian custom to help their neighbours with their chores and in doing so, they discover valuable local techniques.

Results revealed that more females (68.4%) obtain their local knowledge from their parents, following grandparents (55.6%) and neighbours (5.3%) compared to the males (parents 57.1%, grandparents 44.4%, and neighbours 4.8%). Majority of the females in many Pacific Island local communities take up domestic duties particularly prioritising activities such as managing houses, looking after the children and the family, securing
food and water resources during disasters and learning to sustainably utilise their limited resources. Most of this knowledge is obtained from the mothers, grandmothers and aunts. The village ladies in these Fijian communities meet on a weekly basis and work together sharing their knowledge on weaving, practicing various methods of cooking and preservation and cultural ways and learning from each other. The women’s committee comprises of young, middle aged and old ladies which allows knowledge to be shared between generations. In contrast, males are either involved in paid job or in fieldwork and mostly hold knowledge on gathering food, especially techniques on planting, fishing, hunting and managing local resources. These techniques are learnt from experienced men in the village including grandfathers and village leaders.

Moreover, participants were asked to indicate if local environmental knowledge was recorded in the community. Out of the 40 locals interviewed, 19 stated that local environmental knowledge is formally recorded. There are no evidences of formal documentation of local knowledge however, this valuable knowledge is recorded as songs, dance and folklores which are transmitted orally through each generation. Therefore local knowledge in these six communities is not formally written down and taught to the younger generation. Green et al. (2010a) portrays similar transmission concept where transmission of local knowledge through generations is considered vital for Torres Strait Islanders, however, their knowledge is not written down but passed down through generations in the forms of songs and stories. Almost all the local knowledge collected in this study has been orally acquired by the participants and improved through repeated demonstrations and individual trials until one completely masters the technique and becomes perfect with it. The data obtained on the ways in which local environmental knowledge is recorded is presented in Table 5.1.
Table 5.1: Ways in which local environmental knowledge is recorded in the community (n= 40)

<table>
<thead>
<tr>
<th>Means of recording</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stories</td>
<td>13</td>
</tr>
<tr>
<td>Songs</td>
<td>10</td>
</tr>
<tr>
<td>Dance</td>
<td>7</td>
</tr>
<tr>
<td>Folklores</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
</tbody>
</table>

The common means of recording local environmental knowledge is through stories and songs. Elders and parents tell stories and sing the songs to the children and explain the significance of those stories and songs. There were also a few responses on how local knowledge has been recorded in traditional dance. For example, one of the Elders from Taveuni summarised how this is carried out:

*When we teach the children the traditional Fijian dance (sea-sea to girls/ladies and wesi to boys/men), we explain to them the stories the dance reveals. The lyrics of the songs explain stories of olden days and events (#4 pers. comm., 2012).*

The village of Naselesele (Fiji) has the Captain Cook Cruises which is a tourist ship coming every six months. The village Elders teaches the village ladies, young girls and boys the traditional “meke” and traditional stories which they enact to the tourists. In a “soli” (village occasion) or when there is opening of the new building, the village leaders and parents prepare the children and teach them the traditional stories which they enact to the public and through such performances their traditional knowledge are passed onto the performers (#5 pers. comm., 2012). Other times, local knowledge is passed down through direct instructions and demonstrations.

There are concerns that local knowledge is being lost. The village high Chief of Naselesele highlighted how Christianity discouraged the traditional systems:

*Our old mekes revealed stories and prophecy of the future. Those traditional mekes got lost when Christianity came in. Our traditional mekes and*
traditions were looked down upon by Christianity and western ways. We have lost the sailing skills and knowledge. But this knowledge with the technology today, I am afraid that some are lost (#6 pers. comm., 2012).

The new culture brought in by the missionaries forbids traditional songs and dances so most information in it stayed within knowledge holders and could hardly be passed on to the younger generation. These local communities have also changed with time and are adapting to the new technology. In doing so, some parts of the local knowledge of the people are being lost.

Similarly, traditional ways were discouraged in Vanuatu. Local knowledge is mostly transferred through ‘word of mouth’. This is because the missionaries outlawed traditional songs and mekes. This is described by one of the Elderly woman from Piliura village (Vanuatu):

Knowledge is transferred by word of mouth because after the missionaries came, there was no use of songs and dance. It was discouraged by the missionaries when they came as it’s considered non Christianity. We teach our children our ways and what we do through verbal means (#19 pers. comm., 2012).

Therefore, their knowledge is transferred through verbal means and direct demonstrations.

One of the Elders from Lonamilo village (Vanuatu) highlighted the custom practice of circumcision when boys learn local ways from their fathers in the “nakamal” which is a gathering place for men and young boys:

Every afternoon the boys go with their fathers who drink kava in the nakamal. They tell stories customs, seasons, planting, teach about circumcision and they learn from there. The daughters learn at home from their mothers as they are not allowed to go to the nakamal (#38 pers. comm., 2012).

The fathers usually teach young boys the custom ways and responsibilities while the mothers teach their daughters how to carry out household chores.
5.3 Preparing for Flooding Events
Out of the six communities interviewed, only two communities, Qeleni village (Fiji) and Lonamilo village (Vanuatu) had experienced flooding episodes in the past. The locals of Qeleni village and Lonamilo village have developed techniques to prepare for flood events. These communities are able to use their local knowledge to forecast weather. When heavy rain is forecasted and flooding is expected, locals bring their fishing boats/canoes closer to their house. Sometimes, these canoes are used to move from one village to another to collect food items especially when the flood waters have not receded and the household has run out of food supply. Locals also collect cassava and yams from their plantations and prepare “lovo” in an underground oven. It often becomes difficult to cook food using fire when the fireplace gets wet from heavy rainfall so locals prepare “lovo” for consumption and wait for the fireplace to dry (#3 pers. comm., 2012). They also collect raw food like fruits and buy preserved food items so that they have enough during bad weather. The females collect rainwater for drinking.

5.4 Preparing for Droughts and Water Shortages
Drought conditions are one of the eminent climatic concerns affecting many parts of Fiji and Vanuatu. Through past years, local communities have learnt various consequences induced by drought conditions and have developed skills to secure their food and water supplies mostly by preparing for it in advance. Farmers possess local techniques that help secure food and water resources. This local knowledge has been principally obtained from the older generations and the younger generations have successfully learnt this knowledge through practice. The village high Chief of Naselesele (Fiji) reflected on the drought in the 1960s when extremely low rainfall and intense heat destroyed all the young suckers of the dalo plants. In response, as an adaptation strategy, learnt from their ancestors the locals pulled out mother dalo as explained below:

They pulled out the mother dalo and put the suckers back into the soil to prevent the suckers from dying (#6 pers. comm., 2012).

This was a very successful strategy as this prevented the suckers from dying and instead of one dalo; they could get a few more from the suckers that could receive rain after the drought.
Moreover, before the dry seasons approach, farmers plant certain crops like kumala (sweet potato- *Ipomoea batatas*), tivoli (wild yam- *Dioscorea villosa*), kawai (yam- *Dioscorea esculenta*), uvi (Dioscorea alata), giant swamp taro (*Cyrtosperma chamissononis*) and wild cassava which can survive seasons with low rainfall (#6 pers. comm., 2012). The village high Chief of Naselesele (Fiji) stated that locals always have these crops planted in their gardens for food security:

*What we always do, we have a crop on standby; say kumala, kawai or yams in case of severe weather events like hurricane or drought (#6 pers. comm., 2012).*

Therefore, multiple cropping is a common farming practice during drought seasons.

Wild yam and kumala (crop and leaves) grows all year around and is often used in times of drought to replace vegetables (#6 pers. comm., 2012). Some locals use their local knowledge to build bamboo structures for wild yams to creep onto for support when the nearby trees die or has been cut down for firewood (please refer to Plate 5.1). During water shortages, locals rely on spring water. The assistance received from Government Departments is also a practical short-term coping strategy for temporarily securing food resources. The locals of Yanuca received assistance from the Government that supplied drinking water and the Agriculture Department provided seedlings for sweet potatoes, cabbage, eggplant, cassava and yam branches to assist with the farming.

Likewise, locals of Piliura and Tassiriki villages (Vanuatu) plant food crops which are drought resistant. These include cassava, wild yams and certain varieties of bananas locally known as “Malele” (*Musa balbisiana*), “Vietnam banana” (a variety of the *Musa balbisiana*), and “China banana” (*Musa acuminata*). These are common local bananas mainly used for food so once these bananas are planted under favourable conditions; they are able to survive harsh conditions (#27 pers. comm., 2012). The varieties of banana preferably planted for drought seasons by locals of Lonamilo village are called “saaina” (*Musa balbisiana*) and “suwip” (a cultivar of *Musa acuminata*) in Tannese language. In times of water shortages, locals prepared big containers and portable plastic tanks to collect water from nearby springs and dig groundwater wells for washing,
bathing and at times cooking. Locals then do farming closer to water source mainly on mainland that has rivers and streams so that crops prone to dry conditions can survive.

The knowledge of locals on selecting certain crops to be cultivated during drought seasons was successful in providing communities with adequate food during limited rainfall. There was no food shortages even after the vegetables and some other food crops wilted. The locals had diversified their produce and there were always other crops that they could rely on. Newsham and Thomas (2011) demonstrate a similar practice of farmers in North-Central Namibia where they prepare for drought seasons by storing surplus harvests, growing crops better adapted to local conditions for cash cropping, digging wells for water, sharing available food, and receive Government assistance.

Plate 5.1: Using bamboo structures to allow yams to creep on in Qeleni (left), wild cassava consumed during drought in Naselelele (middle), and common Vietnam banana for drought conditions in Vanuatu (Photos: Karen McNamara)

5.5 Preparing for Cyclones

Local knowledge is extensively utilised in these six communities to prepare for cyclone events. Mainly, men and women share their duties in preparing practically for cyclones. Women collect preserved canned foods, processed food items, water supplies, torches, radios and kerosene. One of the ladies of Naselelele (Fiji) describes her households’ preparation as:

*First of all you have to close the shutters and you have to accumulate food and water, clean water. If we have a gas stove or primus, we keep it ready, need light, torch, radio and enough kerosene. We cut down big trees near our*
house. With our food, what we do with cassava we make stems short and also yaqona cut down low, it is safer and they will grow again...very little damage to our plantation because as soon as hear warning, he (husband) runs to plantation to cut it down (#3 pers. comm., 2012).

The young girls assist their mothers in making the preparations and in collecting food supplies.

Men usually secure houses and plantations. They removed guttering of tanks to reduce contamination of their drinking water and placed big pots to collect rainwater. Those who owned boats brought their boats to the shore; some used the boat to fill in rain water so that it doesn’t get turned over by the strong wind (#18 pers. comm., 2012). Men also removed any weak branches near the house that would fall with the strong winds, put down shutters; some covered their windows with iron roof, nailed the roofs and tied houses with rope (#17 pers. comm., 2012). McNamara and Westoby (2011, p. 888) illustrate the efforts made by Fijian communities to build houses using local materials that were “collapsible” and were used to “protect against cyclones”, and collected emergency food that the locals called “hurricane food”. One of the Elders of Naselesele (Taveuni) explained the strong winds during recent cyclones and suggests that more precautions are needed when putting down shutters and that a small area is always kept for wind to come through and not to make it impossible to get out of the house in case there is damage (#1 pers. comm., 2012).

In addition to this, locals secured livestock and tied cattle in old gardens/patches or in places away from big trees. Pigs were placed safely in pig pan away from tall trees. To reduce damage in the plantations men prune the cassava (refer to Plate 5.2) and yaqona (kava) plants to reduce the surface area of the leaves exposed to the wind, and take off matured fruits from the trees. For instance, one of the participants indicated that if it was breadfruit season, they take off 2 to 3 bags of breadfruit and harvest vundi fruit (banana) (#10 pers. comm., 2012). The matured vundi is hanged inside the house and let to ripe. Some farmers collected root crops from their “teitei” (farms) and made a “lovo” using
cassava so that it can be preserved for over a week and be used as food during the
cyclone.

Drawing off the interviews in the three communities in Vanuatu, similar preparations are
done at both the household and community levels. Men tie houses with ropes and then
the rope is tied to a big tree. For thatched houses, they weave and tie banana leaf veins
with green coconut leaves and use it to cover the thatched roofs to keep it intact. For iron
roof, they place heavy cement bricks or sacks filled with sand on roofs to prevent it from
being blown away with strong winds. They also prune cassava and banana leaves.
Matured breadfruit and bananas are collected from farms and stored in the houses for
consumption. They preserve surplus bananas by making a dish called “nimare”. These
locals grow crops which mature quickly and help with food shortages particularly
kumala, corn, and certain varieties of cassava.

Cattle are set free so that they can find shelter. Elderly, women and children are housed
in strong buildings. Women store water in buckets and containers and prepare tanks so
that it gets filled with rainwater before the winds get very strong (refer to Plate 5.2).
They also gather processed food and store sufficient amounts of food (#29 pers. comm.,
2012). The efforts made by the locals of Fiji and Vanuatu were often successful in
reducing the risks from cyclones. For example, the cassava crops were not badly affected
after it had been pruned, most of the roofs remained intact and there was adequate food
available.
Plate 5.2: Collecting rainwater in Pele (left), the Turaga ni-koro of Naselesele village showing the appropriate height to prune cassava plants (middle) and securing roofs using bricks in Qeleni (Photos: Karen McNamara)

5.6 Using Local Knowledge to Predict Extreme Weather Events

Locals of these six communities are able to forecast weather using their local knowledge of seasons, temperature, wind direction, fruiting patterns, and changes in animal and plant behaviour as environmental indicators. This knowledge has been gained from their parents, village Elders and relatives and is being passed down to the younger generations. For instance, one of the Elders from Qeleni (Fiji) sites explained the curled up young vundi leaf as a sign of an approaching cyclone (refer to Plate 5.3):

That’s what our fathers teach us the vundi leaf, the one in the middle grows bent over. It tell us the weather will be very bad, like a cyclone (#17 pers. comm., 2012).

Also in fruiting season, when certain fruits bear more yield than usual indicates cyclone. For example, when breadfruit is plentiful (three to four in one branch) but normally there’s one breadfruit per branch. Observing animal behaviour is also a source of forecasting knowledge. For example, when bees put their hive close to the ground, and not up high in upper branches of the trees as normal, it predicts a cyclone. The change in turtle nesting behaviour predicts an approaching cyclone. For instance, turtles normally nest in the beach, however, when the turtle’s come and nest inland it indicates possibility of a cyclone during the turtle nesting season (#15 pers. comm., 2012).

In addition to this, locals of Fiji use the sun, sea surface temperature and wind direction to forecast weather. One of the Elders from Yaniuca (Fiji) explained that during a normal long day, the sun will move to the mountain end, but if it only comes halfway and moves back (sets), it indicates a cyclone is approaching (#15 pers. comm., 2012). When the sea water temperature is warmer than normal, or when sea water under the surface water doesn’t appear clear and is shaking (this does not happen normally), it implies an approaching bad weather, rough seas and possibility of a cyclone. The normal wind for
Fiji is the South East trade winds, but when the wind blows from North, it signifies cyclone (#15 pers. comm., 2012).

A vast range of techniques are utilised by the locals of Vanuatu to predict extreme weather conditions. For people of Piliura village (Vanuatu), the shape and colour of the primary clouds during sunrise and sunset are widely used to predict weather. One of the Elders described the dark blue clouds that indicated cyclone:

*Sometimes we indicate it from the dark blue clouds, we can’t see the sky, a cyclone is coming and we hear in the radios that a cyclone is approaching (#19 pers. comm., 2012).

A similar demonstration has been made by Weatherhead et al. (2010, p. 524) on the use of indicators particularly reading of the sky by Elders of Inuit communities to monitor “shapes, color and movement of clouds” to forecast changes in weather.

Likewise, the locals of Piliura community (Vanuatu) monitor the colour of the sky during sunset to predict weather. When the sky is red in colour at sunset then changes suddenly to dark, indicates rain the following day but when the sky is yellow during sunset, it indicates that the wind is going to change from what it currently is and mosquitoes will come with it (#23 pers. comm., 2012). Piliura villagers also monitor changes in the behaviour of animals and plant to predict weather. For example, one of the Elders of Piliura (Vanuatu) described the “white wood” that sheds leaves before a cyclone:

*We have a special tree that indicates cyclone the white wood when it is losing all its leaves it means a cyclone about to hit us but if the white tree is not throwing out leaves, it means the cyclone will not hit us (#25 pers. comm., 2012).

The locals monitor the leaves of this “white wood” to forecast cyclones and make preparations for it. The bird from Mataso Island, when seen flying around areas of Pele Island instead of Mataso Island where it normally stays, indicates an approaching cyclone and locals prepare for it. Another local bird called “mala” makes unusual sounds which the locals describe as “mala cries making a lot of noise” (which it normally does
not), indicates drought conditions so the locals start collecting and saving as much water as they can (#21 pers. comm., 2012).

Likewise, in Tassiriki village, there’s a bird locally called “sura”, when it makes plenty noises (which it doesn’t do normally) signifies either a cyclone or heavy rain. These locals read clouds to predict rain and earthquake. One of the Elders highlighted the use of local knowledge to observe clouds and earthquake to make forecast:

*Dark clouds means heavy rain, dark clouds moving very fast means cyclone anytime soon...when we have a long line white clouds it speaks of earthquake...sometimes I read the clouds and I told people we have some earthquake little or big earthquake and it is real...When we have light earthquake, it means no rain for long time six to seven months so we save water, start collecting water, manage what we have...in heavy earthquake we know lot of rain for next two to three months (#29 pers. comm., 2012).*

Using forecasts, the locals plan their water usage, prepare their gardens and plant crops that will survive the approaching drought.

One of the Elders of Tassiriki village (Vanuatu) explained “Naburau loa” clouds which is a black cloud that signifies heavy rain with the cyclone. The “Namadama” cloud is the white clear clouds that indicate a sunny day with no rain, so the locals expect a good weather. The third type of cloud is “Naburau milaya” cloud which means red clouds at sunset that implies weather to be bright (sunny) the next day and it sometimes indicates mosquitoes. Also, the locals of Tassiriki village believe that there are indicators from the ancestors on impending disasters or a good year. One of the Elders of Tassiriki village (Vanuatu) highlighted the significance of the sound of the “conch shell” which is a customary believe as a caution from the spirits on how the year would go for the locals. Sign for good year means no cyclone. The Elder explained:

*The conch shell it is our custom that if we hear the shell been blown which we believe is from the ancestors... it’s the spirits who blow it. It is blown at night at the beginning of the year we normally hear it for ten times, it indicates that*
if there is a cyclone affecting Vanuatu, their village won’t be affected, they will have a good year (#30 pers. comm., 2012).

The locals of Tassiriki also observe changes in wind patterns to indicate cyclone. When the wind changes from the normal North East (locally called “suafate”) to South West (locally called “Tokelau”) direction, it implies an approaching cyclone. One of the villagers of Tassiriki village (Vanuatu) highlighted the importance of local knowledge of wind direction in predicting cyclones:

When the wind changes from normal North East winds but it comes from South West direction opposite direction, it indicates cyclone is coming. South west winds are called Tokelau and North East wind is called suafate. Traditional knowledge is reliable; whatever the old people predicted it came true (#32 pers. comm., 2012).

This community has strong believes in the use of indicators for forecast and believe that their predictions are often correct.

The locals of Lonamilo village also utilise environmental indicators which are similar to Piliura and Tassiriki villages. However, there are a few extra techniques that they have. For instance, “Manak Ire” is a saltwater bird which usually stays in the sea but this bird flies inland to indicate heavy rain or a cyclone that is one to two days away. When cattle’s start jumping and appear very uneasy/restless making a lot of “moo” noises, indicates heavy rainfall in next one to two days (#35 pers. comm., 2012). Also, from the past experiences, the locals observed that a long drought often follows a cyclone in the next season so locals start preparing for the cyclone.

The Lonamilo villagers specified certain winds and clouds used to make predictions. One of the locals of Lonamilo (Vanuatu) explains the “Luotu wind” which is the North wind that indicates cyclone:

Wind Luotu is north wind means cyclone. From October, November to May falling year is the cyclone season and if we have Luotu winds it means a cyclone is approaching (#39 pers. comm., 2012).
The “nipelap cloud” is a white cloud that appears like smoke and is used to indicate the direction of the wind during cyclone, so villagers make preparations accordingly (#36 pers. comm., 2012).

The indicators discussed above are used extensively to make forecast that allows locals to make compulsory preparations that has helped them reduce their vulnerability and secure their food and water resources during extreme weather events in the past. King et al. (2008) illustrates that integration of local knowledge of predicting weather with scientific forecast systems can offer opportunities for increased accuracy in weather and climate forecasting from which both the locals and western meteorology can benefit (King et al. 2008).

Plate 5.3: Turaga-ni-Koro (Qeleni) showing us the normal growth of the young vundi leaf that indicates normal conditions and no cyclone is coming (left) and what the young vundi leaf does if cyclone is coming (right) (Photos: Karen McNamara)

5.7 Managing Local Resources Sustainably

Extreme weather events and changes in the climate pose wide range of challenges for communities and their access to food and water resources. Many local communities have developed mechanisms to manage their natural resources to avoid over-exploitation and scarcity. Local people have adapted useful planting techniques to diversify their produce to provide for adequate food supplies for their households. One of the most fascinating uses of the customary laws is the establishment of “taboo” areas.
Many times, the village Chief makes a decision that part of the fishing grounds will be closed for a certain period. In Fiji, this “taboo” is imposed for two reasons. The principal reason for the “taboo” is the custom practice of showing respect due to the passing away of an Elder in the village. The other reason is for resource management. The temporary closure of the fishing grounds encourages the juveniles to mature and the adults to breed. It is the Chief who decides when to open the “taboo”. Such an approach encourages sustainable use of ocean resources and restrains overfishing and depletion. The high Chief of Naselesele (Fiji) highlighted the importance of a ‘taboo’:

*In a village meeting the problem of overfishing was brought up. I requested for experts to come and study. There were visits from concerned groups who make us aware of the situations. Lately, when my cousin died, we have a taboo for six months and thinking of extending to one year. Approximately 3-5km wide goliqoli till the reef (including the reef). Some of the food we lost is coming back. We observed the taboo then opened it (#6 pers. comm., 2012).*

When the “taboo” was lifted, the community was allowed to get together and there was a big fish catch. The villagers eventually realised the importance of the “taboo” and have no objection following it.

Communities in Vanuatu practice a similar approach. When the whole village comes together especially when there are concerns that fish is declining, the Chief sets up a “taboo” that the whole village agrees to. In Lonamilo village, the Chief sets up an ocean conservation area every year for eight months from the months of October to May. One of the Elders from Lonamilo village (Vanuatu) explained how this “taboo” is marked:

*The Chief uses a wood stick to mark the conservation area in the sea and hangs the Nukulau leaves as a custom practice especially when they see that the resources are declining. We have it every year, the last one was in last year October and the taboo was lifted this year May (#37 pers. comm., 2012).*

To ensure that everyone obeys the “taboo”, the village Chief sets up a law not to fish from the protected area and often impose fines and punishment to discourage people from breaking this law. The locals pointed out that setting up the “taboo” area has
always been effective in managing the ocean resources. Nonetheless, there were no evidences of any frustrating issues raised by the communities regarding the establishment of the “taboo” areas that could affect and restrict the livelihoods of the locals.

Likewise, the locals of Lonamilo village reflected on the significance of the establishment of a protected forest area in the village territory. The village committee has setup a forest conservation area with strict controls on the community’s access to the conserved forest. Locals are not allowed to cut trees, graze cattle or even hunt for wildlife in the reserved forest area. One of the ladies from Lonamilo village (Vanuatu) explained that it was important to conserve the forest resources for future generations, for fresh air and to lessen the impacts of strong winds during cyclones. She summarised:

_We set conservation area because sometime we lost it, we have some native trees in Tanna, our future children will just hear stories about it but cannot see it, we save it so they can see it. Conservation area helps prevent the cyclone and helps keep our wild animals and sometimes it helps our crops to grow, it especially gives us fresh air to breath and we feel healthy (#36 pers. comm., 2012)._ 

The locals respect and abide by the village laws. Such effort made by the local communities in the conservation and sustainable usage of ocean and forest resources provides opportunities to restore fisheries, forest and wildlife resources that are also vulnerable to climate change threats.

**5.8 Planting and Preserving: Securing Food at times of Need**

Communities have developed strategies to maintain their land, improve soil fertility and increase food production. This knowledge has been acquired from the Elders, parents or village leaders. One of the participants from Qeleni village (Fiji) discussed how this knowledge is obtained:

_When we see someone holding good planting techniques, we ask them and follow what they do. When we drink yaqona at social gatherings or in the_
evening, we listen to the village Elders as they share their planting and fishing techniques with us (#12 pers. comm., 2012).

This knowledge is then taught to children who learn through practice.

The participants from Fiji use their local knowledge of seasons and utilise the Fijian Calendar to plan their farming. They select and cultivate appropriate crops suited for the local climate in each season. For example, in the months of June and July, weeding activities are carried out and locals prepare their land for planting in the next season. August and September are the months for the planting of Uvi and yams starts. In July, farmers plant long yams while in August they plant short yams and build bamboo structures for yams to creep on. October and November is the “Balolo season” when locals mostly catch and consume worms locally known as “Balolo lailai” and “Balolo levu”. The village Chief of Yanuca village (Fiji) informed that the month of October is best for “Balolo lailai” and November is best for “Balolo levu” (#15 pers. comm., 2012). December to January is the season for the “Nuqa” which is the rabbit fish and locals mostly rely on this fish for their food (#15 pers. comm., 2012).

Correspondingly, locals of Vanuatu have developed a vast range of techniques to increase food production. Root crops are a staple diet for these communities. For rainy seasons, cyclone seasons and droughts conditions, “taro viti”, corns and kumala are best to plant. Locals have noted that kumala is able to survive cyclones as the strong winds take away the twinning’s and ropes of kumala but kumala crops remain healthy in the ground and just take three months to grow. In wet seasons, kumala is grown on raised pile of soil (mountain of soil) to prevent flood waters from washing it away.

Communities in Vanuatu have developed techniques to increase the yield of taro. When the flower comes out in the middle, the farmers cut the flower and exchange it with the next plant. After that the flower is left to dry and then sow the seeds like cabbage. This allows the taro to grow into many varieties of taro that will be able to survive drought and extreme conditions. Yams can be planted using mixed cropping techniques. One of
the locals (Tassiriki village) described planting yams with pawpaw or banana plants to increase the yield of yam:

_Yams you plant with banana or pawpaw tree, dig big holes, put the soil and yam in so that the yam can grow big... it will follow the root of the pawpaw or banana plant in the soil_ ( #29 pers. comm., 2012).

Also, “marrow” is one of the attractive varieties of yam which is planted for drought season to obtain more yields. One of the locals (Tassiriki village) pointed out the technique used to plant this variety of yam:

_I have a special yam marrow variety. When you plant one fruit in the ground and it is ready, it gives you 15-20 fruits. But when you plant it, in the month of November and December, cut out all the leaves, leave it for one month without the leaves, after one month I take it out it becomes good big healthy yams, it is the sweetest yams and sells at good price...it works for dry season too_ ( #29 pers. comm., 2012).

Using their local knowledge of planting, the locals plant this special “marrow” variety that bears more fruits and is mainly planted for cyclone and drought seasons for food security.

Moreover, in seasons that receive low rainfall, the locals of Vanuatu plant “taro viti”, “cassava rice” and local bananas called “malele” and “Vietnam” banana. These bananas are cultivated using strategies that increase their yields and are discussed as follows. First, for banana plant, if the mother tree is bearing new fruit, the young suckers are removed and planted separately. This technique allows the banana fruit to grow large and healthy. However, if the new sucker is not removed from the mother plant, the banana fruit grows small and unhealthy. Also, the young sucker that has been removed from the mother plant has to be planted facing the sun so it can grow well. These methods are used for both dry and wet seasons to increase fruit yield.

To increase soil fertility, maintain plant nutrients and avoid pest invasion, locals use the “claricidia” plant. One of the Elders of Piliura village (Vanuatu) explained how the “claricidia” plant is used:
Sometimes when the locals plant cassava they use claricidia plant which is a host plant on a piece of land for planting and the soil is still fertile for years and years, it makes the soil rich. When the rats eat cassava, we cut the claricidia leaves like cabbage, grate coconut flesh, put a stone on fire till red hot, mix the chopped leaves with grated coconut using hot stone, this makes the mixture very nice smelling, we put the mixture in empty coconut shells and put it around the garden, the smell attracts rats to come and eat but the claricidia leaves are poisonous, the rats will die, we collect and throw them (#25 pers. comm., 2012).

Diversification of crops is one of the crucial strategies locals to enhance food security in the events of disaster (Plate 5.4). The knowledge of seasons (when to expect rainy seasons, cyclones and droughts), selecting suitable crops that are best suited for a particular season and the various techniques of farming are being continuously constituted and passed down to younger generations.

Plate 5.4: Planting lot of crop and fruit tree varieties which is also considered as an adaptation strategy - food diversification (Photos: Karen McNamara)

One of the captivating applications of local knowledge is in food preservation. The root crops, fruits and other food items vulnerable to damage or spoilage during extreme weather events are often preserved. As discussed in the previous sections, locals in Fiji and Vanuatu take off the matured fruits and root crops before a cyclone to prevent it from further damage. The surplus foods are then preserved. In Fiji, damaged cassava and
other root crops are buried in the ground to keep them good for up to three weeks (#19 pers. comm., 2012). “Lovo” is prepared in an underground oven pit using cassava so it can be preserved for over a week. However, if the same cassava is left outside without cooking it in “lovo” would rot in two or three days.

In contrast, the ladies in Piliura village preserve cassava using drying techniques. They grate cassava, mix it with coconut cream and then cook it on stones to dry. This dried mixture is then used as a food while the locals prepare the gardens for the fresh food supplies. There are plans to use the same technique with other root crops that are otherwise thrown after incurring damages, so that it could last longer and be used as food during cyclones and heavy rain (#24 pers. comm., 2012).

Moreover, breadfruits are preserved by packing them in big sacks and submerging them in the sea for about a week. When the skin is gone, the breadfruit is cut, seeds are removed, and the edible parts are covered with banana leaves and placed on hot stones for two to three hours. After that, the banana leaves are removed and replaced with fresh green once and hung over the fireplace. It stays fresh if it gets smoked daily. The dried breadfruit can be kept for longer periods (almost a year) and used for food as described by one of the Elders of Piliura village (Vanuatu):

\textit{It can last one year, make tea, drop it in the tea for one minute; it gets soft and start eating them just like biscuits} (#25 pers. comm., 2012).

A second preservation technique for breadfruit is by peeling it, cutting it in big pieces and covering them with leaves. These covered pieces are then set on hot stones for two to three hours, cooled, and stored in containers. Breadfruit preserved this way can be kept for few days and used for meals.

Similarly, bananas are preserved using special techniques. Banana is grated using local graters made of shells; the grated banana is wrapped in green banana leaves, washed in salt water then wrapped again in fresh banana leaves. It is then made to hang in cool air especially on trees (not in the kitchen or the house). One of the Elders of Lonamilo
village (Vanuatu) pointed out the need to change the wrapped leaves to keep this food (locally called “nimare”) longer:

*You can keep changing the wrapped leaves with the fresh ones and it can last for two to three weeks. This is locally called nimare and is used to make lap lap which is mainly made of the nimare, island cabbage and coconut milk (#35 pers. comm., 2012).*

The “lap lap” is mostly eaten as a delicacy and is considered one of the most used preservation techniques for bananas in Lonamilo village. Also, locals in Tassiriki village cover the fallen bananas with green banana leaves and leave it for a month for the fruit to mature.

The locals of Taveuni are largely dependent on the sea for food. These locals use their knowledge of winds and fish behaviour to catch fish that can replace the vegetables they have lost during droughts. Sometimes when the catch is huge, the ladies smoke the fish so that it can last longer without spoilage. One of the Elders from Naselesele village (Fiji) explains how this process is carried out:

*Fish we smoke it. This we do by putting wires and sticks across the earth oven and if you want to keep the fish for much longer you can smoke it every second day and sit them on top of the wood heap (#1 pers. comm., 2012).*

One of the Elderly ladies in Qeleni village (Fiji) explained the olden ways of fishing and sea food preservation before the advent of fishing lines and nets:

*Before there were no fishing lines and net, we used to break one of the fingers of the garden fork and tied it to the stick and used it to spear fish. When there was big fish catch, we preserve it. We wrap it up in coconut leaves and place it over chopped coconut leaf vein and arrange it in a rectangular shape and the fish is place over the sticks. Put the smoke (not fire) under the arrangement and smoke it every day to make it dry until it is eaten...can be kept for a week (#13 pers. comm., 2012).*

Similar preservation techniques can still be applied when there are power outages after cyclones. To cope with the aftermath of cyclones, the people use their local knowledge to preserve the food they have to help them survive until the gardens grow back.
5.9 Chapter Conclusion

The findings represent oral methods particularly story-telling, songs, demonstrations from experienced members and individual practice by coping Elders as most common ways of transferring local knowledge. Local communities are largely dependent on their environmental indicators to predict weather. These forecasts have been useful in planning daily activities such as fishing and farming. Setting up of conservation areas has proven an effective community-based approach in managing ocean and forest resources. The uses of local techniques in food preservation using drying and smoking procedures are effective in preserving certain local foods. Local knowledge of diversifying food crops, planting seasonal crops, growing fast foods, developing techniques of mixed cropping, and fishing/hunting for animals that are in seasons are valuable local methods of securing food in times of disasters. The next chapter discusses on the valuable local strategies employed to cope up with extreme weather events in the past.
Chapter 6: Learning from the Past to Adapt to Climate Change Impacts

6.1 Chapter Introduction
This chapter reflects on the significant application of local knowledge in formulating adaptation strategies to cope with the past impacts of various extreme events. The first section evaluates the potential levels of knowledge held by the locals of six communities to adapt to localised climate change. This is followed by the presentation of various techniques utilised by locals to adapt to different environmental conditions including adaptation to floods, cyclones, droughts and water shortages, sea level rise, king tides, inundation and coastal erosion. This chapter widely acknowledges the efforts made by these local communities who effectively utilise their limited local resources to devise mechanisms to adapt to extreme events.

6.2 Local Climate Change and Adaptation Knowledge
Prior to exploring this adaptation knowledge in more detail, participants were requested to indicate their level of knowledge about climate change based on a Likert scale of 0 (‘no knowledge at all’) to 4 (‘extremely high levels of knowledge’) in order to understand the level of knowledge detained by the locals to adapt to the impacts of climate change. Figure 6.1 provides a summary of the outcome of this assessment. Out of all the locals interviewed, four have no knowledge at all about climate change; 24 indicated that they have a little knowledge, 11 held moderate level of knowledge and only one held very high level of knowledge about climate change. However, none of the respondents held extremely high level of knowledge about climate change.

The overall mean for the respondent’s level of knowledge on climate change is 1.23. The locals of Fiji held slightly greater knowledge (mean=1.28) than the locals of Vanuatu (mean=1.18). For Fiji sites, the locals of Naselesele village hold more knowledge on climate change (mean=1.38) compared to Qeleni village (mean=1.20) and Yanuca village (mean=1.20). In Vanuatu, the locals of Piliura village hold more on climate change (mean=1.50) compared to Lonamilo village (mean=1.33) and Tassiriki village (mean=0.75). A non parametric hypothesis test (Mann-Whitney test) was conducted to
test if there was any difference among the two countries (Vanuatu and Fiji) level of knowledge on climate change. The null hypothesis for this analysis was set to be that statistically there is no significant difference between the two countries. The test gives a “p value” of 0.629. This value is more than 0.05 so we accept the null hypothesis indicating that there is no significant difference between two countries level of knowledge on climate change.

The trend indicates that locals hold little knowledge on climate change but possess large amount of knowledge on adaptation to climate change related impacts. These communities are noticing changes to their environment and climatic conditions and are adjusting their activities in response to these changes. However, locals do not seem to always link these observed local changes to the impacts of climate change, which could be due to a lack of awareness on climate change and its impacts. Yet, these large amount of knowledge on adaptation to climate related impacts held by the locals will be valuable for community-based climate change adaptation planning. It is apparent that more work is required in sharing scientific perceptive of climate change and its projected impacts with local communities. This can increase their knowledge on climate change impacts and also provide opportunities for integrating useful aspects of local knowledge in planning for community-based climate change adaptation.

![Figure 6.1: Levels of local knowledge about climate change held by the respondents (n=40)]
Moreover, respondents indicated their level of knowledge in adapting to different climatic events (Figure 6.2). The results illustrate locals have more knowledge in coping with the impacts of cyclones (mean=1.67) than to water shortages (mean =1.50) and droughts (mean=1.10). However, respondents held little knowledge in adapting to coastal erosion (mean=0.55), flood (mean=0.50), sea level rise (mean=0.22), king tide (mean=0.20) and inundation (mean=0.15). The various adaptation strategies practiced by the six communities using their local knowledge to cope with extreme weather events are detailed in the sub-sections below. Adaptation to drought conditions and water shortages will be discussed together as the means are quite close. Similarly, the coping strategies for sea level rise, inundation and king tides will be discussed together.

Figure 6.2: The level of local knowledge held by respondents to adapt to different climatic events (n=40)

Likewise, locals were requested to identify local changes that are becoming more severe (Figure 6.3). The result shows coastal erosion, cyclones and sea level rise as becoming more severe. Coastal erosion can be attributed to two major factors. These are sea level rise whereby more water comes inland and from cutting down of coastal plants especially mangroves for fuel wood. This prevents the soil from being held in position and accelerates erosion of this unstable soil during king tides, heavy precipitation and floods. The observed rise in sea level can be linked to global warming that causes
increased melting of glaciers and polar ice sheets and results in increased sea levels as discussed in the report by (UNFCCC 2007).

Flooding was only a problem for Qeleni and Lonamilo villages, which are situated close to the river. Locals of Qeleni and Lonamilo villages indicated that they are recently experiencing soil erosion during heavy rainfall and cyclones. During field work, the washed away shorelines, the beach area and the land around the other four villages were evident. However, majority of the locals in the six communities do not consider inundation and king tides as major environmental problems because they do not affect their crops and activities to a greater extent as yet and has only been associated with sea level rise. The respondents explained water shortages as a problem mainly during droughts when freshwater supplies drop.

**Figure 6.3**: Extreme events that are becoming more severe as indentified by the respondents (n=40)

Communities have developed various mechanisms to respond to major environmental impacts such as coastal erosion, cyclones, water shortages and droughts as these events are greatly affecting their livelihoods. The impacts of each of the climatic events were documented during the interviews where participants specified the local measures taken at the household and community levels to moderate the impacts of these environmental catastrophes. The interviewees were also asked to indicate their level of concern on the impacts of climate change in the future. The response on this is presented in Table 6.1.
Increasing their resilience, managing adverse impacts of these extreme weather events and securing their livelihood are crucial priorities for the locals of these six communities.

**Table 6.1**: Level of concern over the impacts of climate change in the future, according to the respondents (n=40)

<table>
<thead>
<tr>
<th>Levels of concern</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>None at all</td>
<td>0</td>
</tr>
<tr>
<td>A little</td>
<td>4</td>
</tr>
<tr>
<td>Moderate</td>
<td>5</td>
</tr>
<tr>
<td>Very high</td>
<td>3</td>
</tr>
<tr>
<td>Extremely high</td>
<td>28</td>
</tr>
</tbody>
</table>

Based on the above results, it is clear that the participants are extremely concerned about climate change in the future. Despite this extreme level of concern about climate change, participants indicated that they required a more intimate understanding of climate change and what this means for their local community, As such, they have requested for training opportunities and advice necessary to cope with the changing climate.

### 6.3 Adapting to Coastal Erosion

Coastal erosion has been identified as one of the major environmental problems. The three villages in Fiji have experienced coastal erosion along the foreshore since the 1980s and have been eroding gradually since then (#1 pers. comm., 2012). The village High Chief of Naselesele (Fiji) described the famous Naisaogo point in Naselesele, which once used to be a beautiful beach and held potential for tourism, is now being severely eroded:

> *I was thinking of setting up a tourism activity at the Naisogo beach, but my boys are saying that the beach is not as it used to be, it is being washed away (#6 pers. comm., 2012).*
The village Turaga-ni-koro (spokesman) highlighted that the beach and the coconut trees do not grow very well along the eroded area when it gets frequently inundated with salt water.

The adaptation actions taken by the Naselesele community to minimise coastal erosion includes construction of the seawall along the beach in-front of the village and the construction of the new tar-sealed road along the coast which is a Government initiative that also acts as a barrier and prevents the seawater from coming inland during high/king tides. People of Naselesele have been advised not to cut mangroves for firewood. However, these actions have not yet addressed the issue and the beach is still being eroded extensively. The village high Chief Naselesele (Fiji) proposes on replanting mangroves along the coast in collaboration with the University of the South Pacific’s EU-GCCA project as a practical measure and suggests for the construction of a stone groin at the end of the beach. This would prevent further erosion and allow sand to collect along the side of the groin. In doing so, the village high Chief indicated that he requires advice from experts.

Likewise, locals of Qeleni village (Fiji) are experiencing severe coastal erosion since 1998. The area in-front of their village once used to be a picnic area is being eroded and even the Vunitarawa side beach is being washed away and has caused the coconut plants to perish due to frequent inundation with saltwater during high tide (#13 pers. comm., 2012). The extensive use of mangroves for fuel wood is exacerbating coastal erosion in Qeleni. The winds during Cyclone Tomas in 2010 also destroyed massive amounts of mangroves. The community used to do replanting of mangroves in response to coastal erosion but this practice has stopped after Cyclone Tomas. It was found that locals would only resume replanting activity after all the dead mangroves have been cleared. Their village Chief has a law reinforced for locals not to cut down any undamaged mangrove trees for fuel wood as a measure to conserve mangrove resources. Only the damaged mangroves are used for fuel wood as summarised by one of the village Elders (Qeleni):
We were planting mangroves before Cyclone Tomas in 2010 in response to coastal erosion (community initiative) but Cyclone Tomas (2010) damaged it greatly as they were at approximate height of 30cm or more. It’s the law in our village not to cut the green ones just the ones that are dead. We distinguish the dead ones as it has no fresh leaves (#11 pers. comm., 2012).

The village Turaga-ni-Koro (Qeleni) proposes to build a sea wall along the river banks of the Qeleni River using the big stones in the river (#10 pers. comm., 2012) (Plate 6.1).

Conversely, coastal erosion has been recognised as one of the imperative environmental issues affecting the locals of Yanuca. Approximately 15 to 20 meters of land has been washed away in the past 20 to 30 years (Plate 6.1). One of the village Elders of Yanuca (Fiji) highlighted that coastal erosion is severely washing away the beach and destroying the coconut trees along the coast:

Water came inland and houses near the beachfront has saltwater coming under their houses. We are losing coconut trees along the beach. The roots of these trees stopped coastal erosion, and when they fall down, it’s easier for water to come in as the roots are no longer holding the soil together (#17 pers. comm., 2012).

These coconut trees once prevented coastal erosion with the roots holding the sand in place. When these trees fall, there is no holding of the sand and the beach gets eroded more easily.

Locals of Yanuca have adopted relocation as one of the key adaptation actions practiced since years back when the village used to have traditional bure’s. One of the village ladies of Yanuca (Fiji) described how her parents and neighbours had to relocate their bure’s’ further inland when the sand where the bures were situated were getting washed away and the people commenced the planting of coastal plants along the coastlines to reduce coastal erosion:

We had bures there before but when we started losing sand we started moving inland. When I was small girl, that time we still had bures. Before our elders used to plant coastal plants like vutu (Barringtonia edulis), sinu (Phaleria
disperma), tavola (Beach almond tree- Terminalia catappa), nawanawa (Cordia subcordata) along the coastlines and were very strict not to cut the trees, but more waves are coming inland we are losing these plants. It is not planted anymore. We are also losing our coconut trees affecting our food we have to go further inland to get coconuts (#16 pers. comm., 2012).

Coastal erosion affects local practices as it forces community members to go further inland to collect coconuts for food. Even the planting of the coastal trees is not done anymore. The only other measure taken in response to coastal erosion is the construction of the sea wall as an initiative from the village Turaga-ni-koro and his father (#14 pers. comm., 2012). Yet, there are no plans for planting coastal vegetation.

In the same way, coastal erosion is a major environmental problem affecting all the three research sites in Vanuatu. In Piliura village coastal erosion has been a problem since the 1990’s and has recently become more severe. The beach and the coastlines are being eroded. Inundation during high tides causes the non salt-tolerant coastal plants to perish and further erosion occurs. One of the Elders described that due to increased erosion and more water coming inland a few house had to be relocated:

_My house was close to the sea before, the seashore used to be further but now it’s coming more inland, when rough seas the seawater came inside my house so I shifted it inland that was in 1972 (#23 pers. comm., 2012)._  

This response demonstrates relocation from local environmental changes.

Another specific adaptive action undertaken by the locals of Piliura village is the replanting of the coastal trees. This community in collaboration with the GIZ community-based climate change adaptation program has planted certain coastal plants along the coastline to minimise erosion. The GIZ has put up a nursery in Piliura village that grows vetiver grass, pine, mahogany, sandalwood, navel (Barringtonia edulis) and kasis mangroves (Leucaena leucocephala - locally called “fish poison tree”) as an adaptation strategy (Plate 6.1). Vetiver grass and mangrove species have been planted along the coast to prevent coastal erosion. The Piliura Village Chief (Vanuatu) highlighted his actions to support the program:
Since 2000, sea level rise and coastal erosion are becoming bigger and bigger. Mainly we plant coastal trees which can hold the ground and the soil like poison fish tree, vetiver grass (*Vetiveria zizanioides*), natoto plant (*Murraya paniculata*), purao plant (*Hibiscus tiliaceus*), navuevue (*Canavalia rosea*), namiro (*Cordia subcordata*) and the wild pandanus (*Pandanus tectorius*). They are grown in the nursery and when the plants have grown we plant them on the beach, the vetiver planted between the trees to hold the soil (#20 pers. comm., 2012). According to the locals, this action has been successful in minimising further erosion along the beach and the coastline.

Moreover, locals of Tassiriki village have indicated coastal erosion as an important environmental issue since the 1990’s and has been one of the main reasons for loss of land along the coastline that has caused changes in landscape that affects the outlook of their village (#28 pers. comm., 2012). Saltwater inundation has caused the washing away of land; reparation to the beach system and loss of coastal trees, mangroves and “natong tong” (*Rhizophora sp.*) trees along the coastline (#27 pers. comm., 2012). A few houses that were built closer to the coast had to be relocated to higher grounds because the area became inundated with saltwater at high tide (#32 pers. comm., 2012). The only initiatives to minimise coastal erosion has been taken by a few villagers living close to the sea. These residents have tried building stone seawalls using cement, dead corals and rocks (#34 pers. comm., 2012). This did not work for some due to improper plans and lack of expertise, however, the stone wall built by those managing the guesthouse has been effective in preventing further erosion of the area in-front of the guesthouse. Only some of the locals have started to plant trees locally called “seru”, “napakuda” (*Callophyllum inophyllum*) and “neyaru” (*Casuarina equisetifolia*) along the coast since 2011.

The Lonamilo village (Vanuatu) is situated away from the coast further inland and has no issue of coastal erosion but experiences the impacts of soil erosion along the river banks. The river that is situated close to the village is experiencing severe erosion along
its banks since the 2010 flooding. In response, villagers have planted local trees along the river banks as explained by one of the village women of Lonamilo:

*The river-banks have been severely washed away since 2010 flooding. The villagers have planted local trees mainly nekatu and narara (Eretrina) to hold the soil. It has being effective in minimising erosion (#35 pers. comm., 2012).*

The planting of coastal vegetation along the river banks has minimised further erosion of the river banks.

Plate 6.1: Top row- eroded coastline in Yanuca (left), stones from Qeleni river proposed to be used in constructing sea wall along the river banks (middle), nursery near Piliura village growing coastal plants to be planted along the coast lines to minimise erosion as an initiative from GIZ (right)

Bottom row- Planting vetiver grass and coastal trees in front of large unstable tress on the foreshore in Piliura village, Vanuatu (Photos: Karen McNamara)

### 6.4 Adapting to Cyclones

The Islands of Fiji and Vanuatu experience cyclones from the months of November to April. In Fiji, cyclone Ami hit the three villages in the year 2004 and did moderate damages to the houses and root crops. Cyclone Tomas impacted the villages in 2010 and
caused devastating impacts. In Naselesele village, it partly damaged a community hall, severely damaged crops including cassava that was not pruned, dalo, yaqona, vundi, pawpaw and pandanus plantations. The roofs of old buildings got blown away, mangroves along the coastal fringe got destroyed and the coconut trees got badly damaged. These damages were severely incurred by families who did not carry out necessary preparations before the cyclone. The roofs of old buildings could not withstand the intense winds of Cyclone Tomas. The water pipes from the catchment got damaged and disrupted water supply. Some of the main roads to towns were blocked for almost a week due to fallen trees and debris that hindered access to town and main centers.

In Qeleni village, Cyclone Tomas destroyed 20 houses (mainly the old bures), damaged vegetable gardens, yaqona plantations, coconut trees, yams and breadfruit trees and pipelines that impeded access to main water supply. In Yanuca, the strong winds during Cyclone Ami destroyed ten old wooden houses and damaged plantations. Cyclone Tomas partly damaged three houses, some of the old iron roofs got blown away, the school buildings and the wireless house for telephone incurred severe damages. Seawater came inland that brought in dirt and debris and most vegetables got destroyed from the saltwater spray. Cassava, vundi (banana), and coconut plantations were damaged. Saltwater came in with winds and mixed with the freshwater in water tanks and contaminated it.

The locals of Vanuatu experienced many cyclones in the late 1980’s and 1990’s. The participants informed that the trend is now one cyclone in two years and that the impacts of the cyclones are not as severe as before. On the contrary, the model projections discussed in the country report for Vanuatu by Australian Bureau of Meteorology and CSIRO (2011) indicates a decline in tropical cyclone numbers and an increase in the numbers of more intense tropical cyclones. Many locals recalled the last destructive cyclone experienced in the year 1987 that damaged many houses, Church, plantations and vegetable gardens. The recent cyclone that affected Vanuatu was in the year 2009 that hit Vanuatu waters after a drought and damaged old houses and plantation, blocked
roads (from fallen trees) and caused flooding. In Lonamilo the rainwater that collected in the hollow area of the village and the river caused massive flooding that inundated vegetable gardens situated closer to the river and washed away river banks.

In Fiji, the village Chiefs’ of the three communities usually set up a team of young village men who move around and help locals secure houses, move Elderly people to evacuation centers and inform people of the latest weather updates (#14 pers. comm., 2012). The villagers used the school buildings, Church houses, village dispensary and neighbouring houses (that were strong) as evacuation centers.

An Elderly woman from Qeleni village (Fiji) described her childhood experience of a cyclone that affected her village in Qamea Island and reflects on recent cyclones that are more intense than before:

*Long time ago (can’t actually remember when) we had bures we experienced cyclone. The winds blew most of the bures so we evacuated in the strong ones that still stood. The strength of the cyclone in the past was not as strong as it is now. Back in Qamea, we dig pit similar to a cave as an evacuation center. This was built horizontal we put timber on the bottom of the dugout cave and places dead leaves and mat on the floor. This was very effective, we had a door made of timber and closed it to keep out strong winds but enough to let fresh air in. We used firewood as light in the cave (#13 pers. comm., 2012).*

The use of local knowledge and the collective practice of locals in creating an evacuation centre in the cave served as a good shelter and housed all children, men and women especially after all the bures got destroyed.

A variety of strategies have also been adopted by locals of Vanuatu to cope up with cyclones. These strategies are quite similar those practiced by the communities in Fiji that include securing their houses and plantations (Plate 6.2), pruning of cassava and yaqona, and storage of food and water (discussed in Chapter 5). Pruning techniques protects plants from strong winds and is an effective measure as the pruned stems and
leaves usually grow back. However, locals of Lonamilo village (which is a very traditional village with almost all thatched houses) build special houses for evacuation known as the “hurricane house”. The “hurricane house” is constructed using bamboos, wild cane and coconut leaves and is known to withstand strong winds. Locals consider it as the best place to evacuate. One of the participants from Lonamilo village (Vanuatu) explained:

_When its hurricane season we know from January to April so we make hurricane house using bamboo and wild cane and coconut leaves so we use it never gets blown down (_#36 pers. comm., 2012_).

To protect the village from strong wind, the villagers have planted special tress locally called “burao trees” (*Hibiscus tiliaceus*) around the village compounds. This tree acts as a wind-break and reduces the impact of strong winds during the cyclones making their thatched houses less vulnerable.

Community response during natural disasters is very strong in Vanuatu. The villagers help each other prepare for the cyclones after a forecast has been made. The community members work together and organise houses, village halls and schools that are strong to be opened as evacuation centres. The Chiefs appoint a group of men that move around and assist people who leave in flood prone areas secure their belongings and escort people to the evacuation centres. The community members help each other clean up and assist people who have lost their homes and gardens to rebuild houses and prepare new gardens. These locals then consume “Fiji taro” as it survives cyclones while they grow fast growing crops like corn (refer to Plate 6.2), cassava and sweet potatoes since it yields fast (_#23 pers. comm., 2012_). Communities suffice on these food crops while they prepare gardens to plant other local crops and vegetables. The efforts made by these communities at both the household and community levels were effective in coping with cyclones.
Plate 6.2: Securing thatched houses in Piliura village (left), planting corns as fast food crops (middle), the community hall used as one of the evacuation centres in Naselesele (right) (Photos: Karen McNamara)

6.5 Adapting to Sea Level Rise, King Tides and Inundation

Sea level rise and king tides are affecting Fiji and Vanuatu. In Fiji, locals informed that they are experiencing sea level rise since 1880s. They observed water getting deep and comes higher up on the beach during king tides. These communities use their local knowledge and observations to predict king tides. For example, when crabs are in season and make abundance of crab holes indicates king tides. One of the Elderly women from Naselesele (Fiji) explains:

*I know king tide time because lot of crabs and crab holes: I can see them in my pandanus plantation as it’s near the beach. So normally November, December months for the king tides and its crab season here (#3 pers. comm., 2012).*

Other locals used their local knowledge of the full moon to predict when there will be a king tide and prepare for it beforehand.

King tides have done moderate levels of damage in Naselesele and Yanuca villages. King tide floods roads and the salt water affects the vegetables in the nearby gardens, especially home gardens that are used for subsistence. Since many plantations in Naselesele village are located up the hill, no damage is done to crops through king tides and inundation. Very few initiatives are made by the locals living close to the sea/estuary to reduce the impacts of saltwater intrusion during king tides. For example, locals have built houses on stilt particularly used for storage and ventilation purposes that also serve to keep away flood waters during inundation and heavy rain (#1 pers. comm., 2012).
The impacts of king tides and inundation are huge in Yanuca village. This is because the houses and the home gardens are situated closer to the sea. The salt spray during cyclones and king tides affect vegetables that are grown near the house. One of the Elders from Yanuca village summarised the impacts of king tides on their home gardens:

*King tides wash out the soil, the land...the spray from the strong wind, the salt spray goes straight up the hill and affects crops; bele, baigan (eggplant) and cabbage, they are the only vegetables we grow near the house (#14 pers. comm., 2012).*

A few locals have built seawalls and moved their gardens more inland to reduce exposure to seawater.

Furthermore, king tides is not a problem for Tassiriki and Lonamilo villages but has caused moderate damage on Piliura village over the past few years. The locals of Piliura village described their experience with what they call “spring tides” that are mostly experienced during cyclone seasons. When there is a westerly wind blowing across the island during a spring tide, the village gets salt spray that damages the vegetables in the home gardens used for subsistence. One of the Elders summarised:

*We have king tides every year during the cyclone seasons. When we have westerly winds during spring tides we get salt spray. Our gardens are up in the hills, we have wild pigs which damage our cassava, banana, taro, and yam so we have moved it down to a leveled place where we plant cassava, island cabbage, and banana (#25 pers. comm., 2012).*

The community has not taken much action in response to the impacts of king tides and their gardens are being affected by salt spray that causes the non-salt tolerant crops (mainly local vegetables) to perish.

Conversely, there were no concerns raised by the locals of Piliura and Lonamilo villages on the effects of sea level rise and inundation. However, one of the locals of Piliura village (Vanuatu) explained on the impacts of sea level rise on a nearby village on Pele Island:
On the other village on the island called Worsiviu, sea level rise is washing away the cemetery; the villagers relocated the cemetery and put another cemetery inland. We have started to plant trees along the coast to prevent erosion and water coming in (#25 pers. comm., 2012).

Inundation has been a problem since 2000 and has been a major reason for salt water intrusion of their ground water wells. Salt water sometimes destroys the young plants in gardens located closer to the village. One of the Elders of Piliura village (Vanuatu) summarised:

*It is a problem since 2000. Our underground well is becoming too salty. Before we were using for cooking and washing but it is not used for cooking now because our septic tank is contaminating our underground water, we have a channel that comes to the village from the sea, the saltwater kills what all we planted. Normally we leave it because we don’t know what to do, we just wait for the rain to come and wash away the salt, then we plant again (#25 pers. comm., 2012).*

Not much has been done by the locals to minimise salt water intrusion.

### 6.6 Adapting to Droughts and Water Shortages

Fiji experienced two droughts recently. One was from 1997/1998 and the other in 2004 after cyclone Ami. The locals ranked the 1998 drought as more severe than the one in 2004. During the 1998 drought, crops and cattle were affected. One of the Elderly women from Yanuca village (Fiji) explained that the 2004 drought conditions affected the plantations severely and described the heat as *wild fire burning the soil* (#15 pers. comm., 2012). The local vegetables largely grown for subsistence by the three Fijian communities are “bele”, “rourou” (dalo leaves), cabbage, lettuce and beans that mostly require water for growth. These vegetables along with dalo, cassava and kumala, which are common root crops and their leaves are also consumed were greatly affected and shortages of the leafy vegetables were experienced.

These communities then survived on other staple food sources including breadfruit (which was in season at the time), vundi, cassava and yams. The village Chiefs of these
communities made decisions to open the whole “Qoliqoli”, half of which may at particular times be closed for cultural purpose. The local’s caught fish and other marine organisms such as sea shells, sea urchins and sea slugs to replace vegetables. Some locals who sold copra or had a more expendable income could purchase vegetables from Suva markets.

Water shortages was not a major problem for the villagers of Naselesele during this drought as they have access to three freshwater sources including the Mua catchment, the borehole and the spring however, locals were encouraged to conserve it (#3 pers. comm., 2012). Locals of Qeleni and Yanuca mostly depend on rainwater for drinking and cooking and therefore experienced huge water problems during droughts. In Qeleni village, water shortages become more prominent when it does not rain for more than four months that causes the water levels in the river to drop, but the water pipes remain at the original levels (i.e. at a higher level than where the dropped water level now stands). Thus, the transport of the water through the pipes to the houses ceases (#10 pers. comm., 2012). These villagers then use the Vunitarawau and Cawaki springs to collect water.

One of the Elderly women from Qeleni village (Fiji) emphasised on the use of local knowledge to store water in big coconuts shells in the past before the containers and pots arrived. She explained:

_We take out the flesh by making a small hole and using a stick. Our grandmother made a basket from coconut leaves and we place the empty coconut shells in the basket and carried it to the spring. We filled the shells with water and did our washing and bathing there. We used the pandanus leaves to put on top of the shell as lids (#13 pers. comm., 2012) (refer to Plate 6.3)._

The water was used for cooking and drinking straight from the shell. This was effective approach since the water had no contamination after it was covered with pandanus leaves as the lid.
The locals of Yanuca access water from a small stream that connects into a village tank (refer to Plate 6.3). In dry seasons this stream dries up so villagers travel to the nearby springs to collect water. One of the Elders from Yanuca (Fiji) explained that the village greatly suffered water shortages in 1984 when it did not rain for almost eight months, so the Government distributed water six times (#15 pers. comm., 2012). Locals also travelled to Taveuni in their canoes to collect water in empty fuel tanks, buckets and 44-litre gallon tanks. These three Fijian communities are also investing in arranging for big water tanks and piping systems to fill spring water in times of future droughts.

The three research communities in Vanuatu experienced drought conditions in 2008 and 1994/1995. These droughts caused extensive damages to food crops. However, locals had alternative sources of food and water that they depended on. In Piliura village, droughts were reported in 1994/1995 and 2005/2006. There was no rain for about six months and the intense heat caused the grasses and gardens to dry. Crops that were affected include cassava, banana (especially the variety that is locally called “Ena”), taro, kumala, lettuce, tomatoes, Chinese cabbage, bele and capsicum. Locals relied on food and water sources from the mainland for their sustenance. The only surface water source on the island was managed wisely and used for washing, bathing and flushing toilets (not for drinking because of contamination from nearby toilets).

The locals of Tassiriki village experienced severe droughts in 1994/1995. The impacts of the droughts were similar to the ones experienced in Piliura village discussed above. Other than that, livestock was severely affected. Cattle, chickens and pigs died due to lack of water. Drinking water was greatly affected so villagers had to get water from mainland. Lonamilo villagers also faced the brunt of the 1994/1995 drought, and the more recent one was in 2008. There were water shortages on the island and many local crops dried. One of the Elders explained on the effects of the heat on common crops:

*The sun burns the ground, kumala and other plants can’t grow so we plant manioc and Fiji taro. It’s much good; it can grow (#38 pers. comm., 2012).*

Even people’s health, especially the children in Lonamilo village, was affected due to shortages of vegetables. One of the Elders in Lonamilo village (Fiji) emphasised:
Our children got sick, no vegetables to give to the children to eat (#36 pers. comm., 2012).

The three communities in Vanuatu adopted a variety of techniques to cope with the droughts. The locals of Piliura village planted drought resistant crops especially “taro Viti” and “malele” banana. The locals of Tassiriki village depended on gardens in mainland (Efate) which had swampy soil for vegetables to survive. They also relied on bananas and wild yams as these crops survived the drought. Seafood became an essential part of the people’s diet during droughts. One of the Elders explained:

*We eat all the things from the sea...the area in front of the village is conserved we used another side of the island* (#29 pers. comm., 2012).

The locals of Lonamilo village also planted drought resistant crops including: “taro Viti”, banana, cassava and wild yams called “saaina”, “suwip”. One of the participants from Lonamilo village (Vanuatu) specified the consumption of wild plants:

*The villagers relied on wild plants to replace their vegetables that normally grow wild in the bush napalanku, ialken- apen and karwatu that grows mainly near the river* (#35 pers. comm., 2012).

These wild plants were replaced as alternative sources of nutrients. Locals also consumed kumala and wild fern species (refer to Plate 6.3) that they could find. Many villagers opted to eat fruits (bananas, pawpaw) and local leaves so there is no food shortage.

One of the mechanisms practiced to prevent vegetables from dying is illustrated by one of the respondents working with the Agriculture in Tanna. He explains the use of certain legume plants in farming to fallow land and shade low lying plants, particularly vegetables grown underneath:

*We have manim which is local leafy plant, it is drought tolerant and can withstand cyclone, flood, we eat the fruits and the leaves so there is no food shortages. I plant under Narara Erithryna and Cliricidia sopium are legume trees introduced by Agriculture which we also use to fallow an area and is also used to shade plants. I plant island cabbage under it as it will block the*
sun’s rays during drought when the sun is very strong (#40 pers. comm., 2012).

By shading the crops, many local leafy vegetables were prevented from drying. At the community level, people who were vulnerable (paralysed, poor and sickly) were identified and assisted mainly by sharing food. Salick and Byg (2007) illustrate a similar approach where locals diversify their resource base by growing different varieties of crops and gather wild food plants along with fishing/hunting activities to minimise the risks of food shortages in times of extreme events.

With regards to water shortages, the locals of Piliura, Tassiriki and Lonamilo villages argue that they have more water shortages during drought conditions. Almost every household dug out ground water wells which they covered with cement to prevent contamination and evaporation. Bridges and McClatchey (2009) demonstrate a similar approach utilised by the locals of Rongelap Atoll who use their local knowledge to identify freshwater lens on the Island and shelter it to prevent from drying. Ground water in these three communities is not used for drinking and washing because it gets contaminated with nearby toilets and can only used for washing, bathing and for flushing toilets.

In Piliura village, locals had to build a catchment around the only stream in the island and used pipes to transport water to the village. This was not enough to cater for the needs of the whole village so villagers had to obtain fresh water from the hills located in the next village. In extreme times, water was brought from the mainland in 25-litre gallons. Eventually, more tanks were built to collect water when it rained. One of the ladies in Piliura village (Vanuatu) shares her technique of constructing a cement tank within their patio (veranda) that can hold large amounts of water:

We have also built a tank under the floor as part of the patio so when our tank gets filled; we connect pipes to the tank and fill the tank built within the patio (#21 pers. comm., 2012).

This acts as a bigger tank within the patio and filled up using a pipe connected to a water tank in which rain water is initially collected before being transferred to this bigger tank.
This technique is great for storing water but the materials needed for construction is expensive and not an easy option for all.

Locals of Tassiriki brought drinking water from the mainland (Efate). These locals used to drink water from their ground water wells some four years back, however, due to recent salt water intrusion and contamination from the toilet facilities, the water is no longer safe for drinking. One of the Elders summarised this:

_We go to the mainland because it has a river and we get drinking water from there, we take containers for washing we use the groundwater well it’s also used for cooking. It was alright when we came, we used to drink it but for the last four years we not drinking it...it is a bit salty_ (#29 pers. comm., 2012).

The water collected from the mainland is used wisely and at times shared with the needy ones in the village. These villagers also utilised their local knowledge of tides to access freshwater from coastal springs which are never known to dry, however, the communities’ reliance on spring water has decreased due to ground water wells being located closer to their homes (#32 pers. comm., 2012). The cattle and other domestic animals were set free so that they could look for water. At the community level, the Chief advised people to conserve water and families were encouraged to share the available water.

Lonamilo village was worst affected by droughts. Water shortages become a huge problem when it does not rain for more than four months or longer and the river water dries out (#38 pers. comm., 2012). The locals then travel to nearby creeks and sometimes to the spring located close to the coast to collect drinking water. However, when the creek dries out during prolonged drought conditions, the village people have to travel to the coast. Sometimes they walked two to three kilometres to get to the springs and those with expendable income used/hired trucks. Also with the persisting drought, the villagers of Lonamilo temporarily move to the seaside and make provisional houses to cater them during their short stay.
Temporary relocation was an important strategy employed by the locals of Lonamilo village in response to severe drought condition in 2008. The locals had to leave their village and temporarily reside near the coast where tarpaulins were used to construct temporary houses. Water from a spring near the coast was used for drinking, cooking and washing. One of the Elders from Lonamilo village explains how spring water is harvested:

*During the drought that lasted for six months (doesn’t remember the year), there was lack of drinking water. The village people went to the spring close to the coast when the tide goes down, people access the fresh water. It’s not too salty we can drink, cook, and wash clothes and containers (#37 pers. comm., 2012).*

The water collected during low tide is stored in containers and used wisely till the next low tide. These locals move back to their village when rain returns.

Plate 6.3: Top row: The freshwater supply in Lonamilo village (left), the “ialken-apen” fern that is consumed to replace vegetables during dry conditions (right)
6.7 Adapting to Floods

The locals of Qeleni village in Fiji and Lonamilo village in Vanuatu were identified to be most vulnerable to flooding. This is mainly because the village is situated closer to the river that runs through the village. During heavy rain the river water gets flooded. Flooding is exacerbated by rain water that collects in hollow ground. The locals of Qeleni village experienced recent flooding from heavy rain in the year 2010 during Cyclone Tomas and in 2003 during cyclone Ami. During Cyclone Tomas in 2010, the flood waters damaged and washed away water pipes, damaged food gardens and washed away the river banks. Flood-water entered few houses that were situated closer to the river and destroyed the household items (Plate 6.4). The floods before the recent ones were in 1886 and 1983 that stayed for three days after few days of persistent rain and completely washed away three houses that were built at ground level. Participants from Qeleni village informed that this was particularly due to improper planning when the houses were constructed.

In the year 1998, the villagers of Qeleni experienced flooding twice. The floods washed away the household belongings from houses situated close to the river. There was also massive flooding in 2007. The river water that is used for drinking got dirty and pipelines from water catchments delivering water to homes got washed away. The villagers then used the spring water for drinking, cooking and washing. Food items got spoilt so people had to go to the bush to collect wild yam and fished in the sea. Men relied on their local knowledge of fishing to maximise their catch from the ocean. For example, the knowledge of the Dabi tree that the grandparents and ancestors had learnt about through observations and had been passed on to the children. The Turaga-ni-koro of Qeleni village illustrated:

_The Dabi tree has dark green leaves normally. But sometimes it turns its leaves to red in colour. This is an indication that there’s octopus and crabs on the reef just ahead the tree. “It has always worked and we catch_
Such knowledge was used to collect maximum food to feed the families as the leftover food from the flooded gardens was not sufficient. Community cohesion was great in and everyone helped do the clean up and worked together to build shelter to store household items for families whose houses got damaged. After the flood some of the locals of Qeleni decided to build their houses on stilts. This method was effective during the 2010 flooding as elevating the houses using stilts and building on higher grounds kept the flood waters away.

A catastrophic flood affected Lonamilo village in the year 2010 which damaged vegetable gardens, houses and impacted drinking water supplies. The river got flooded and the water stayed in the gardens for almost a month. Consequently, vegetables, root crops, and yaqona were destroyed and caused extensive erosion of the gardens and river banks. Besides, the floodwaters that entered three houses and eight kitchen houses damaged the stored food and household items. The freshwater source on the island was affected and villagers had to rely on rainwater and boiled water from the river.

The locals of Lonamilo village have devised a few strategies at the household and community levels to cope with flood events. At household level, families built houses on stilts about 20cm above ground level to keep out floodwaters. The locals filled their containers and tanks with rainwater for drinking. In times of food shortages, villagers consumed bananas as they grow above ground and are not affected by floods. They also have two or three gardens and in one garden they grow crops that are less vulnerable to the impacts of floods such as bananas, water taro, “Fiji taro”, cassava, yam and kumala. Thus, diversifying food crops secured food sources. At community level, villagers made channels to keep the floodwater out of the gardens and assisted those affected by moving their household items to other houses that had space and helped in rebuilding another house and replanting their gardens. Some gardens were also relocated inland. These strategies were useful in coping up with the flooding events especially in securing food and water supply.
Plate 6.4: Turaga-ni-Koro (Qeleni) showing where last river flood reached on houses (left), houses situated closer to Qeleni river vulnerable to flooding (middle) and traditional houses built at ground level vulnerable to flooding from accumulating rainwater in Lonamilo village (Photos: Karen McNamara)

6.8 Chapter Conclusion
The findings of the research presented in this chapter show that communities hold very little knowledge on climate change and yet have vast knowledge in coping up with the impacts of various extreme weather and environmental events. Since Fiji and Vanuatu are being greatly impacted by cyclones, coastal erosion from sea level rise, floods and drought conditions, the locals have formulated techniques to effectively respond to the impacts of these events. Locals have learnt to diversify crops and secure their food sources, protect and upgrade their access to water resources, build effective evacuation centres for shelter in times of emergencies and practice relocation as common response to cyclones, floods and droughts. Their local knowledge is expanding as they rapidly search for innovative options to respond to new changes in their local environment and climate systems in order to secure livelihoods and increase their resilience. The next chapter presents the key findings and provides recommendations.
Chapter 7: Conclusions and Recommendations

7.1 Chapter Introduction
This chapter presents a summary of the key findings of the research. The first section represents the potential sources of local knowledge and ways through which this knowledge is transmitted through generations. A review of the local ways of predicting and preparing for extreme weather events using local knowledge is also provided. The following section presents a summary on the application of local knowledge in managing land resources sustainably. Then important planting and preserving techniques identified as significant practices for securing food are discussed. The next section outlines major coping strategies practiced by communities to adapt to extreme weather events. This is followed by the presentation of discussion on the assessment of the role of local knowledge in climate change adaptation planning. Finally, recommendations have been provided for further research agendas to address specific gaps in this research project.

7.2 Conclusions

7.2.1 Local Knowledge Overview
The six communities identified local knowledge as an important element for local livelihoods. Local knowledge has been largely applied in planning daily activities, formulating adaption actions, managing local environments and conserving resources. The Elders, village leaders, parents and relatives play a vital role in ensuring local knowledge and practices are passed down onto the children. The findings of this research shows that local knowledge is recorded in oral forms mostly stories, songs and dances but is not formally written down. The knowledge holders orally pass this knowledge to the younger generation through storytelling/songs/dances and elaborating on the lessons of these stories, songs and dances. The knowledge held on preparing and adapting to extreme weather conditions is passed on to the younger generation so that they could apply these adaptation strategies to cope up with extreme events in future.
The children learn valuable local techniques through direct observation, instructions and individual practice and eventually become holders of this acquired knowledge, which they then transfer to their children to ensure that this process continues. However, there are concerns that this valuable knowledge system is being lost. The study identified two main reasons as to why this knowledge is disappearing. The first reason is that Christianity has discouraged traditional knowledge systems. The second reason is that locals are adopting new technology. Orcherton (2012) emphasises the importance of recording local knowledge and states that many Indigenous groups are now realising the importance of recording local knowledge in both written and oral forms. It is crucial that local knowledge is passed on, documented, understood and effectively applied in adaptation and management practices to promote sustainability. In doing so, Orcherton (2012) and King et al. (2008) encourage the ethical handling and recording of local knowledge that can be used by future generations and also be applied in local climate change assessments and adaptation.

### 7.2.2 Using Environmental Indicators to Predict Extreme Weather Events

One of the key findings of this research is preparing for extreme events using early warning systems are significant techniques in reducing the vulnerabilities of local communities. The information discerned from interviews illustrate that communities are able to use certain environmental indicators such as cloud patterns, wind direction, changes in animal behaviour and the nesting and migration patterns of local birds, changes in sea surface temperature, changes in the quantity of fruit yields and changes in the growth patterns of local plants as signs to predict extreme weather events (Chapter 5). The conclusion reached is that locals read signs to anticipate upcoming weather events and make necessary preparations particularly preparing for cyclone, heavy rain and drought conditions.

This finding links to the work done by Lefale (2010) on the Samoan community where the locals of Samoa monitor changes in plant and animal behaviour, read clouds and observe changes in wind direction and intensity as indicators to forecast local weather events and prepare for it. For example, the “appearance of a female frigate bird” to
predict approaching tropical cyclones and locals prepare for it (Lefale 2010, p. 329). Hodgson (2008) also concludes that local system of providing early warning is useful strategy in disaster preparedness and can help reduce vulnerability of local communities to extreme events.

### 7.2.3 Using Local Knowledge to Prepare for Extreme Weather Events

The various measures taken by locals in preparing for an approaching extreme event was investigated. The key preparations made for flooding events included: collecting fruits and root crops from the plantations, preparing “lovo” from root crops and collecting and storing water. The major preparations made for droughts are planting crops which can survive dry conditions and conserving water. The crops that can withstand dry conditions: sweet potato; wild yam; wild cassava; giant swamp taro; ‘taro Viti’; local bananas “malele”, “Vietnam”, “China banana”, “saaina” and “suwip”. The rich knowledge held on various ways of harvesting ground and surface water using ground water wells, freshwater springs and coastal water lens to secure water sources during drought seasons was successful.

The preparations made by locals for cyclones mostly include securing houses, pruning cassava/yaqona, storing water, collecting matured fruits and root crops, preparing “lovo”, accumulating emergency items, conserving available water, securing livestock and planting local crops that are best suited for local conditions and those that can survive extreme weather conditions. While the impact of climate change is likely to be more severe in the future, the findings show that the preparations made by the locals of Qeleni and Lonamilo villages to respond to flooding events are not adequate. However, these locals were able to secure their food and water supply during floods that can help prevent the outbreak of water borne diseases and food shortages. The study also documented the use of traditional plants such as “claricidia plants” to increase soil fertility and prevent pest infections of root crops.

Similar conclusions have been discerned from the work by Nakashima and Roue (2002) on local knowledge of farmers in selecting appropriate crops to be planted per seasons,
provide methods to improve soil fertility and identify plants with insecticidal properties. The preparations made by these six communities were often successful in reducing the vulnerability to cyclones as cassava and yaqona were not badly affected after it had been pruned, roofs that were secured remained intact and food and water supplies were adequate to meet the household requirements.

7.2.4 Using Local Knowledge to Adapt to Past Impacts of Extreme Weather Events
Locals have perceived changes in their local environment and are effectively responding to the impacts of extreme weather events; however, people’s understanding of climate change is inadequate. This is particularly due to lack of awareness in climate change issues. The two case studies used in the project illustrate that locals have developed effective adaptation strategies overtime that can assist in providing viable pathways in planning for effective adaptation actions to moderate the impacts of climate change.

The major component of local level adaptation was found to be either individual (household level) or community oriented. The collective efforts made by local communities to prepare for cyclones have been effective in coping with the impacts of extreme events particularly cyclones and droughts. Mobilisation of young men particularly youths is seen as a community-based initiative to assist the Elderly and the disadvantaged to secure well for extreme weather conditions. The short-term adaptation measures used to respond to extreme events include digging drainage to allow flood waters to flow to minimise chances of flooding, building special houses for evacuation known as the “hurricane house”, temporarily opening of “taboo areas” for locals to collect sea food and temporary reliance on Government remittances after a disaster.

The long-term adaptation options identified include planting special tress locally called “burao trees” around the village compounds that act as a wind break during cyclones and makes houses less vulnerable to falling. Houses located in flood prone areas are being built on stilts to keep away flood waters. Locals have moved gardens away from areas vulnerable to the risks from salt spray and to places with fresh water supplies.
Communities are conserving mangroves and growing coastal vegetations to be re-planted along coastlines to minimise coastal erosion.

The adaptation strategies used by locals farmers include cultivation of quick crops mainly corn, cassava and sweet potatoes that matures fast (in about three months) after cyclone or flood. Together with this, the local knowledge of various plants has enabled locals to opt for wild edible food sources that could be consumed to replace vegetables during famine from droughts or any other extreme conditions. Based on all these arguments, another important notion derived from this study is that adaptation strategies should be implemented at a local level with the engagement of the locals such as those done by the SPC/GIZ project.

Relocation practices have largely been applied in Vanuatu as a long-term adaptation to avoid overexploitation of resources due to population growth and in response to coastal erosion. Locals have made successful efforts to shift their gardens and houses further inland or on other fertile land. The water harvesting techniques such as digging ground water wells and using coastal springs has been successful in securing water for the households in times of droughts. Food sharing in times of disaster is a common local response. Berkes and Jolly (2011) illustrates a food sharing practice of the Inuit communities to provide communal support and minimise risks during seasonal variabilities.

The outcomes of this research support studies by Yakub et al. (2010) on Naselele, Qeleni and Yanuca villages and a study by Bartlett (2007) on Piliura village. In the study by Yakub et al. (2010) it was found that the locals of Yanuca village are implementing adaptation measures such as the building of a sea wall, installing solar panels and improving water catchments. This research discovered that locals of Yanuca have built a sea wall but coastal erosion is still an issue on the sides that do not have the sea wall. The villagers of Yanuca are planning to extend the seawall; however, such plans are still on hold due to financial constraints and limited availability of resources. They have been
able to construct the water catchment and improve the catchment area by placing cement around the water catchment for clean water to be collected.

One of the important findings of this study is that limited availability of resources is one of the barriers to the effective implementation of adaptation measures. It was evident that lack of building materials and expertise knowledge were the reasons for not widely using groins to stop coastal erosion. Kurrupu and Liverman (2011) portray a similar message that the coping capacity of a society is dependent on the resources available for adaptation and the expertise available to effectively utilise the available resources to plan adaptation. Also, cultural beliefs and reluctance to prepare for extreme events is interpreted as a possible cause of increase susceptibility. For instance, one of the participants explained that their household did no preparation for the cyclone and only prayed inside their home for their safety (#8 pers. comm., 2012).

It is concluded that adaptation to climate change should be implemented at a local level. As evident in this research, communities differ in their vulnerabilities and susceptibility to extreme weather events. Adaptation can be made effective if it is planned and implemented based on the extent of a community’s exposure and their vulnerability to climate stressors. This position is argued by Kpadonou et al. (2012), for instance, climate change will impact the most sensitive sectors such as water and ecosystems that the locals extensively depend on and those that jeopardise local livelihoods. Adaptation will therefore depend on the vulnerability of the exposed sectors and the resources available to initiate adaptation.

The results demonstrate that these six communities have employed various strategies that have been effective in coping with extreme weather events. However, there is no evidence of local knowledge being applied in setting up fixed disaster risk management plans at these six study sites. Mostly, preparations and adaptation measures take place in situ to the extreme weather events or after the Elders have observed signs of an approaching extreme weather. It is then that the village spokesmen/village leader or news through the media is used to inform the rest of the community. Since PICs are
often faced with climatic threats, it is particularly important that local institutions and environmental departments put disaster risk management plans in place for vulnerable communities. This can facilitate adaptation and locals can cope with extreme environmental events using both; local knowledge and disaster risk management plans.

### 7.2.5 Using Local Knowledge to Manage Land and Ocean Resources Sustainably

This study acknowledges the important contributions of local knowledge in resource management and environmental protection. These six communities have been using their local ecological knowledge to sustainably manage their land and ocean resources. The key management practices include establishment of protected forest areas and the enforcement of ‘taboo areas’. The establishment of protected forest area prevents deforestation, overgrazing livestock and overhunting of wildlife. A study by Raymond *et al.* (2010) highlights a forest management approach used in Kenya to prevent the overexploitation of forest reserves. The ‘taboo areas’ helps avoid over-exploitation of ocean and fisheries resources allowing adequate time for the juveniles to grow and adults to reproduce. This finding contributes to the findings made by Silvano and Jorgenson (2008) where locals use their ecological knowledge of fish behaviour to monitor their abundance and fish catch.

Following on from this finding, exploration on the types of management practices revealed that the traditional ‘taboos’ in resource management works better in the six communities as it deals with customary control of resources that is often obligatory and locals follow the laws out of respect and avoid the punishment imposed for not following the ‘taboo’. This finding links to the verdict of the study by Kumasi *et al.* (2012) that recognises that including affected communities in locally based resource management projects can promote collective management and prevent over-exploitation of local resources. The Vanuatu Cultural Centre (2005, p. 3) also highlight the concept of customary control of ocean resources that is known to work better than the “western conservation initiatives” which fails due to lack of resources to monitor conservation areas. However, under traditional systems, village heads and the community members effectively monitor their natural resources.
These local management practices allow the growing population to suffice using the available resources and at the same time conserve for the future. Therefore, local management practices can help create a perpetual and sustainable environment without restrictions on local people’s livelihood. It can be concluded that local knowledge of managing land and ocean resources can be applied to PICs in the management of natural resources to avoid over-exploitation and maintain environmental sustainability.

7.2.6 Application of Local Knowledge in Planting and Preserving for Food Security

An important finding of the research is that food preservation techniques and diversification of crops are proficient methods for overcoming food shortages in extreme weather events. Locals mostly plant food crops and depend on marine catches that can be preserved and are available during extreme weather events such as droughts, floods and cyclones. The locals of the six communities use their local knowledge to diversify local produce, switch seasonal crops, dig wild food crops (wild cassava, wild yam), collect edible bush (wild) plants and catch particular marine organisms using local ecological and seasonal knowledge which are effective in securing food resources. Berkes and Jolly (2001) have discussed similar short-term coping strategies with reference to the Arctic communities who adjust their hunting and fishing patterns for food security. The findings of this research also link to the study by McDowell and Hess (2012) that highlights the local practices of Palca farmers that use crop diversification to grow varieties of food and use food storage methods to dry and store traditional foods for food security during extreme weather conditions.

Assuming that the communities in the study will be highly vulnerable to the projected risks of climate change events in the coming years, there will be more pressures on the food sector particularly with the increasing population. The local systems of planting can be used for food security during droughts and cyclones as knowledge of local climate system and seasons (when to expect rainy seasons, cyclones and droughts) allow farmers to select crops that are best suited for a particular season.
However, there are concerns that under future climate change, it will be difficult to forecast local weather using the local knowledge systems that depend on environmental indicators (Ford et al. 2006). Therefore, the local practices discussed above will require modifications to suit future climate. Such factors can lead to common conclusions that food security will be a problem for many vulnerable PICs under future changes in climate. Therefore, local communities will require scientific knowledge and interventions to provide alternatives for adjusting to future climate change impacts.

7.3 Discussion

The results for these six communities reveal that cyclones, floods, droughts and coastal erosion are amongst the leading environmental factors that affect local livelihoods. The results show that Fiji is experiencing occurrences of intense cyclones that have devastating impacts on agriculture, infrastructure and major sectors. This matches with the scientific projections for Fiji that show a decrease in the trends of tropical cyclone but an increase in the occurrence of more intense tropical cyclones (Australian Bureau of Meteorology and CSIRO 2011). In Vanuatu, tropical cyclones have caused serious damages to agriculture, buildings and infrastructure and incurred huge economic losses. Drought conditions pose great challenges to locals particularly in harvesting clean drinking water and accessing fresh food supplies while floods and coastal erosion do considerable damage to landscape, gardens and vegetation.

This research reveals that variations exist in the levels of knowledge on climate change held by the respondents of Fiji and Vanuatu. The results showed that the locals of Piliura village in Vanuatu hold more knowledge on climate change than the locals from the other five villages. This is most probably due to the implementation of adaptation projects by GIZ in Piliura village. Lack of awareness programs and limited accessibility of locals in Qeleni, Yanuca, Tassiriki and Lonamilo villages to updated media can be the most likely reason for their limited levels of knowledge on climate change. It is probable that providing local level awareness training and educational programs in the local language to these communities can increase opportunities for locals to strengthen their knowledge on climate change.
Future impacts of climate change on PICs are uncertain. The extent of damages imposed and the severity, intensity and frequency of extreme weather events on PICs under future climate change is still not clear due to uncertainties in global and regional projections. It is concluded that those successful adaptive responses practiced in the past can provide useful learning that can be used to formulate adaptation measures to response to future climate changes. Nyong et al. (2010) discusses that adaptation initiatives should be formulated with the incorporation of local strategies employed by communities that had been effective in coping with impacts of extreme weather events in the past. Likewise, Agrawal (2008, p. 9) argues that even if the intensity and frequency of extreme events increases under future climate change, the adaptive capacity of local people and rural societies can be enhanced by facilitating their adaptation and building their adaptive capacity using their “past adaptive responses and historical experience and knowledge”.

More research studies on other Pacific Island communities should be conducted to: evaluate people’s levels of knowledge on adaptation to climate change; assess and utilise appropriate strategies to cope with impacts of extreme weather events; and facilitate local adaptation to climate change. Studies exploring how local knowledge can be used to perceive long-term changes in the local climatic conditions can also be used analyse trends in local environmental change to monitor regional and local impacts of climate change.

Policy strategies and adaptation actions that incorporate positive learning’s from local knowledge systems into decision-making can be relevant in addressing climate change issues at local, national and regional levels. This argument has also been put forward by Srinivasan (2004) and Denton (2012) on the need for policy makers to incorporate valuable local knowledge practices into climate change planning and decision-making. Local knowledge can be used along with scientific procedures to assist in alleviating the extreme impacts of climate change.

Green and Raygorodetsky (2010) states that local knowledge can be used to complement western science in the understanding of climate change by providing specific
information on observed environmental change and changes in weather conditions of a particular location. However, the incorporation of local knowledge systems in climate change decision-making remains a challenge for many PICs. It is important to note that incorporating local knowledge systems in scientific studies can provide scientific studies on information of locally perceived changes in climate and also facilitate in planning for culturally-appropriate adaptation strategies in response to future climate threats.

Local governments and institutions, climate change national plans, policy strategies and programs should work with local communities, incorporate their local knowledge and practices, and facilitate them with scientific expertise to develop appropriate adaptation and management measures. Agrawal (2008) defended such notions, arguing that the effectiveness of adaptation practices depends on how the actions of individuals and local institutions are structured. Macchi (2008) demonstrates that adaptation practices used in the past can be applied to manage risks under future climate change. Incorporating local institutions in planning and implementing adaptation projects at a local level can allow greater coordination and implementation of effective adaptation measures in alleviating the adverse impacts of climate change.

Not all aspects of local knowledge should be considered as useful; however, certain aspects of local knowledge and practices can be applied to climate change adaptation planning. There is a need for more studies to assess the possible ways local knowledge can be utilised to address the impacts of climate change. This study explored the valuable learnings that local knowledge systems can provide for climate change adaption planning and decision making. Local knowledge can value-add to local government decision-making on climate change impacts and can be used to identify sustainable responses needed to adapt to change.

7.4 Recommendations
This section provides suggestions for further work required to address the gaps in this research. Most importantly, there is need to identify the best ways to integrate the findings of this study into community-based climate change adaptation planning to
increase the adaptive capacity and resilience of these communities. It is vital to include those science-based adaptation strategies identified as significant, with appropriate locally-based adaptation practices documented in this research to enhance the adaptive capacity of communities. The findings of this research needs to be combined with other climate change adaptation work being carried out in the PICs to provide comparisons and better understanding of the value of local knowledge in climate change adaptation planning under a broader scale.

As evident in the literature, there are concerns that climate change will impair the ability of locals to forecast weather using environmental indicators. It is fundamental that future research projects focus on determining the impacts climate change will impose on local climate system and how this will affect the ability of locals to make accurate weather predictions. It is equally important that the methods of collecting local knowledge are refined and improved. This is to facilitate documentation of important aspects of local knowledge necessary for local survival that are continuously being lost.

There is a need for further studies to identify how climate change can impede current local methods of securing food resources. This is important as the current farming patterns and local crops may be affected under climatic change. The planting of local crops, farming and preservation techniques may need to be modified to suit future climate. Communities need to be advised on selecting crops that are more tolerant to salt intrusion and extreme temperatures.

For most of the local communities situated in remote settings, like those in Fiji and Vanuatu, who are largely depended on their local knowledge, acquiring scientific knowledge on crucial global issues such as climate change is difficult. It is also recommended that future studies on local knowledge and climate change could provide climate change awareness trainings to local communities to increase their level of knowledge on climate change issues. Climate change education and awareness programmes should be carried out in local communities.
The findings of this study demonstrate the valuable insights local knowledge system holds that is necessary for local survival. There is a need to document this important information that includes planting of coastal vegetation; forest and ocean conservation methods; farming and food preserving techniques; useful water conservation practices and most importantly, preparing for extreme events using indicators and forecasts. These practices reduce the vulnerability of local communities to extreme weather events. The observations, local practices, and adaptation responses to local environmental changes presented in this study demonstrates the need for on-going adaptation programmes to integrate this local knowledge with scientific methods when developing community-based climate change adaptation initiatives.
Bibliography


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Appendix A

Semi-structured Interview Guide

Date: ____________       Length of interview: ____________       Location: ______________

Section 1: Socio-economic Characteristics

1. Are you:  ○ Male  ○ Female

2. Where were you born? ________________________________________________

3. How long have you lived in this village? ___________________________

4. Please indicate the year you were born: ____________________________

5. Please select what you do to primarily make a living (select only one):
   ○ Fisher person  ○ Handicraft worker  ○ Domestic duties  ○ Pastor  ○ Retired
   ○ Farmer  ○ Small business owner  ○ Physical labourer  ○ Student  ○ Other ______

6. Please select the highest level of formal education that you have received so far (select only one):
   ○ Primary school  ○ Secondary school  ○ Trade  ○ Degree  ○ Other ________

Section 2: Access to resources, local knowledge and changes

7. Do you have access to land and ocean resources?  ○ Yes  ○ No

   If yes, what does this access include (size of resource, number of people using the resource)?

   If no, why not and how do you get access to food resources?

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

8. Do you have control over (i.e. ownership) land or fisheries/ocean resources?
   ○ Yes  ○ No
9. Please tell me **who** you gained your ‘local knowledge’ from (select all that apply)?

- [ ] Parents
- [ ] Grandparents
- [ ] Neighbours
- [ ] Village leaders
- [ ] Other

10. Please tell me **how** you gained your ‘local knowledge’:

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

11. Has local environmental knowledge been recorded in your community?  
- [ ] Yes  
- [ ] No

**If yes, how?**

- [ ] Songs
- [ ] Dance
- [ ] Folklores
- [ ] Stories
- [ ] Other

12. Has this local environmental knowledge been transferred to the younger generation?  
- [ ] Yes  
- [ ] No

**If yes, how?**

____________________________________________________________________________
____________________________________________________________________________

13. Are any of the following local changes or events becoming more severe (select all that apply)?

- [ ] Flooding
- [ ] Droughts
- [ ] Cyclones
- [ ] King tides
- [ ] Coastal erosion
- [ ] Sea level rise
- [ ] Inundation
- [ ] Water shortages

14. Please indicate your level of knowledge about climate change (select only one):

- [ ] None at all
- [ ] A little
- [ ] Moderate
- [ ] Very high
- [ ] Extremely high

15. Please indicate your level of knowledge about adaptation to environmental change (select only one):

- [ ] None at all
- [ ] A little
- [ ] Moderate
- [ ] Very high
- [ ] Extremely high

16. Please indicate your level of local knowledge to adapt to the following events:

<table>
<thead>
<tr>
<th>Events</th>
<th>No knowledge at all</th>
<th>Moderate level of knowledge</th>
<th>High level of knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood</td>
<td>[ ]</td>
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<td>[ ]</td>
</tr>
</tbody>
</table>
17. Thinking about the future, are you concerned about the impacts of climate change?  
○ Yes  ○ No

How concerned?

○ None at all  ○ A little  ○ Moderate  ○ Very high  ○ Extremely high

18. How are concerns about environmental problems dealt with by the community?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Section 3: Past adaptation to environmental change

19. Please reflect on the following past environmental change events and how you responded at a household and community level.

<table>
<thead>
<tr>
<th>Events</th>
<th>1 Timeframe</th>
<th>2 Impact(s) of the event</th>
<th>3 How did you respond to these impact(s) at the household level?</th>
<th>4 How did the community as a whole respond to these impact(s)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood</td>
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<tr>
<td>Drought</td>
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<td>Cyclone</td>
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<td>King tide</td>
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<td>Coastal Erosion</td>
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<tr>
<td>Sea level rise</td>
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<tr>
<td>Inundation</td>
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</tbody>
</table>
Water shortages

Probing Questions

1. Can you tell me when the event took place?
   - How long did the event last?
   - When did it start and end?

2. What happened during these events?
   - What were the main impacts during these events?

3. What strategies did you use to overcome these impacts at the household level?
   - How did you collect and secure drinking water during these events?
   - Were you able to collect and secure enough drinking water for your household using this method?
   - How did you treat your drinking water if it was contaminated during these events?
   - How did you secure your food supply during these events?
   - What particular preservation techniques did you use for your food?
   - Do you have livestock and cattle? How did you take care of them or protect them during these events?

4. What was the response and strategies of the broader community to help the village during these events?
   - How has the community responded to these past events?
   - Tell me about the community leadership during these events
   - What are the community committees? Are any of these committees devoted to dealing with events such as these?
   - Does the community have an early warning system to inform people of upcoming climatic events?
   - Does the community have a disaster management plan?
   - Does the community have an evacuation centre?

5. Were these actions, at either the household or community level, successful?
   - What worked well and what did not work well?
   - If so, why? If not, why?
   - What are some of the difficulties experienced by the community in adjusting to past changes in the environment?
Appendix B

Summary of the Findings of the Research for the Six Communities

THE VALUE OF LOCAL KNOWLEDGE FOR CLIMATE CHANGE ADAPTATION PLANNING: CASE STUDIES FROM FIJI AND VANUATU

Introduction

This research explored the role and value of local knowledge in adapting to extreme weather events in the Pacific Region. The study involved forty in-depth interviews in six communities in Fiji and Vanuatu. The six communities involved in this study included Qeleni village, Naselesele village and Yanuca village in Fiji; and Piliura village, Tasirriki village and Lonamilo village in Vanuatu. The research focused on the premise that we must learn from past practices to plan for appropriate climate change adaptation measures in the future. The research intends to build on discussions concerning the value of Indigenous knowledge in planning for community-based climate change adaptation programmes to enhance the adaptive capacity and resilience of local communities in the future. This report provides the summary of the major findings of the research particularly analysis of various environmental indicators that indicate the onset of extreme weather events and provide valuable coping strategies utilised by communities to adapt to the impacts of extreme weather conditions.

Findings 1: Using environmental indicators to make forecast

Locals of these six communities are able to forecast weather using their local knowledge of seasons, temperature, wind direction, fruiting patterns, and changes in animal and plant behaviour as environmental indicators. This knowledge has been gained from their parents, village Elders and relatives and is being passed down to the younger generations. These indicators are:
1. The curled up young vundi leaf as a sign of an approaching cyclone. When the young leaf grows bent over, it indicates bad weather and possibility of a cyclone.

2. In fruiting season, when certain fruits bear more yield than usual indicates cyclone. For example, when breadfruit is plentiful (three to four in one branch) but normally there’s one breadfruit per branch.

3. Piliura villagers described the “white wood” that sheds leaves before a cyclone. The locals monitor the leaves of this “white wood” to forecast cyclones and make preparations for it.

4. In Fiji, the locals monitor the sea water temperature. When the sea surface temperature is warmer than normal, or when sea water under the surface water doesn’t appear clear and is shaking (this does not happen normally), it implies an approaching bad weather, rough seas and possibility of a cyclone.

5. Observing the colour of the sky during sunset and sunrise to make forecasts:
   a) One of the Elders from Yanuca (Fiji) explained that during a normal long day, the sun will move to the mountain end, but if it only comes halfway and moves back (sets), it indicates possibility of a cyclone is approaching in two or three days.
   b) Likewise, the locals of Piliura community (Vanuatu) monitor the colour of the sky during sunset to predict weather. When the sky is red in colour at sunset then changes suddenly to dark, indicates rain the following day but when the sky is yellow during sunset, it indicates that the wind is going to change from what it currently is and mosquitoes will come with it.

6. Observing changes in wind direction to forecast weather:
   a) The normal wind for Fiji is the South East trade winds, but when the wind blows from North, it signifies cyclone.
   b) The locals of Tassiriki also observe changes in wind patterns to indicate cyclone. When the wind changes from the normal North East (locally called “suafate”) to South West (locally called “Tokelau”) direction, it implies an approaching cyclone.
   c) The Lonamilo villagers specified certain winds used to make predictions. The “Luotu wind” which is the North wind indicates cyclone. From October, November to May falling year is the cyclone season and if Luotu wind blows, it means a cyclone is approaching.

7. Observing clouds to predict weather:
a) For people of Piliura village (Vanuatu), the shape and colour of the primary clouds during sunrise and sunset are widely used to predict weather. The dark blue clouds that makes it impossible to see the blue sky, indicates a cyclone.

b) In Piliura village, dark clouds means heavy rain, dark clouds moving very fast means cyclone anytime soon and when there are long line white clouds it indicates earthquake.

c) In Tassiriki village (Vanuatu) the “Naburau loa” clouds which is a black cloud signifies heavy rain with the cyclone. The “Namadama” cloud is the white clear clouds that indicate a sunny day with no rain, so the locals expect a good weather. The third type of cloud is “Naburau milaya” cloud which means red clouds at sunset that implies weather to be bright (sunny) the next day and it sometimes indicates mosquitoes.

d) In Lonamilo, the “nipelap cloud” is a white cloud that appears like smoke and is used to indicate the direction of the wind during cyclone, so villagers make preparations (e.g. put shutters) accordingly.

8. Observing animal behaviour is also a source of making forecasts:

a) For example, when bees put their hive close to the ground, and not high up in upper branches of the trees as normal, indicates a cyclone is approaching.

b) The change in turtle nesting behaviour indicates an approaching cyclone. For instance, turtles normally nest in the beach, however, when the turtle’s come and nest inland it indicates a cyclone during the turtle nesting season.

c) In Tassiriki village, there’s a bird locally called “sura”, when it makes plenty noises (which it doesn’t do normally) signifies either a cyclone or heavy rain.

d) The bird from Mataso Island, when seen flying around areas of Pele Island instead of Mataso Island where it normally stays, indicates an approaching cyclone and locals prepare for it.

e) Another local bird called “mala” in Piliura, makes unusual sounds which the locals describe as “mala cries making a lot of noise” (which it normally does not), indicates drought conditions so the locals start collecting and saving as much water as they can.

f) Lonamilo villagers informed of “Manak Ire”, a saltwater bird which usually stays in the sea but this bird flies inland to indicate heavy rain or a cyclone that is one to two days away.
g) The locals of Lonamilo observe cattle behaviour. When cattle’s start jumping and appear very uneasy/restless making a lot of “moo” noises, indicates heavy rainfall in next one to two days.

9. The locals of Tassiriki village (Vanuatu) highlighted the significance of the sound of the “conch shell” which is a customary believe is a caution from the spirits on how the year would go for the locals. Sign for good year means no cyclone. If the locals hear the conch shell been blown at night at the beginning of the year (they normally hear it for ten times), it indicates that if there is a cyclone affecting Vanuatu, their village won’t be affected, they will have a good year.

**Findings 2: Managing local resources sustainably**

Local communities have developed mechanisms to manage their natural resources to avoid over-exploitation and scarcity. These are:

a) Adoption of useful planting techniques to diversify their produce to provide for adequate food supplies for their households. These techniques include:

i. Shading vegetables by growing under tall plants e.g. *Narara Erithryna*

ii. To increase soil fertility, maintain plant nutrients and avoid pest invasion, locals use the “claricidia” plant.

iii. Multiple cropping

> Communities in Vanuatu have developed techniques to increase the yield of taro. When the flower comes out in the middle, the farmers cut the flower and exchange it with the next plant. After that the flower is left to dry and then sow the seeds like cabbage. This allows the taro to grow into many varieties of taro that will be able to survive drought and extreme conditions.

> Yams can be planted using mixed cropping techniques. planting yams with pawpaw or banana plants increases the yield of yam:

> Also, “marrow” is one of the attractive varieties of yam which is planted for drought season to obtain more yields. When this yam is cultivated, cutting out all the leaves allows the yam to grow big and healthy. Using this technique, the locals plant this special “marrow” variety so that it can
bear more fruits and is mainly planted for cyclone and drought seasons for food security.

iv. Selective cultivation of seasonal and drought resistant crops

- For rainy seasons, cyclone seasons and drought conditions, “taro viti”, corns and kumala (sweet potato) are best to plant.
- Locals have noted that kumala is able to survive cyclones as the strong winds take away the twinning’s and ropes of kumala but kumala crops remain healthy in the ground and just take three months to grow.
- In wet seasons, kumala is grown on raised pile of soil (mountain of soil) to prevent flood waters from washing it away.
- The locals of Vanuatu plant “taro viti”, “cassava rice” and local bananas called “malele” and “Vietnam” banana for dry and rainy seasons. The young suckers are removed and planted separately facing the sun so it can grow well. This technique allows the banana fruit to grow large and healthy.

v. Cultivate wild varieties that tolerate extreme conditions

vi. Produce surplus food and preserve

b) Establishment of “taboo” areas.

- In Fiji, this “taboo” is imposed for two reasons.
  1. The principal reason for the “taboo” is the custom practice of showing respect due to the passing away of an Elder in the village.
  2. The other reason is for resource management. The temporary closure of the fishing grounds encourages the juveniles to mature and the adults to breed.

- Communities in Vanuatu practice a similar approach when there are concerns that fish is declining. The Chief sets up a “taboo” that the whole village agrees to so every year for eight months or more that allows the fish to breed and replenish.

c) Establishment of a protected forest area in the village territory. The village committee in Lonamilo has setup a forest conservation area with strict controls on the community’s
access to the conserved forest. Locals are not allowed to cut trees, graze cattle or even hunt for wildlife in the reserved forest area.

The locals pointed out that setting up the “taboo” area has always been effective in managing the ocean resources. The locals believe that forest protected area helps to conserve the forest resources for future generations, for fresh air and to lessen the impacts of strong winds during cyclones. Such effort made by the local communities in the conservation and sustainable usage of ocean and forest resources provides opportunities to restore fisheries, forest and wildlife resources that are also vulnerable to climate change threats.

**Findings 3: Using local knowledge in food preservation**

The root crops, fruits and other food items vulnerable to damage or spoilage during extreme weather events are often preserved. Locals in Fiji and Vanuatu collect matured fruits and root crops from farms when a cyclone is forecasted to prevent them from further damage. The surplus foods are then preserved.

a) In Fiji, damaged cassava and other root crops are buried in the ground to keep them good for up to three days.

b) “Lovo” is prepared in an underground oven pit using cassava so it can be preserved for over a week. However, if the same cassava is left outside without cooking it in “lovo” would rot in two or three days.

c) In Piliura village cassava is preserved using drying techniques. Cassava is grated, mixed with coconut cream and then cooked on stones to dry. This dried mixture is then used as a food while the locals prepare the gardens for the fresh food supplies.

d) Breadfruits are preserved by packing them in big sacks and submerging them in the sea for about a week. When the skin is gone, the breadfruit is cut, seeds are removed, and the edible parts are covered with banana leaves and placed on hot stones for two to three hours. After that, the banana leaves are removed and replaced with fresh green once and hung over the fireplace. It stays fresh if it gets smoked daily. The dried breadfruit can be kept for longer periods (almost a year) and used for food.

e) A second preservation technique for breadfruit is by peeling it, cutting it in big pieces and covering them with leaves. These covered pieces are then set on hot stones for two to
three hours, cooled, and stored in containers. Breadfruit preserved this way can be kept for few days and used for meals.

f) Bananas are preserved by grating banana; the grated banana is wrapped in green banana leaves, washed in salt water then wrapped again in fresh banana leaves. It is then made to hang in cool air especially on trees (not in the kitchen or the house). The wrapped leaves need to be change frequently to keep this food (locally called “nimare”) longer. The “lap lap” is mostly eaten as a delicacy and is considered one of the most used preservation techniques for bananas in Lonamilo village.

g) Locals in Tassiriki village cover the fallen bananas with green banana leaves and leave it for a month for the fruit to mature.

h) The locals of Taveuni are largely dependent on the sea for food. Sometimes when the catch is huge, the ladies smoke the fish so that it can last longer (over a week) without spoilage.

**Findings 4: Using local knowledge to prepare for extreme weather events**

1. **Preparing for flooding events**

   Communities are able to use their local knowledge to forecast weather. When heavy rain is forecasted and flooding is expected:
   
   i. Locals bring their fishing boats/canoes closer to their house. Sometimes, these canoes are used to move from one village to another to collect food items especially when the flood waters have not receded and the household has run out of food supply.

   ii. Locals also collect cassava and yams from their plantations and prepare “lovo” in an underground oven. It often becomes difficult to cook food using fire when the fireplace gets wet from heavy rainfall so locals prepare “lovo” for consumption and wait for the fireplace to dry.

   iii. They also collect raw food like fruits and buy preserved food items so that they have enough during bad weather.

   iv. The females collect rainwater in tanks and fill containers for drinking.

   v. Locals moved to higher grounds.
vi. They stored belongings securely away from flood prone areas.

vii. Built houses on stilts about 20cm above ground level to keep out floodwater.

2. Preparing for droughts and water shortages

Drought conditions are one of the eminent climatic concerns affecting many parts of Fiji and Vanuatu. Farmers hold local techniques that help secure food and water resources:

i. Locals pulled out the mother dalo and put the suckers back into the soil to prevent the suckers from dying.

ii. Using certain legume plants in farming to fallow land and shade low lying plants, particularly vegetables grown underneath. Narara (Erithryna) and Cliricidia sopium are legume trees introduced by Agriculture which is used to fallow an area and is also used to shade plants. Island cabbage (bele) is grown under it as it will block the sun’s rays during drought when the sun is very strong. Shading prevented the vegetables from drying.

iii. Before the dry seasons approach, farmers plant certain crops like kumala (sweet potato- Ipomoea batatas), tivoli (wild yam- Dioscorea villosa), kawai (yam- Dioscorea esculenta), uvi (Dioscorea alata), giant swamp taro (Cyrtosperma chamissiononis) and wild cassava which can survive seasons with low rainfall.

iv. Locals always have certain crops (Kawai, corn. yams) planted in their gardens for food security in case of severe weather events like hurricane or drought.

v. Wild yam and kumala (crop and leaves) are grown all year around and is often used in times of drought to replace vegetables.

vi. Bamboo structures are built for wild yams to creep onto for support when the nearby trees perish or have been cut down for firewood.

vii. During water shortages, locals rely on spring water and coastal water lenses.

viii. Likewise, locals of Piliura and Tassiriki villages (Vanuatu) plant food crops which are drought resistant. These include cassava, wild yams and certain varieties of bananas locally known as “Malele” (Musa balbisiana), “Vietnam banana” (a variety of the Musa balbisiana), and “China banana” (Musa acuminata).
ix. The varieties of banana preferably planted for drought seasons by locals of Lonamilo village are called “saaina” (*Musa balbisiana*) and “suwip” (a cultivar of *Musa acuminata*) in Tannese language.

x. In times of water shortages, locals prepared big containers and portable plastic tanks to collect water from nearby springs and dig groundwater wells for washing, bathing and at times cooking.

xi. The villagers consumed wild plants to replace their vegetables that normally grow wild in the bush “napalanku, ialken-apen and karwatu” that grows mainly near the river.

xii. The Chief’s opened the “taboo” areas so locals could fish to avoid food shortages

### 3. Preparing for cyclones

Local knowledge is extensively utilised in these six communities to prepare for cyclone events.

a) Women collect preserved canned foods, processed food items, water supplies, torches, radios and kerosene. They also collect and store water in buckets and containers and prepare tanks so that it gets filled with rainwater before the winds get very strong.

b) Men usually secure houses and plantations.

- Removed guttering of tanks to reduce contamination of their drinking water and placed big pots to collect rainwater.
- Bring boats to the shore; some used the boat to fill in rain water so that it doesn’t get turned over by the strong wind.
- Removed any weak branches near the house that would fall with the strong winds, put down shutters; some covered their windows with iron roof, nailed the roofs and tied houses with rope.
- Secured livestock and tied cattle in old gardens/patches or in places away from big trees. Pigs were placed safely in pig pan away from tall trees.
- To reduce damage in the plantations men prune the cassava and yaqona (kava) to reduce the surface area of the leaves exposed to the wind, and collect matured fruits from the plantations. For instance, one of the participants indicated that if it
was breadfruit season, they collect 2 to 3 bags of breadfruit and harvest vundi fruit (banana). The matured vundi is hanged inside the house and let to ripe.

- Some farmers collected root crops from their “teitei” (farms) and made a “lovo” using cassava so that it can be preserved for over a week and be used as food during the cyclone.
- After the cyclone, locals grow crops which mature quickly and help with food shortages particularly kumala, corn, and cassava.
- Young men help move people to evacuation centres, secure belongings.
- Locals of Lonamilo village build special houses for evacuation known as the “hurricane house”. The “hurricane house” is constructed using bamboos, wild cane and coconut leaves and is known to withstand strong winds and considered the best place to evacuate.
- In Lonamilo, to protect the village from strong wind, the villagers have planted locals tress called “burao trees” (*Hibiscus tiliaceus*) around the village compounds. This tree acts as a wind-break and reduces the impact of strong winds during the cyclones making their thatched houses less vulnerable.

### 4. Preparing and responding to coastal erosion

In coping with coastal erosion locals:

a) construct stone walls

b) replant mangroves along the coast

c) minimise/stop their use of mangroves for fuel wood

d) relocate houses inland away from the sea

e) In Fiji, locals plant coastal plants like vutu (*Barringtonia edulis*), sinu (*Phaleria dispersa*), tavola (*Beach almond tree- Terminalia catappa*), nawanawa (*Cordia subcordata*) along the coast lines

f) In Piliura village coastal trees are planted along coastlines: vetiver grass (*Vetiveria zizanioides*), pine, mahogany, sandalwood, navel (*Barringtonia edulis*) and kasis mangoes (*Leucaena leucocephala* - locally called “fish poison tree”), natoto plant (*Murraya paniculata*), purao plant (*Hibiscus tiliaceus*), navuevue (*Canavalia rosea*), namiro (*Cordia subcordata*) and the wild pandanus (*Pandanus tectorius*).
g) In Tassiriki village locals plant “natong tong” (*Rhizophora sp.*) trees along the coastline and build stone seawalls using cement, dead corals and rocks. Only some of the locals have started to plant trees locally called “seru”, “napakuda” (*Calophyllum inophyllum*) and “neyaru” (*Casuarina equisetifolia*) along the coast since 2011.

h) In Lonamilo village (Vanuatu) locals planted local trees mainly nekatu and narara (*Eretrina*) to hold the soil that has being effective in minimising erosion.

5. **Adapting to Sea Level Rise, King Tides and Inundation**

Sea level rise and king tides are affecting Fiji and Vanuatu. The strategies employed in response to Sea level rise and king tides are:

- Local’s have built houses on stilt (20cm above ground level) to keep away flood waters that also helps to keep away salt water during inundation
- A few locals have built seawalls and moved their gardens more inland to reduce exposure to seawater and salt spray that damaged the vegetables in the home gardens used for subsistence.

**Conclusion**

The findings of this study demonstrate the valuable insights local knowledge system holds that is necessary for local survival. There is a need to document this important information that includes planting of coastal vegetation; forest and ocean conservation methods; farming and food preserving techniques; useful water conservation practices and most importantly, preparing for extreme events using indicators and forecasts. These practices have enabled communities to reduce their vulnerability and be resilient to extreme weather events. The observations, local practices, and adaptation responses employed by locals to cope up with local environmental changes presented in this study demonstrates the need for on-going adaptation programmes to integrate this local knowledge with scientific methods when developing community-based climate change adaptation initiatives. Increased awareness programmes are required to enhance the level of knowledge of local communities on climate change issues and their impacts. As many of the local ways of managing environment and responding to extreme weather events is embraced in the local knowledge systems, there is a
growing need to preserve this valuable knowledge source as it suffers modern challenges and is at the verge of disappearing.