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PERCEPTIONS OF FUTURE CLIMATE CHANGE IN A VULNERABLE COMMUNITY AND ITS IMPLICATIONS FOR FUTURE ADAPTATION: A CASE STUDY OF THE REWA DELTA, FIJI

by

Shalini Lata

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

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School of Islands and Oceans
Faculty of Science, Technology and Environment
The University of the South Pacific

August, 2010
DECLARATION OF ORIGINALITY

Statement by Author

I, Shalini Lata, hereby declare that this thesis is the result of 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 of 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 Ms Shalini Lata.

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Designation: Professor of Oceanic Geoscience
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ABSTRACT

Pacific Island Countries are a particularly vulnerable region of the developing world owing to their comparative smallness, remoteness, fragility of ecosystems, limited resources, and heavy dependence on marine and coastal resources. In most parts of the Pacific, coastal ecosystems and communities are already experiencing changes in the natural environment as sea-level rise erodes coastlines and king tides inundate agricultural and freshwater lands. As part of a wider interest in the effects on island river deltas of current and future climate change, this paper examines the contemporary and future nature of sea-level rise stresses on the Rewa River delta in the south west Pacific. The Rewa Delta in Fiji Islands is the largest fluvial system in the South Pacific and sustains a population of almost 70,000. Sea-level rise will cause significant landward movement of the shoreline threatening the livelihoods and traditional homes of the delta’s inhabitants.

The results achieved show that climate change is not perceived as an issue of high concern by the people and local decision-makers of the Rewa Delta. Although most of the respondents have heard of the term, most commonly from the media, most are not aware of the nature of changes and the risks associated with climate change. Even though changes are evident in the natural environment in the form of increased erosion, king tides and inundation, people commonly see these as something normal and natural -something they cannot do much about. Most feel that changes are happening because god is punishing them. The communities do not plan to re-locate even if threats intensify due to their strong cultural links with traditional land. The perception was found to be more concentrated on short-term climate variability and thus is a barrier for longer-term climate-change adaptation in the Rewa Delta. The results imply that risk perception of climate change essential at all levels of society for successful implementation of adaptation policies and strategies.
<table>
<thead>
<tr>
<th>Acronym</th>
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<tbody>
<tr>
<td>AAAS</td>
<td>American Association for the Advancement of Science</td>
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<td>ADB</td>
<td>Asian Development Bank</td>
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<tr>
<td>AIACC</td>
<td>Assessments of Impacts and Adaptations to Climate Change</td>
</tr>
<tr>
<td>AR4</td>
<td>IPCC Fourth Assessment Report</td>
</tr>
<tr>
<td>ENSO</td>
<td>El-Niño Southern Oscillation</td>
</tr>
<tr>
<td>EPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<td>FLIS</td>
<td>Fiji Land and Information System</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>GISS</td>
<td>Goddard Institute for Space Studies</td>
</tr>
<tr>
<td>IPCC</td>
<td>United Nations Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>PICCAP</td>
<td>Pacific Islands Climate Change Assistance Programme</td>
</tr>
<tr>
<td>PICS</td>
<td>Pacific Island Countries</td>
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<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<tr>
<td>NGOs</td>
<td>Non Governmental Organization</td>
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<td>SIDS</td>
<td>Small Island Developing States</td>
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<td>SOPAC</td>
<td>South Pacific Applied Geoscience Commission</td>
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<td>SPCZ</td>
<td>South Pacific convergence Zone</td>
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<td>SPREP</td>
<td>South Pacific Regional Environment Programme</td>
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<td>UN</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>UNFCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<td>WMO</td>
<td>World Meteorological Organization</td>
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CHAPTER 1
INTRODUCTION
1.1. Introduction
This chapter is intended to explain the background of this study, setting up the context and rationale for the thesis. It provides an introduction that discusses the scientific basis of global climate change and its potential impacts on global, regional (Pacific Islands) and national (Fiji Islands) level. The chapter begins with an overview of climate change from a global perspective and which narrows down to the Pacific Islands discussing the nature of recent change. The chapter also states the aims and objectives of the Master’s thesis and the structure of the thesis.

1.2. Background Information
1.2.1. Global climate change
In recent times climate change has been recognized as a key global issue. It is one of the greatest environmental, social and economic threats facing the planet today (European Commission, 2008). “Warming of the system is unequivocal, as it is now evident from observations of the increase in global average air temperatures, widespread melting of ice and rising average sea level” (IPCC, 2007: 30). Scientific evidence has attributed climate change to human activity.

The IPCC has identified human activity in the form of fossil-fuel combustion, deforestation and land-use changes as significant contributors of excess carbon dioxide and other greenhouse gases into the atmosphere. Carbon dioxide, the major greenhouse gas causing global warming, has increased in the atmosphere from 280-380 ppm since pre-industrial times (Stern, 2007). Continued greenhouse emissions have produced many changes in the climate system. A recent report from the Copenhagen Climate Congress (March 2009) found that global change has caused many key parameters to move beyond the natural variability within which human societies thrived in the past (International Alliance of Research Universities, 2009). These parameters are increases in global temperatures, sea-level rise, and changes in precipitation and the nature of extreme events.

1.2.2. Recent Global Change
Since the start of the 20th century, global average surface temperatures have risen by approximately 0.7°C (WMO, 2006). This has caused sea level to rise by 10-20cm (IPCC, 2007).
In a recent study, Rahmstorf et al (2007) has presented an update on annual global mean land and ocean temperature (Fig.1.1) and sea-level trends till date (Fig 1.2).

![Graph of annual global mean land and ocean combined surface temperature from GISS (red) and the Hadley Centre Climatic Research Unit (blue) up to 2006, with their trends (Rahmstorf et al. 2007).](image1)

Fig. 1.1: Annual global mean land and ocean combined surface temperature from GISS (red) and the Hadley Centre Climatic Research Unit (blue) up to 2006, with their trends (Rahmstorf et al. 2007).

![Graph of sea-level data based primarily on tide gauges (annual, red) and from satellite altimeter (3-month data spacing, blue, up to 2006) and their trends (Rahmstorf et al. 2007). IPCC (2007) projection is shown for comparison](image2)

Fig 1.2: Sea-level data based primarily on tide gauges (annual, red) and from satellite altimeter (3-month data spacing, blue, up to 2006) and their trends (Rahmstorf et al. 2007). IPCC (2007) projection is shown for comparison.

This graph (Fig 1.1.) has combined data from NASA GISS, the Hadley Center and IPCC to present annual global mean land and ocean combined surface temperature. The global mean surface temperature increase in both NASA GISS and Hadley Centre data set is 0.33°C since 1990, which is in the upper range of the IPCC (2007) projections. According to the authors it is difficult to establish the reasons for this relatively rapid warming. Few likely possibilities laid
out by the study include intrinsic variability within the climate system, climate forcing other than carbon dioxide, and underestimation of the climate sensitivity to carbon dioxide.

Sea-level reconstructions using tide gauge data and satellite altimeter data since 1990 show that the pace of sea level rise is faster than most models have projected. The satellite data in Rahmstorf et al. (2007) reconstruction show a linear trend of 3.3 ± 0.4 mm/year (1993-2006). This relationship results in a projected sea-level rise in 2100 of 0.5-1.4m.

As global temperatures have increased, changes in rainfall patterns and the nature of extreme events have also been observed. The IPCC notes precipitation trends in various regions. Between 1990 and 2005, precipitation increased in eastern parts of North and South America, northern Europe and northern and central Asia while declining in the Sahel, the Mediterranean, and Southern Africa. The IPCC (2007) has also noted an increase in the number of areas affected by droughts globally. The IPCC argues that extreme events have also changed in frequency and intensity over the last 50 years. Richardson et al. (2009) also notes that at smaller scales, one of the most important changes in climate is the observed increase in extreme events- heat waves, storms and floods.

1.2.3. Future global climate change

Updated presentations on future climate changes depict a picture which poses serious challenges to humankind. According to the SRES scenarios, the baseline global greenhouse emissions are projected to increase by a range of 25-90% from 2000-2030, with fossil fuels projected to maintain their dominant position in the global energy mix to 2030 and beyond (IPCC, 2007). With greenhouse gas emissions continuing, temperatures are expected to rise further in future.

The IPCC has projected a global average surface warming of 1.8-4.0°C under a best-estimate by the end of the 21st century. This in turn would increase sea levels by 0.18-0.59m by the end of this century (IPCC, 2007). This projection in itself was difficult for many national decision-makers and global strategists to accept, and then an even bigger scenario emerged. Reports from the March, 2009 Climate Change Congress in Copenhagen, show that greenhouse gas emissions and many aspects of the climate are changing near to the upper boundary of the IPCC (2007) range of projection. In the same report, in a study of changes in the Greenland Ice
sheet, it was shown that new observations of the increasing loss of mass from glaciers and the
Greenland and Antarctic Ice Sheets lead to predictions of global mean sea-level rises of 1 m
(±0.5 m) during the next century (International Alliance of Research Universities, 2009).

Based on a range of models, the IPCC has projected a strong possibility of more intense and
devastating cyclones in a warmer world. Projected patterns of precipitation show likely
decreases in subtropical land regions and increases in high latitudes. Many of the most
damaging effects of climate change are associated with extreme events (International Alliance
of Research Universities, 2009). High intensity and more frequent cyclones and storms have
the potential to cause widespread distress to poor and vulnerable coastal communities
worldwide.

Climate change is certain. It is having, and will have, serious effects on people within and
between countries and regions, on this generation and future generations. Recent
assessments show that human-societies and ecosystems are vulnerable to even modest levels
of change in climate (Nunn, 2007). The IPCC in its 4th assessment described climate change and
its near and long term impacts under different scenarios across a range of sectors and regions.
According to the assessment systems and sectors like ecosystems, food, coasts, health,
industry, settlements and society, and water are at risk from changing climate.

Although climate change and sea-level rise are real issues facing the whole world today, one of
the regions most vulnerable to the effects are Pacific Island countries. Developing nations of
the Pacific are at the frontline of global climate change (Oxfam, 2009). Rising sea levels are
already threatening low-lying coastal settlements in the Pacific islands and future changes are
expected to worsen the situation.

1.3. Climate Change in Pacific Island Countries

1.3.1. The South Pacific

The South Pacific region (Fig. 1.3) is made up of 22 small island developing states and
territories which occupy an area of 30 million square kilometers. The landscapes of the islands
of the Pacific vary from atolls to raised limestone islands to volcanic high islands. The climate
in the region is generally tropical with modest seasonality. There is inter-annual climate
variability associated with the El- Niño Southern Oscillation (ENSO).
Figure 1.3: Map showing the location of the South Pacific region. Source: Nunn (2007)

The region sustains a diverse land area, cultures, biodiversity, economic development (ADB, 2004), socio-economic, and environmental problems. A range of non-human induced environmental changes currently causing concern in the Pacific include sea-level rise, temperature increase, increased frequency of tropical cyclone and El-Nino events (Nunn, 1998). Environmental issues caused by the islanders also exist in the Pacific. Development in recent times has caused massive de-forestation in most Pacific islands. Land and sea based pollution is also a concern. Growing populations have resulted in overexploitation of natural resources either for subsistence or commercial purposes.

Coastal and deltaic areas of the Pacific are densely inhabited and harbor most communities, towns, cities and key infrastructure including ports, airports, businesses, health facilities, hotels, resorts and other key structures. Interestingly, most of these areas have been severely stressed due to immense changes either in the name of ‘development’ or housing in the form of squatter settlements, tourism, roads, ports, causeway and capital. These processes have changed the morphology of coasts and have intensified their natural exposure to future climate changes (World Bank, 2000).

1.3.2. Climate Change in Pacific Island Countries

Within the past 1200 years Pacific Island societies have proved highly vulnerable to various environmental changes, particularly drought and sea-level fall (Nunn, 2007). The last 1000
years has seen an interglacial (comparatively warm) climate throughout the Pacific (Nunn, 1998). The last 100 years of this period has seen increases in temperature and sea-level in the Pacific as a result of global greenhouse emissions.

Widely recorded temperatures for the region show an increase of 0.6-1.0°C (Mimura et al., 2007). Many agree that increases in surface air temperatures in the Pacific are greater than mean global rates of warming. In a World Bank (2000) assessment it is stated that since 1920, temperatures in Noumea (New Caledonia) and Rarotonga (Cook Islands) have risen by 0.6-0.7°C—which is greater than mean global increases. Records for sea-level over the last 50 years from the Honolulu tide gauge show increases around 1.5-1.6mm/yr (Bindoff et al., 2007; World Bank, 2000).

Besides these long-term changes, other climate changes noted in the region include extreme climate variability due to the El-Niño phenomenon. The increased frequency of El-Niño events in the Pacific since 1970s (FAO, 2008) is linked to the increased tropical cyclone activity in the region. The last 50 years observed an increase in hurricane-strength cyclones in the South-West Pacific (Bettencourt et al., 2006; World Bank, 2000). Some examples of recent tropical cyclone activity in the Pacific are: Cyclone Ami in Fiji in 2003, Cyclone Heta in Niue in 2004, 5 subsequent cyclones in the Cook Islands in 2005.

Climate change data for the region also shows a change in precipitation patterns. Comparing the observed climate to earlier historical records during the 20th century it is clear that the Southern Pacific has experienced a significantly drier and warmer climate while the central equatorial Pacific has experienced more rain (Hay et al., 2003). Changing precipitation patterns have caused the South-West Pacific to experience two droughts and increased flooding in the past two decades.

Climate projections for the South Pacific previously indicated a mean global temperature increase of as high as 3.11°C by the end of 2100 (Mimura et al., 2007). Modified estimates indicate greater rise in temperatures in future as ocean warming is about 50% greater than had been reported by the IPCC in its fourth assessment (Domingues et al., 2008; Church et al., 2009). Projections for sea-level rise range from 0.18m-0.58m in 2090-2099 relative to 1980-1999 (IPCC, 2007). Revised estimates since the last IPCC report based on new data for global
warming indicate sea-level rise of more than a meter by 2100 (International Alliance of Research Universities, 2009). Increasing temperatures are projected to increase the occurrence of extreme weather events like tropical cyclones in the region which will be more frequent and intense. Precipitation patterns are also expected to change with intensive rain in the central equatorial Pacific and severe droughts in the South-West Pacific.

1.3.4. Impact of climate change on island nations

Small islands have characteristics that increase their vulnerability to climate variability and change, including small land area, proneness to natural hazards and climate extremes, limited water supplies, high concentrations of population and infrastructure close to coasts, open economies, low adaptive capacity, and adaptation costs that are high relative to national incomes (Mimura et al., 2007). Unfortunately, the islands of the Pacific have all these characteristics; in fact it is a region where a substantial portion of the population live within 1.5km of the sea (Oxfam, 2009) and are particularly vulnerable to climate changes.

Island countries in the Pacific are already reporting the serious socio-economic, environmental, physical and cultural consequences of current and recent climate change and with the absence of prompt and substantial reductions in greenhouse gas emissions these and new impacts will undoubtedly become even more serious (ADB, 2009). The voice of SIDs in the UNFCCC is making it evident that Pacific Island environments are transforming. The major claims made as a result of decades of observation include increase in the frequency of king tides, rapid coastal erosion and land inundation (Fig 1.4). Conversely these claims have been largely contested as such transformation is not so well empirically proven yet.

Few recently well-documented studies on extreme events show that tropical storms/cyclones, droughts, floods and heat waves have increased in the region (Hay et al, 2003; Webster et al, 2005). According to ADB (2009), in 2004 Cyclone Heta caused storm waves to rise over the 30 meter cliffs in Niue, leaving one person dead and many others homeless, and causing US$150 million in damage. In another example, the Cook Islands in 2005 experienced five cyclones within a one month period in three of which were classified as Category Five. Another case in point is Fiji which incurred in excess of FJS$45 million (M) in damages to agriculture (excluding the sugar industry), infrastructure, utilities and properties as result of cyclone Gene in
February 2008. In addition the government had to provide FJ$1.7M worth of food rations (FAO 2008).

Fig. 1.4: The impact of rising sea-levels on Tuvalu, a low-lying atoll, in the Central Pacific. Picture showing Young Tuvaluan men walking over land on Fogafale Islet, flooded by an extreme 3.4 meter king tide. Photo: Jocelyn Carlin/ Panos, Oxfam (2009) report.

The response strategies to manage current disasters in most Pacific countries are inappropriate (Bettencourt et al., 2006). The region in the 1990s alone bore up to $US1 billion as costs related to extreme events of tropical cyclones, floods, storm surges and droughts (Mataki et al., 2007). With immense scientific consensus for future climate change (Mimura et al., 2007; Rahmstorf et al. (2007), the threat intensifies. Various vulnerability assessments (Mimura, 1999; World Bank, 2000; Bettencourt et al., 2006; Gravelle and Mimura, 2008) have identified sectors as varied as coastal, agricultural, fisheries, health, water, human settlement and tourism to be at risk from the effects of climate change.

The IPCC defines adaptation as an adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Implementation of adaptation options to prepare for the effects of climate change is an on-going challenge in the Pacific. The need to implement adaptation measures in the Pacific has been reinforced as urgent (WWF, 2003; Mataki et al., 2007; Veityaki et al., 2007; Nunn, 2009), and was also recently highlighted in the IPCC small islands chapter where it was suggested that employment of risk-reduction strategies and sustainable development planning is important. “Governments, civil society and local
communities have a critical role to play in planning and implementing adaptation strategies in the Pacific “(Oxfam, 2009: 10). Since input from all levels of society is needed for successful implementation of adaptation options it is important to access the view or perception they share on the issue.

As part of a wider interest in the vulnerability of the region, this study looks at perceptions of climate risks in two local communities of the Fiji Islands, in the South-West Pacific, and compares them to scientific projections. The case study area for the study is the low-lying deltaic part of South-east Viti Levu, the Rewa Delta. The two sample sites for the research are Vutia, a rural traditional Fijian community, and Nausori, an urban centre- A full introduction of the case study area follows in chapter 3.

1.4. Justification of Research

1.4.1. The importance of community based research

Research over previous years especially in the developed world has laid down the importance of the study of risk perception in response to tackling the challenges of climate change. While the importance of such studies has been appreciated in the developing world, it has been significantly neglected by researchers working in the developed world (Byg and Salick, 2009) who most of the time are concerned about the physical basis of climate change. Thus lack of adequate and reliable data on the societal aspects of climate change is identified as a constraint in understanding climate change adaptation in developing countries (WMO, 2006).

Being part of the vulnerable Pacific community, it is reasonable to argue that climate change adaptation needs to be taken seriously by everyone as it is the only viable response option. A prevailing assumption in literature is that people who perceive a relatively high likelihood of an adverse event are more likely to take personal ameliorative steps and support government initiatives to do likewise, even in the face of required sacrifice (O’Conner et al., 1999).

The process of adaptation requires contribution from various levels of human society from individual to communities and other decision making bodies (Patt and Grothmann, 2005). Thus research on risk perception amongst local communities is essential as it influences a society’s decision in adapting to a risk. Such a study is essential from a policy point of view as well as in detailing local traditional knowledge (Byg and Salick, 2009).
Research shows that when people fail to be alarmed by a risk, they do not take precautions (Weber, 2006). In order to be alarmed it is important that risks associated with an issue which is likely to alter human livelihoods is understood first. According to Lasco et al (2009), typical projection of climate change impacts in decades and centuries is the reason for perception of climate change as a long-term problem and less important to issues such as food security, employment creation, or pollution in the developing world.

This research will access the perception of the issue of climate change at the grass root level to see how effective policy-makers are in empowering their communities. This would be interesting especially in a region where decision makers themselves often fail to understand the challenges posed by climate change (Nunn, 2009).

1.4.2 The issue

Fiji is expected to come under increasing pressure and risk from various threats resulting from climate change and sea-level rise (Gravelle and Mimura, 2008) especially on the main island of Viti Levu, as 86% of its 750km coast is less than 5m above sea level (Tompkins et al., 2005). Analysis by Feresi et al. (in Koshy et al., 2007) predicts loss of coastal land, which is a prime area for economic activity and human settlements in Fiji, by up to 14% due to sea-level rise and flooding by 2050. This projection could be exacerbated if a do-nothing option is adopted by decision makers and the people of Fiji.

The current position of most Pacific Island Countries including Fiji is that stakeholders are still coming to terms with climate change and its effects while the communities continue to act unsustainably, unaware of the consequences. An example is Viti Levu’s coast, where intensive urban development, growing poverty, de-forestation of watersheds, pollution and increased exploitation of coastal resources has exposed large areas of the coast to inundation and erosion (Tompkins et al., 2005).

Although calls for effective climate change adaptation for the Pacific have been loud, the focus of people and the government has been generalizations and big-picture statements (WWF, 2003) with government outreach on the issue limited to a few pilot projects (Nunn, 2009). “The de-facto present position of most Pacific Island governments is to do nothing and hope
that climate change does not happen” (Bettencourt et al., 2006:3). Even responses to interannual climate variability and events like tropical cyclones and floods, only follow once such events have occurred (Koshy et al., 2007); in other words, actions are reactive not proactive.

Recent times have seen an increase in some adaptation projects which are mainly externally funded in the region. In a study of environmental management in Fiji, Turnbull (2004) showed that there have been many instances where such assistance, earmarked for sustainable development, has been diverted into other revenue generating areas. Most of the time available funds have been used in the construction of seawalls for protection against continued inundation and erosion. The seawall concept has failed as an appropriate adaptive response in most places in the Pacific. Usually there is insufficient data to properly understand coastal dynamics prior to construction of seawalls and also funds are normally limited for regular maintenance (Nunn, 2009).

Climate change planning and policy-making in all Pacific Island countries are currently dominated by top-down approaches. According to Nunn (2009), top-down solutions do not work well in the area of environmental-decision making in the Pacific largely because of lack of enforcement and dissemination of government policy and advice. Also the local communities most of the times are determined to have the final say over their land as most resources are communal.

A major challenge in the Pacific is putting the message across to decision makers to build on strengths unique to the region and to its people and not to keep on adopting policy options which have been successful in the richer world. Leaders of the region still do not understand that policy options which are successful only in the developed world will not necessarily be appropriate in our part of the world. Environmental scientists in the region (Bettencourt et al., 2006; Koshy et al., 2007; Nunn, 2009) have continually called for leaders to take a bottom-up approach and mainstream climate change adaption at the community-level.

To see how much local communities are involved in environmental management, an assessment of vulnerability and risk perception to climate change will be done in two Pacific Islander communities in the Rewa Delta. This local case-study vulnerability assessment will be answered through research on long unanswered questions in the Pacific. These are:
• How do local communities and planners perceive climate change in relation to other socio-economic challenges facing them today?
• What is the importance of effective policy-making in climate change adaptation?
• What role does the private sector play in understanding and supporting climate related changes in their communities?
• What is the importance of risk-perception for future climate change adaptation?

1.5. Aims and Objectives
To provide an improved understanding of the perception of climate change in Rewa Delta by gauging opinions of communities, businesses and planners on global change science, its causes and impacts.

• To use Geographic Information Systems (GIS), to map future sea-level rise scenarios for the Rewa Delta by graphically showing the potential sea-level rise as an output, centrally to highlight risks from inundation and flooding for the community in future.
• To provide an understanding of the perception of climate change in the Rewa Delta
• To survey and assess recent environmental changes in the Rewa Delta
• To determine the link between human perception of global change and the implications it creates for future adaptation

1.6. Implications of Study
Although local perceptions of climate change are crucial given the potential seriousness of climate change for Pacific Islanders, such studies have largely been ignored in the past.
This research is intended to aid the communities, businesses and government of Fiji as well as other Pacific Island governments in adapting to climate change. The perception held by the public about climate change influences the actions they take to deal with the risks. Thus the results of this study would help better explain the likely level of priority and response individuals and policy makers in vulnerable Pacific island communities give to climate change issues. Overall this could help improve the foundation for environmental-decision making in the Pacific. The local vulnerability assessment and GIS analysis of the Rewa Delta would provide a pathway for directing resources and responses strategies to places where it is needed most (Gravelle and Mimura, 2008) and not wasted on stand alone unviable projects. It
would also show scientists what they need to do in order to communicate more effectively to community decision makers in the Pacific Islands.

1.7. Chapter Organizations
This study presents the outcomes of a study of climate-change risk perception in the Rewa Delta. The thesis is structured in seven chapters. These are organized as follows:

Chapter 2: Literature review
This chapter reviews previous work done on the topic in the Pacific as well as globally. The focus of the chapter is more on the theoretical aspects of climate change risk perception.

Chapter 3: Background to study area
Chapter 3 introduces The Rewa Delta and both the sample sites in the context of Fiji. This covers the geography, climate and socio-economic position of the area. This chapter further discusses current environmental issues facing Fiji and the local community of Nausori.

Chapter 4: Methodology
Chapter 4 examines the methods which have been used in this research.

Chapter 5: Results
Using data from a survey of households, businesses and stakeholders and observations in Nausori and Vutia, this chapter answers the aims of this research. Results have been presented in tabulated and graphical forms for better understanding.

Chapter 6: Interpretation of results
In this section, the results are interpreted.

Chapter 7: Discussion
Chapter 7 discusses the findings of this research with reference to findings of similar studies in other parts of the world.

Chapter 8: Conclusion and recommendation
Finally this chapter concludes the thesis by summarizing the key findings of this study.
CHAPTER 2
LITERATURE REVIEW
2.1 Introduction
The following literature review is intended to provide a background for the investigation of perceptions of future global change in a vulnerable area, the Rewa River delta in southwest Viti Levu Island, Fiji. The literature review begins with an exploration of climate change from a global perspective. This section includes a review of the causes, trends and future scenarios of global change. This is followed by an exploration of studies focused on effects of climate changes on human societies. This portion of the review is followed by consideration of global change at a Pacific perspective. This section explains the vulnerability of Pacific Island countries to climate change and elaborates on both the past prevalence and the future importance of adaptation with changing climate. Finally, an examination of studies of perceptions of climate change is provided.

2.2 Climate Change: The Global Perspective
The climate is changing. The earth is warming up, and there is now an overwhelming scientific consensus that change will accelerate in the future. Latest reports have presented strong evidence on the seriousness of the risk of climate change to humanity and the environment. (Parry et al., 2007; International Alliance of Research Universities, 2009)

Out of the many different assessments on global change, the ones most cited are from the United Nations Intergovernmental Panel on Climate Change (IPCC). Since being established in 1988, the IPCC has regularly been disseminating information on global change through assessment reports (IPCC, 1990; 1995; 2001; 2004; 2007) and is currently starting to outline its 5th Assessment Report (AR5). It is interesting to note that although a need for qualitative studies like assessment of community perceptions was identified earlier by Parry for the IPCC AR4, the report saw more emphasis on the scientific consensus on global warming, evaluating its causes, impacts, past and current changes as well as future projections.

The IPCC is not alone in its conclusions on the seriousness of global of greenhouse gases induced global warming and effects on a physical science basis. In recent years almost all major scientific bodies and climate scientists (European Commission, 2006, 2008; FAO, 2008; Parry et al., 2007; Stern, 2007; UNEP, 2007; Gore, 2006; WMO, 2006; AAAS, 2006; ADB, 2004) have voiced a similar judgement on the issue. A recent International climate congress (March
2009) in Copenhagen concluded the same. The full synthesis report of this congress recently presented an up-to-date overview of a broad range of research relevant to climate change – including fundamental climate science, the impacts of a changing climate on society and environment, and the many tools and approaches available to deal effectively with the challenge of climate change (International Alliance of Research Universities, 2009).

2.2.1 Recent climate changes
In discussing the possible causes of global warming, most research has agreed that the recent warming is a result of changes in the earth’s greenhouse effect (Tisdell, 2008; Stern, 2007). Since the industrial revolution, carbon dioxide, the major greenhouse gas in the atmosphere, has increased from 280 to 380 ppm today. This has predominantly been a result of fossil-fuel combustion, deforestation and land-use changes, the primary effect of which has been an overall rise in global temperatures. This in turn has caused changes in sea levels, the frequency and intensity of extreme events, and precipitation patterns.

IPCC (2007) ranked eleven of the previous twelve years (1995–2006) amongst the warmest in the instrumental record of global surface temperature. The total temperature increase from 1850–1899 to 2001–2005 is 0.76°C [0.57°C to 0.95°C]. In AR4 it also noted numerous long-term changes in other aspects of climate change. These include changes in amount of precipitation, wind patterns and aspects of extreme weather such as heavy precipitation and the intensity of tropical cyclones. The following precipitation trends have been observed:

- Precipitation has generally increased over land north of 30°N from 1900-2005, but has mostly declined over the tropics since the 1970s.
- Globally there has been no statistically significant overall trend in precipitation over the past century, although trends have varied widely by region and over time.
- There has been an increase in the number of heavy precipitation events over many areas during the past century, as well as an increase since the 1970s in the prevalence of droughts especially in the tropics and subtropics.

The frequency and intensity of tropical storm systems have varied over the 20th century on annual, decadal and multi-decadal time scales (US EPA, 2009). Following the Atlantic hurricane season of 2005, a great deal of attention focused on the relationship between hurricanes and climate change. To provide an updated assessment of the current state of knowledge of the
impact of global warming on tropical systems, the World Meteorological Organization’s hurricane researchers published a consensus statement (WMO, 2006). Their conclusions include:

- On the inter-annual time-scale, there is no established in situ positive relationship between sea-surface temperature and tropical cyclone frequency.
- The exception to this is the North Atlantic, where it is well established that sea surface temperature is one of the factors impacting the number and severity of cyclones.

Updated knowledge on climate change trends has emerged following the IPCC (2007) report. The recent report from Copenhagen is an updated source for the social and environmental implications of climate change, and the options for society to respond to the challenges. In comparing projections by the IPCC, this report has observed with evidence from various studies that the climate is changing near the upper boundary of the IPCC range of projections. An important contribution to this report has reported that Greenland ice sheet has been losing mass at a rate of 179 Gt/yr since 2003, the mass loss being very large for 2007. The new observations predict a global mean sea-level rise of 1m (±0.5 m) during the next century; double of that the IPCC (Jenson and Stefan, 2009).

Similarly, Rahmstorf et al (2007) have reported that IPCC has not exaggerated but in some respects has underestimated the change, in particular for sea level. The authors have graphically compared the scenarios of the IPCC, annual global mean land and ocean combined surface temperature up to 2006, with NASA GISS and the Hadley Centre data set (see Fig 1.1). Both show an increase of 0.33°C for the past 16 years which is in the upper range projected by the IPCC. A most recent new data set with combined global and marine surface temperatures has shown temperature records from 1850-2008 (Brohan et al., 2009). According to the data set (Fig.2.1), the year 2008 was 10th warmest on record, exceeded by 1998, 2005, 2003, 2002, 2004, 2006, 2001, 2007 and 1997.
Figure 2.1: Graph showing new data set of temperature anomalies recorded from 1850-2008, adopted from Brohan et al. (2009).

Reconstructed tide gauge and altimeter data on observed sea level since 1990 in the same study show a linear trend of $+3.3 \pm 0.4$ mm/year, compared to the IPCC (2007) which projected a best estimate rise of less than 2mm/year.

2.2.2 Impact of climate changes

Studies have depicted high-risk scenarios for societies affected by climate change. IPCC (2007) provided a thorough assessment of possible impacts of climate change. A summary of the major impacts by sectors is summarized in table 2.1.

The *Stern Review* also discussed the effects of global change on the world economy (Stern, 2007). Its main conclusion is that the benefits of decisive, early action on climate change considerably outweigh the costs. The Review states that climate change presents a unique challenge for economics and states and that action over the coming few decades could create risks of major disruption to economic and social activity later in this century and thereafter.
Phenomenon and direction of trend | Likelihood of future trends | Examples of major projected impacts by sector | Industry, Settlement and society
---|---|---|---
Heavy precipitation over most areas | Very likely | Damage to crops, soil erosion | Increased flooding disrupting settlements, commerce and transport.
Area affected by drought increases | Likely | Land degradation; crop damage and failure; increased livestock deaths | Widespread water stress | Increased risk of food and water shortage; malnutrition, and food and water borne diseases | Water shortage for settlements, industries and societies
Increase in intense tropical cyclone activity | Likely | Damage to crops and coral reefs | Damage to pipelines with power outages causing disruptions to water supply | Increased deaths, injuries, diseases and post-traumatic stress | Loss of property by floods and high winds
Increased incidence of high sea level | Likely | Salinisation of fresh water systems | Decreased freshwater availability | Increased risk of deaths and injuries; migration related health effects | Costs of coastal protection and costs of land-use relocation

Table 2.1: Summary of possible impacts of climate change due to changes in extreme weather and climate events, based on projections to the mid-late 21st century. Modified by the author for tropical Pacific Islands from IPCC 2007.

Inspired by the Stern Review, the European Commission has analyzed the impacts of changing climates on loss of ecosystems and biodiversity (European Commission, 2008). Findings on the cost of inaction by the report suggest that, with a “business-as-usual” scenario, by 2050 humanity will be faced with serious consequences. Some of these include:

- 11% of the natural areas remaining in 2000 being lost, chiefly as a result of conversion for agriculture, the expansion of infrastructure, and climate change.
- 60% of coral reefs being lost – even by 2030 – through fishing, pollution, diseases, invasive alien species and coral bleaching due to climate change.

Even more recent observations show that human societies and ecosystems are highly vulnerable to even modest levels of climate change, with poorer nations and communities
particularly at risk (International Alliance of Research Universities, 2009). Similar judgement has been made by the authors of the Small Islands chapter in IPCC AR4, where it was concluded that smaller islands are especially vulnerable to the effects of climate change, sea-level rise, and extreme events (Mimura et al., 2007). The report noted that smaller island states share many similarities that enhance their vulnerability and reduce their resilience to climate variability and change. The main ones are physical size, proneness to natural disasters and low adaptive capacity. Some of the most vulnerable Smaller Island Developing States (SIDs) are Pacific Island Countries (PICs).

2.3 Climate Change in the Pacific Context

From reviewing climate change literature in the region, it is apparent that the issue of climate change still remains poorly understood. Literature which does exist on the topic is mainly in the form of reports, government documents, newsletters, conference papers and research papers. A number have been prepared by bodies like the WWF, SPREP, SOPAC, and the World Bank in an attempt to highlight the significance of the topic for the people of the Pacific. This literature highlights common trends, threats, impacts and solutions in and around the Pacific, mostly based on IPCC assessments.

2.3.1 Nature of changes in the Pacific

In order to understand recent and future changes in the Pacific, an appreciation of long-term climate-society interaction is helpful. An assessment describing the evidence for last millennium climate changes and its effects on environments and societies for the Pacific Basin has been provided by Nunn (2007). This book describes the changes in climate that occurred in the Pacific during the last millennium. The author has used evidence from a range of sources and divided the last millennium into four distinct periods of climate. The first is the Medieval Warm Period, when most Pacific Island people occupied coastlines. This was followed by the AD 1300 event, when sea-level across the Pacific fell by around 80cm. Little Ice Age (AD 1350-AD 1800), followed the AD 1300 event with prevalent cooler conditions and variable climate forcing people into island interiors. In the last few chapters of the book the author has described the fourth period, which is known as the recent warming. Since this period, there have been net rises in temperature and sea level in most of the Pacific Basin. Recent warming
has exacerbated the effects of climate-driven change in the region causing human societies to become more vulnerable to inter-annual climate variability (especially El Niño events).

**2.3.2. Recent climate change in the Pacific**

Within the last 50 years, numerous studies assessing recent climate change in the Pacific have been carried out. The findings based on key parameters of temperature, sea level, precipitation and extreme events are summarized in the following table.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Change</th>
<th>Years</th>
<th>Source of information</th>
</tr>
</thead>
</table>
| Temperature | +0.6 to 1.0°C  
             +0.4°C | 1910-2007  
             1910-present | Mimura et al., 2007           |
| Sea Level | +1.6mm/yr  
             +1.5mm/yr | Last 50 years  
             Last 50 years | Bindoff et al., 2007  
                          World Bank, 2000 |
| Precipitation | Southern Pacific-drier  
                         Central Equatorial Pacific-Intensive rain | Present century | Hay et al., 2003               |
| Extreme Events | Increase in tropical cyclone activity, with most active years associated with El Nino events | 1982-2005 | Mimura et al., 2007            |

Table 2.2: Recent climate change in the Pacific.

In relation to the data presented in table 2, Mimura et al (2007) described climate of the Pacific to be influenced by several contributing factors such as trade winds, the paired Hadley cells and seasonally varying convergence zones such as South Pacific Convergence Zone (SPCZ). This recent up-to-date presentation of climate change on small islands, showed that annual and seasonal ocean surface and island air temperatures have increased by 0.6 to 1.0°C (table 2.2) since 1910 throughout a large part of the South Pacific, south-west of the SPCZ. In accordance with an earlier study Folland et al (2003), the study noted decadal increases of 0.3 to 0.5°C in annual temperatures since the 1970s, preceded by some cooling after the 1940s, to the north-east of the SPCZ in the Pacific basin.
In presenting sea-level rise data for the region, the study compared two sets of data Bindoff et al (2007) and Mitchell et al (2001). While Bindoff et al (2007), used results from SEAFRAME stations with more than 50 years of data, Mitchell et al (2001) analyzed at least 25 years of hourly data from 27 stations installed around the Pacific basin. The mean annual sea level change in the region was identified as +1.6mm/yr and 0.77mm/yr respectively (table 2.2).

For climate variability this assessment identified the El Niño Southern Oscillation (ENSO) as the dominant mode of year-year variability. “The global view of tropical storm activity highlights the important role of ENSO in all basins” (Mimura et al., 2007: 692). In accordance with an earlier study (Levinson, 2005), the assessment observed an increase in tropical cyclone activity in the South Pacific, with the most active years associated with El Niño events, especially during the strong 1982/1983 and 1997/1998 events.

Together with this work, a number of studies have affirmed that global warming could be a major factor in influencing the current climate regimes and changes from the normal that come with ENSO events for the Pacific region (Hay et al., 2003). The authors of this policy report highlighted a mean eastward shift of precipitation is between the central equatorial and the western equatorial Pacific. The key outcomes of the study suggested that during future ENSO events anomalously wet areas could become wetter, and unusually dry areas would become drier.

### 2.3.3. Future Climate Changes in the Pacific

Trends observed in climate change globally have allowed future changes in the Pacific to be extrapolated. Most assessments of future change in the Pacific have been by nongovernmental organizations (NGOs), which mainly have down scaled the outcomes of the IPCC (2007).

The most recent report on climate change in the Pacific has been from Oxfam International (2009). While earlier reports, such as Bettencourt et al (2006) and WWF (2003), pictured climate change as having major consequences in the future, Oxfam (2009) stated that ‘The future is here’. According to the report, Pacific Island countries are feeling the effects of global climate change such as economic losses arising from extreme weather events like storm surges, cyclones and king tides and effect on human livelihood as rising sea levels impact
agriculture, fisheries and freshwater. The study recommended that there is an urgent need to increase support for adaptation in the Pacific and to plan re-location of vulnerable populations and activities. For a secure future and habitable Pacific, governments, civil society and local communities have a role to play in planning and implementing adaptation strategies.

The nature of future climate change for Pacific Islands was documented in the IPCC AR4, Small Islands chapter (Mimura et al., 2007). Since the projections in this report are for small islands worldwide, it is difficult to isolate the trends for the Pacific region. This difficulty was addressed in an ADB (2009) report, where a summarized version of climate projections by the IPCC is provided for the Pacific alone. The projections are:

- Sea-level rise of 0.19-0.58m [1.2m, International Alliance of Research Universities (2009)], resulting in accelerated coastal erosion and saline intrusion into freshwater sources.
- Surface air temperature increases of 1.0 - 4.17 °C in the northern Pacific and 0.99- 3.11°C in the southern Pacific by 2070.
- Rainfall increases or decreases from -2.7% to +25.8% in the northern Pacific, and -14% to +14.6% in the southern Pacific, causing worse floods or droughts.
- Tropical cyclones becoming more frequent and intense with increased peak wind speeds and higher mean and peak rainfall.

2.4. Key Future Impacts and Vulnerabilities

2.4.1. Impact of future changes on Pacific Island countries

In a recent study, Tompkins et al (2005) explained how existing social, economic and environmental vulnerability can magnify the risks associated with climate change and describe actions that can be undertaken to prepare for changes. Table 2.3 identifies the sectors likely to be severely affected by rising sea surface temperatures, sea-level rises and extreme hazards.

In a later study, Bettencourt et al (2006) showed similar climate change impact assessments for the Pacific island countries. This World Bank funded study examined the possible impacts of changes in climate on a high and low island nation of the Pacific. These were Fiji and Kiribati respectively. The analysis of this report clearly shows that Pacific Islanders are likely to face substantial impacts of climate change. Among these would be loss of coastal infrastructure.
and land resulting from inundation, storm surge, and shoreline erosion. Climate change could also cause failure of subsistence crops and coastal fisheries, losses in coral reefs, and the spread of malaria and dengue fever.

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Climate change</th>
<th>Examples of climate change impacts</th>
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<tbody>
<tr>
<td>Water resources</td>
<td>Changes in precipitation</td>
<td>Water supply problems</td>
</tr>
<tr>
<td></td>
<td>Sea-level rise</td>
<td>Salt water intrusion of freshwater resources</td>
</tr>
<tr>
<td>Terrestrial biodiversity</td>
<td>Sea-level rise</td>
<td>Mangrove migration inland</td>
</tr>
<tr>
<td>Marine biodiversity</td>
<td>Increases in sea temperature</td>
<td>Coral bleaching</td>
</tr>
<tr>
<td></td>
<td>Sea-level rise</td>
<td>Reduced fish catch</td>
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<tr>
<td></td>
<td></td>
<td>Inundation of estuaries, deltas and coastal wetlands</td>
</tr>
<tr>
<td>Tourism</td>
<td>Changing temperature and sea-level rise, tropical</td>
<td>Damage to tourism infrastructure</td>
</tr>
<tr>
<td></td>
<td>cyclone intensity</td>
<td>Loss of beaches</td>
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<tr>
<td>Human settlement and</td>
<td>Sea-level rise</td>
<td>Coastal inundation causing relocation inland</td>
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<tr>
<td>infrastructure</td>
<td></td>
<td>Damage to industrial infrastructure</td>
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<tr>
<td>Agriculture and forestry</td>
<td>Changes in rainfall patterns</td>
<td>Drought or flood conditions</td>
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<tr>
<td>Health</td>
<td>Extreme temperatures</td>
<td>Increased incidence of vector and water-borne diseases</td>
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Table 2.3: Sectors likely to be affected by changing climate in future. Modified by the author to show key future impacts of climate change specifically for Pacific islands from Tompkins et al (2005).

On one hand where the earlier study provided a generalized impact on all sectors of the Pacific, FAO (2008) provided an assessment in terms of future food security in the Pacific. This report has concluded that while climate variations and extremes are disrupting food production and water supply, future projections indicate reduced food security especially at household level. The authors recommend profound adjustments in human attitudes with effective planning for future eventualities.
In another assessment, Gilman et al (2006) highlighted the effects of rising sea levels on coastal ecosystems of the Pacific region. The survey undertaken for the report assessed the vulnerability of mangroves. It concluded for the development of a strategy to plan and adapt to site specific mangrove responses including the critical need for community based approaches in Pacific Island communities.

2.4.2. Vulnerability Assessment

The assessment of future vulnerability to climate change is vital as it identifies who and what is exposed and sensitive to change (Tompkins et al., 2005). According to the report, not all small islands will experience the same type of hazards and the severity of a hazard will depend on the geo-physical, social and economic characteristics of each island. Nonetheless there are some common characteristics which make small islands like Pacific Islands vulnerable to changing climates. These include:

- High exposure to natural hazards
- Limited physical size
- Limited natural resource and over-exploitation
- High population densities
- Growing urbanization
- Limited financial and human resource skills
- Widespread poverty (Oxfam, 2009)

In exemplifying this vulnerability assessment, the authors used the example of Viti Levu, the largest in the Fiji group where 77% of the population, the major cities and industries are located. In examining the vulnerability of Viti Levu’s coast the study showed that it is already naturally exposed to weather events. Since about 86% of the 750 kilometers of coast on the island are less than 5 meters above sea level with shorelines retreating due to loss of mangroves, it is immediately apparent where the most vulnerable areas are.

2.5. Adaptation to climate change

2.5.1 Global adaptation

While there is certainty that climate change is a serious issue, there is less certainty as to how the issue should be responded to. A number of reports including the IPCC have stated that
fossil fuel emissions need to be reduced through policy change. However, currently there is ambiguity about how this could be achieved.

<table>
<thead>
<tr>
<th>Region Country</th>
<th>Climate-related stress</th>
<th>Adaptation practices</th>
</tr>
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</table>
| Africa (Egypt) | Sea-level rise          | -Adoption of national climate change action  
|                |                        | -regulating setback distances for coastal infrastructure; installation of hard structures in vulnerable coastal areas |
| Asia (Bangladesh) | Sea-level rise; salt water intrusion | -consideration of climate change in the national water management plan  
|                |                        | -building of flow regulators in coastal embankments; use of alternative crops and low-technology water filters |
| Europe (UK)   | Floods; Sea-level rise | Coastal realignment, converting over 84ha of arable farmland into salt marsh and grassland to provide sustainable sea defenses. Provision of guidance to policymakers, chief executives and parliament on climate change and the insurance sector |

Table 2.4: Examples of adaptation initiatives by region, undertaken relative to present climate risks, including conditions associated with climate change. Modified by the author to depict global adaptation to climate change, from Adger et al (2007).

Adaptation as an option has been proposed in most recent reports. The above table (2.4) provides a few explicit adaptation strategies implemented in some major continental states. Responses like floods and salt water intrusion in Europe and Asia are implemented due to current state of changes whereas examples of adaptation measures for sea-level changes in the three regions provide an account of adaptation measures put in place for future climate change and adaptation.

Another study by Adger (2000) has developed a theoretical perspective on institutional adaptation to social vulnerability to environmental risks. The case study highlighted local-level institutional adaptation in Nam Dinh Province in Northern Vietnam. The study highlighted local-level institutional adaptation to environmental risks associated with flooding and typhoon impacts in the coastal environment. This case study was carried out through
fieldwork involving qualitative household surveys and interviewing to elicit present and recent coping and adaptation strategies in the context of rapid changes in property rights and economic circumstances. This study found that Vietnam’s transition from state central planning increased social vulnerability to climate change by decreasing collective action for risk management by state institutions. This led to the emergence of civil institutions to mediate vulnerability to environmental change.

Some important research in the area of climate change adaptation has focused on behaviour and strategies to encourage people. An earlier psychological research on climate change by Conner et al (1999) examined the relationship between risk perceptions and willingness to address climate change. The data are a national sample of 1225 mail survey that include measures of risk perceptions and knowledge tied to climate change, support for voluntary and government actions to address the problem, general environmental beliefs, and demographic variables.

Few other studies have focused on strategies to narrow risk from climate change through adaptation. Recently the Atlantis study considered an extreme climate scenario to elevate climate change risk perception. These studies use a worst case scenario of a 5-6m sea-level rise induced by the collapse of the WAIS (Poumadère et al., 2005) in Rhone delta France; and Lonsdale (2005) in Thames estuary in UK and Olsthoorn (2005) in Netherlands).

Analysis of results obtained through stakeholder participation in the Rhone Delta study and Netherlands show a high level of cooperation mobilized to face a 5-6m sea-level rise issue. This is not evident under a normal projection scenario. Both these studies recommend that the methodology used here be applied to other risk situations and serve for policy exercises and crisis prevention. Similarly, Lonsdale et al (2005) considered the perceptions and responses of selected stakeholders to a scenario of rapid sea-level rise in Thames estuary. The study used a process of dialogue involving one-to-one interviews to address influences on decision making and the ability to plan and prepare for coping with an extreme scenario. The project found that awareness is needed to jolt people out of their comfort zones and see the threat as real. The policy exercise of the study did create a shock by mimicking the scenario to get people to think through the possibility of greater risks.
2.5.2 Adaptation in Pacific Island countries

With respect to adaptation in small islands, Tompkins et al (2005) have suggested various national climate change strategies which could be effective if followed closely. The study provided a useful guiding adaptation strategy (Fig. 2.2), which could be applied to every country.

Figure 2.2: The eight elements of an adaptation strategy. Modified by the author to show the key elements to adaptation in Pacific island countries, from Tompkins et al (2005).

Studies of adaptation options for Pacific island countries have focused on adjustments to sea-level rise and storm surges associated with tropical cyclones (Mimura et al., 2007). In an earlier study, Mimura (1999) classified adaptation options in three broad contexts.

- Information options: knowledge of climate change and their effects is an important basis for establishing adaptation strategies. People’s proper understanding of future threats and planned countermeasures is needed to implement adaptive options.
- Technical options: This includes a range of specific measures of planning and engineering for adaptation. It is important that communities use two-dimensional protection for coastlines. Natural protection in the form of mangroves, coral reefs and sandy beaches as well as artificial structures like seawalls.
• Policy options: it is important to integrate adaptation policies for climate change with other policies such as environmental conservation, coastal management, and national plans for sustainable development.

Correspondingly, The World Bank (2000) concluded that adaptation goals need to be identified as a priority in national policies. “The objective would be to transform climate change from ‘something that may happen in the future’ to a priority feature of current development planning” (World Bank, 2000:12). The report recommended guidelines for selecting adaptation measures for Pacific Island Countries, some of which include:

• Adopting a ‘No regrets’ adaptation policy: putting in place policies aimed at increasing the natural resilience of the islands and reducing their vulnerability to present-day weather events.
• Bottom up approaches: using community based interventions in the adaptation process.
• Environmental impacts: adaptation options need to be selected based on their impact on the overall vulnerability, not only on their impacts at a particular site.

More recent studies (ADB 2004 and Oxfam 2009) have focused on ways to reducing vulnerability to climate change. The Oxfam report highlighted a number of innovative projects at community level to climate proof villages. Bodies like Red Cross and the SPREP have produced useful resources for local communities to assess vulnerability and develop local adaptation programs. In most island nations climate activist are working on community level responses to flooding of agricultural land, drawing on local knowledge.

2.6. Vulnerability of Fiji to changes in climate

In reviewing Fiji’s vulnerability to current climate variability and future climate change, Porter (1994) identified various sectors as being vulnerable to changes. These include:

• Agriculture: occurrence of tropical cyclones and droughts can cause damage and destruction to tree and ground crops.
• Forestry: is vulnerable to tropical cyclones and dry conditions which could induce forest fires.
• Water resources: dry spells or droughts can result in shortage of water supplies.
Population: since most of Fiji’s population and agricultural activity is located along the coast, so is at risk from the impacts of sea surges. Similarly, activities located along rivers are at risk from river flooding.

Health: heavy rainfall and flooding can result in outbreaks of diarrhea and other water borne diseases.

Economy: negative effects of extreme events on primary resources, tourism and infrastructure have the capacity to impact the economy.

Through their vulnerability assessment of Viti Levu Island, Gravelle and Mimura (2008) have also shown Fiji’s coastline to be particularly vulnerable to rising sea levels and storm surges in future. The study used the approach of GIS mapping to merge sea-level scenarios and high-risk areas. This analysis allowed important areas facing risk to be identified for future action. The study concluded that since the coastline of Viti Levu is vulnerable to climate change effects, most of Fiji’s cities and towns are placed at high risk by default. Therefore adaptation measures need to be implemented as soon as possible. The drawback of this study today is that it is outdated, as 0.88m was the highest sea-level scenario used by the authors. It is already discussed earlier that new scenarios indicate a rise of more than one meter. This shortcoming will be addressed in this research, though not for the whole of Viti Levu.

Recent studies such as Mataki et al (2007) and Koshy (2007) pointed to the many key challenges in climate change adaptation in the Pacific. The first study, being a case study of Navua, a small town in Fiji, involved the overview of perception of floods in the area using an interview survey. This study was undertaken with the goal of enhancing the technical and human capacity of Pacific Island Countries in assessing vulnerability and adaptation to climate change. It found that connective top-down and bottom-up approach and clear responsibilities of all stakeholders are the way forward to climate change adaptation. The study depicted Navua as a typical Pacific Island community due to its poor socioeconomic conditions coupled with limited input to government decision-making.

The other project was executed as part of the regional AIACC initiative to enhance the capabilities for responding to climate change by building scientific and technical capacity through case studies in Fiji and the Cook Islands (Koshy, 2007). In addition to the case study approach, the authors used field surveys and climate change modeling to illustrate and
quantify their message in this assessment. The major groups studied for this report included, farmers, business people, urban and rural communities and government officials in Navua and Natadola on Viti Levu, Fiji. Amongst key findings of the study included poor governance and improper land-use practices in the Pacific Islands as important determinants of the overall vulnerability of people to climate change and its present variations. Both assessments identified capacity building through community involvement in policy formulation as major needs in climate change adaptation in the Pacific.

An important earlier study which solely addressed environmental management complexities in developing states using Fiji as a case study was by Turnbull (2004). This in-depth review of environmental management in Fiji concluded that environmental practice in Fiji is far less rational and thus differs from developed countries. The results also reflected that socio-political factors are influencing environmental management priorities and practices. The author recommended that to understand the complexities of implementing modern environment management in Fiji, future consideration of cultural, social, political and economic factors is necessary. This issue has not since then been addressed in Fiji and needs further exploration even today.

An exception to this literature is a recent paper by Nunn (2009). This paper discussed the management and technological challenges in responding to climate change in Pacific Islands. According to the author, the principal reason for writing this paper was to explain the state of preparedness for future climate change in the region. Areas of interest raised in this paper which are very important for this research are decision-making in Pacific countries, climate change international funding, effectiveness of top-down and bottom-up approaches, importance of community empowerment and mainstreaming, and significance of technological and traditional management responses in the Pacific. To summarize this work, the biggest current challenge to adaptation in the Pacific region is still denial, where there is a perception and belief by communities and states involved that the area will somehow survive.
2.7. Studies of community perceptions of climate change

2.7.1. Developed Countries

Public views on climate change have been of interest to researchers and policy makers for several years now. The risk community and other scholars have used a variety of methods to discern public opinion towards, and perceptions of climate change. These views have been elicited mainly through primarily quantitative social surveys and more recently in-depth qualitative studies. Most of these studies have been conducted in the developed world, which is generally less vulnerable to changes and better financially equipped to bring about effective adaptation.

Researchers on risk perception have generally found that climate change adaptation lacks a sense of urgency. In a study of risk perception in the United States, Leiserowitz (2006) helped explain the paradox in Americans risk perception of climate change. The study was implemented through a mail survey of a representative sample of the American public (n=673). It concluded that while large majority of Americans believe climate change to be real and consider it a serious problem, it remains a low priority for individual action relative to other national and environmental issues.

In another overview of public opinions and attitudes regarding climate change in the USA and Europe, Lorenzoni and Pidgeon (2006) found that for most individuals’ climate change is a complex and misunderstood issue. Unlike the previous study, findings of this research were drawn from various datasets and research studies across nations, supplemented with in-depth data collection in the United Kingdom. The authors found that although there is widespread concern about climate change, it is of secondary importance when compared to other issues in people’s daily lives. The paper also discussed limitations of data comparability across surveys and underlined the need for more longitudinal tracking studies of risk perceptions.

A recent social survey carried out in two German towns was presented from a socio-economic point of view towards the necessity of climate protection measures at political down to individual levels (Paeth and Otto, 2009). The results show that the German population is clearly sensitized to the climate change issue with over 80% assigning observed climate change to a larger or even very large extent to human activity. However, even under these
optimal conditions the climate change problem is ranked clearly behind other societal challenges like fighting against famine, war and diseases. The political and individual options in climate change protection are estimated to be limited. This paradox has been described earlier by Leiserowitz (2006) for US citizens and Lorenzoni and Pidgeon (2006) for UK citizens.

Some studies have shown that the perception of climate change risk is also important from a policy point of view. In an interview survey with key stakeholders in two English regions (East Anglia and north-west England), Shackley and Deamwood, (2002) found that, while local and regional impacts are of considerable interest to regional stakeholders, their ability to respond through adapted policy and practice depends on their understanding of the policy and decision-making systems.

2.7.2. Perceptions of climate change in developing countries

Research on risk perceptions of climate change in developing world countries is vital as these countries lack adaptive capacity to optimally respond to changes in climate. This has been expressed as “the vital question which has yet to be adequately addressed in climate change research is: Do communities in the developing world perceive climate change as being a significant threat when compared to other developmental and environmental problems?” (Shisanya and Khayesi, 2007:272). Lack of adequate and reliable community perception data can be considered a major constraint in developing an accurate understanding of climate changes in developing countries.

The journal *Climatic Change* has made an effort to address this lack of data by issuing some important research papers on the psychological aspects of climate change. An article by Weber (2006) in the journal indicates that governments and citizenries of many countries show little concern about climate change and its consequences. The author has argued that people’s perception of risks is important in order for them to take actions.

In a similar study of local perceptions of global warming in Tibet, Byg and Salick (2009) concluded that climate change is not purely a physical science phenomenon, but also has social, cultural and economic aspects. Field work for the study was carried out using semi structured interviews. The results for the study were analyzed using statistics to detect significant patterns among people and places with regards to climate change risk perception.
It was found that people in the six Tibetan villages studied were not aware of the phenomenon of global climate change and mostly assumed the changes they observed as local.

A case study of a resettlement program in Mozambique showed a comparable scenario (Patt and Schroter, 2008). The authors used both qualitative and quantitative research methods. From a set of workshops, qualitative data on differences in farmer and policymakers’ perceptions of climate risks was collected while quantitative evidence was gained from questionnaire surveys. The study found that farmers and policymakers disagreed about the seriousness of climate risk and the need for adaptation. The results highlighted the need for active dialogue across stakeholders, as a necessary condition for formulating policies that can then be successfully implemented.

Other than these notable studies, very little published research on the perceptions of global change and its role in decision-making and policy development in the developing world has been done. Even less such research exists for the Pacific Islands. The most recent work on climate change in the Pacific region, Oxfam (2009) has shown governments, civil society and local communities have a critical role to play in planning and implementing adaptation strategies in the Pacific. A case study in the report on climate-proofing communities in Fiji, Oxfam (2009) argued for the importance of analyzing vulnerabilities in local communities. This would help in the development of environmental management plans that can help in adaptation to future climate change.

2.8. Climate change or climate variability

While reviewing the literature of risk perception of climate change, the fact cannot be ignored that misperceptions are widespread. The confusion between ‘weather’ and ‘climate’ is common. Studies in the past have stressed the implication of climate change and climate variability misrepresentations in adaptation. In showing the relationship between weather and climate, IPCC (2007) stated that there are important differences between the two terms. While chaotic nature of weather patterns makes it unpredictable beyond a few days, long-term climate change projections are much more manageable.
Various studies of climate change and variability have reached similar conclusions (Rebetez, 1996; Vedwan and Rhoades, 2001; Patt and Grothmann, 2005; Bryan et al., 2009). One important question that arises in the literature assessing farmers’ perceptions is whether farmers make responses to adapt to short-term climate variability or long term climate change. Most do agree that adaptation responses taken upon perceiving short-term climate variability is a barrier to long-term adaptation. The earliest of these studies analyzed current climate in Switzerland (Rebetez, 1996). It found that human expectations regarding weather and climate can lead to perceptions of climate change not being supported by observational evidence. The paper stressed that short-term extreme events are not necessarily indicative of long-term shifts in climate.

The literature demonstrates that adaptation to short-term climate variability could increase vulnerability to long term climate change. A study on risk perception and perceived adaptive capacity drew this conclusion from two case studies (Patt and Grothmann, 2005). The first case study examined the precautionary behaviour of German residents to floods while the second examined the responses of Zimbabwean farmers to drought. It found that responses by farmers and residents to effects of floods and droughts in the area did not qualify as adaptation to climate change as a global, long-term phenomenon. It qualified as adaptation to climate change related regional and short-term impacts.

A similar conclusion was reached in a later study (Vedwan and Rhoades, 2001). This study compared locally idealized traditional weather cycles with climate change as perceived by farmers in Western Himalayas of India. It found that farmers described climate change as the temporary displacement of the weather cycle and is not perceived as altering the idealized weather calendar. An important result which came out through this study was the importance of culture in climate change risk perception and adaptation. The study found that the cultural model of climate in the farmer’s weather calendar inhibits the perception of climate change. The authors concluded that the framework for making agricultural decisions and climate cannot be isolated from culturally constituted ways of seeing, knowing and valuing the world.

Most studies have shown that government outreach to communities is the reason for misperception amongst people. In a study of adaptation to climate change by farmers in South Africa and Ethiopia, Bryan et al. (2009) concluded that policy-makers must create an enabling
environment to support adaptation by increasing access to information, credit and markets, and make a particular effort to reach small scale subsistence farmers, who have limited resources to confront climate change. Using data from a household survey of 1800 farm households in the two countries, this study presents the adaptation strategies used by farmers in both countries and analyzes the factors influencing the decision to adapt. Using a pooled dataset, an analysis of the factors affecting the decision to adapt to perceived climate change across both countries reveals that farmers more likely adapt if they have access to extension, credit, and land. Food aid, extension services, and information on climate change were found to facilitate adaptation among the poorest farmers.

Some authors in the past have underscored this prospect. Vedwan and Rhoades (2001) argued that policy based solely on educating people as a means of generating consensus on the issue of global warming and its potential solution is not likely to go very far and incentives for adherence to recommendations are necessary. Another argued that psychological factors are equally important in determining adaptation (Patt and Grothmann, 2005).

Interestingly, no significant literature on climate change risk perception is done in the Pacific which could be used to compare results and draw on misconceptions. The overwhelming literature on risk perception to climate change in the developed world does reveal its importance. There is an increased call for a qualitative approach as well to better understand public risk perception to climate change especially in the developing world. Thus this thesis is an attempt to address the shortcomings of research in this field in this part of the world.
CHAPTER 3

BACKGROUND TO STUDY AREA
3.1. Introduction
The following chapter reviews the background of the Fiji Island group. Topics covered in this section include location, climate, population, economy and environmental sustainability in the country. The importance of current and future impacts of climate change in Fiji is also discussed in this section. Following this a more focused picture of the case study area is provided. This chapter presents various maps and pictures so that the reader has a better view of the area of study.

3.2. The Fiji Islands
3.2.1. Geography
In many ways, the Fiji Islands (Fig 3.1) lie at the hub of the South-West Pacific Ocean, between longitude 175°E and 178°W and latitude 15° and 22°S. The islands cover a total land area of 18,376 km². Land ownership in the country has three basic components. In 2003, Native land comprised 82.5%; state lands are 9.5% while freehold land is equivalent to 8% (Parliament of Fiji Islands, 2003). In the meanwhile close to 90% of the land is Native Land.

The Fiji archipelago straddles a boundary between the Pacific and Indo-Australian plates. Geologically, the formation of the Fiji group is attributed to the broadly southwards subduction of the Pacific plate beneath the Indo-Australian plate between the early Eocene and early Miocene (Nunn, 1998). The island group contains a great variety of island types including high and low volcanic islands as well as high and low limestone islands.

The approximately 330 islands comprising the Fiji group vary in size. The largest island, Viti Levu, which is the focus of this study, occupies 10,388 km² of land. 77% of the population, the major cities, industries and tourism activity of Fiji are located on Viti Levu. Suva, the capital of Fiji is located on south-east of this island. Other main islands of the Fiji group include Vanua Levu, Taveuni, Kadavu, Gau and Koro (Fig 3.1).

3.2.2. Climate
Fiji has a tropical maritime climate. The average daily temperature varies seasonally from 23°C to 25°C in the dry season and from 26-27°C in the rainy season (Fiji Meteorological Office, 2009). The predominant winds over Fiji are the south-east trade winds. These moisture-laden winds, when combined with the high relief of an island like Viti Levu, gives rise to orographic
precipitation. This process creates a distinct wet zone on the eastern side and a drier leeward zone on the western side of the major islands in Fiji.

Another important influence on rainfall in Fiji is the South Pacific Convergence Zone (SPCZ). The group usually experiences more rain around January due to the proximity of the SPCZ to the island which produces excessive convective and cyclonic rainfall (Nunn, 1994). Average annual precipitation over the group ranges from 1500 mm on smaller islands to 7000 mm on elevated large islands. Fiji is normally affected by tropical cyclones and depressions during the November- April Cyclone season. Tropical cyclones in the past usually in this period results in massive flooding in most parts of Fiji.

3.2.3. Population and Economy

Fiji possesses a mix of different races of people. Of the total population of 837,271 recorded in 2007, 56.82% were Fijians, 37.48% were Indo-Fijians and 5.70% comprised other races. Since in every society there is a culturally unique way of viewing the natural environment, cultural influences on climate change perception are important. Cultural practices, beliefs, attitudes and traditional values play an integral role in climate change risk perception amongst the societies of Fiji. Cultural values of the distinct mix of people making up the population of Fiji can be exploited to bring about changes in the way people perceive changes in climate and the possible adaptive measures.
Over the past 50 years, an increasing trend of urbanization has emerged in the country. Many people have left rural villages, to live in towns and cities situated in low-lying coastal flats in the hunt for better jobs, education and better facilities and services which urban centres usually provide. This has caused a massive boom in the coastal population of Fiji. According to PICCAP (2005), over 90% of Fiji’s population in 2005 in both rural and urban areas was coastal dwellers.

High population densities in the urban centres of Fiji have led to a number of environmental problems. Lack of land to cater for high population densities has seen the development of squatter settlements in many coastal flats. These have not only exposed those living there to a range of natural hazards and future climate changes but it also has created problems such as increase in both land and water pollution and stress to natural resources in the area.

Fiji, like all other Pacific Island countries, has a narrow economic base. In past years, Fiji has been heavily dependent on the agricultural sector for income. Sugar export was the major foreign exchange earner for the country until the industry started to collapse in late 1990s due to political and land-lease issues coupled with negative impacts of natural disasters. In recent times, the tourism sector has grown significantly. Of the FJS2871.0 m GDP of the country in 2007, agriculture, forestry, fisheries and subsistence contributed 14% while the hotel sector contributed 18% (Fiji Islands Bureau of Statistics, 2008). Other significant sectors comprising Fiji’s economy are manufacturing, garments, mining, retail, and real estate.

3.3 Environmental Sustainability

3.3.1. Current environmental stresses

Fiji, due to its small size, geographical isolation and growing population, is vulnerable to a range of social, economic and environmental problems. Important socio-economic issues in Fiji include high population growth, rural-urban drift, breakdown of traditional lifestyles, a strong dependence on foreign aid coupled with increasing inflation (Veitayaki, 2007). High population growth and urbanization have highlighted the topic of environmental sustainability as it has been linked to environmental ills like pollution, land and marine resource exploitation, de-forestation and land degradation. These socio-economic and environmental issues in recent times have been a challenge for local authorities to address (Fiji Government,
There has not yet been a fool proof solution formulated by the stakeholders to tackle these issues and the early impacts of climate change have started to aggravate the problems.

As global climate is changing, its effect is being felt throughout the Pacific region including Fiji. Based on an analysis of observed data for high and low rainfall extremes, Hay (2003) argued that annual extremes have increased in recent decades in both frequency and magnitude in Fiji. In the past 37 years (1970-2007), Fiji reported 124 natural hazards of which tropical cyclones accounted for 50 per cent, floods (33%), earthquakes (8%) and tsunamis and drought constituted 5% (Lal et al., 2009). These events caused the country to incur an estimated loss of US$532m, whereby cyclones were the major contributing factor. Accordingly the 1997-1998 drought events resulted in F$104m loss in earnings for the sugar industry while in other agriculture sectors; revenue loss was F$15m (WWF, 2003).

A study based specifically on tropical cyclones asserted that between 1970 and 1997, a total of 37 cyclones traversed Fiji waters, an average of 13.7 cyclones per decade, which on a geomorphologic timescale is a frequent occurrence (Terry and Raj, 1999). In an assessment demonstrating the link between natural disasters and poverty in Fiji, Lal et al (2009) argued otherwise asserting that while the number of climatic events (cyclones and storms) does not show a significant upward trend, the incidence of flooding events has increased, particularly in Fiji since mid-1987. In terms of a single event, cyclone Kina in 1993 and Cyclone Ami in 2006 affected most parts of Fiji and were highly destructive. According to Terry et al (2004), Cyclone Ami which severely impacted Vanua Levu Island in Fiji tragically caused 17 fatalities and extensive damage to farms, infrastructure, homes, and commercial property.

The most recent extreme weather event in Fiji was in January 2009, and was peculiar as it was not tropical cyclone originated. Based on an IUCN assessment of the 2009 floods it is evident that the floods resulted from a confluence of forces being high precipitation rate, two consecutive depression zones and associated rainfall over a short period of time, intense rain coinciding with high tides - interacting together with the geographic characteristics of the various catchment areas (Lal et al., 2009). This period of excessive rainfall caused low-lying areas in the country to be underwater for several days. Overflowing of the Nadi (Fig 3.3), Ba (Fig 3.4), Sigatoka, Navua, and Rewa Rivers caused widespread damage in the respective
localities. Suva City (fig 3.5) also got affected. The sugar belt alone sustained a total economic loss of F$24m.

Figure 3.2: Aerial view of Nadi town, on the western side of Viti Levu during the January 2009 floods. Figure 3.3: Flood waters in Ba town during the 2009 flood. Photos courtesy of Fiji village.com (2009).

Figure 3.4: Flooding of Suva Street during the January 2009 flood. Photo courtesy of FijiVillage.com (2009)
3.3.2. Future Risk scenarios

In discussing the level of exposure of Fiji to climate change, Tompkins et al (2005) showed that judging from the existing hazards and current social, economic and environmental conditions, Fiji is moderately to highly vulnerable to changes in climate. With about 86% of the 750 km coast of Viti Levu Island being less than 5 m above sea level (Tompkins et al., 2005), these areas are at risk from the impacts of tropical-cyclone generated winds and storm surges (Porter, 1994). Large areas of Fiji’s coast are already severely eroded and inundated (World Bank, 2000; WWF, 2003).

The already challenged environmental and economic situation of Fiji is expected to be exacerbated as climate change accelerates. Projections of systematic changes in the average global climate imply significant changes in the future climate of Fiji. These include higher temperatures, higher sea levels, more intense tropical-cyclone activity with storm surges and winds, and a change in precipitation patterns as a result of more regular ENSO events (PICCAP and Fiji Islands, 2005).

The coastal zone, the most densely inhabited parts of Fiji, which is already under pressure due to unsustainable use by communities and recent climate change, will suffer the most from future climate change and variability. The effect of more tropical cyclones and storm surges is likely to exacerbate coastal erosion and inundation. Increased coral bleaching and exposure of beaches to wave action will have economic repercussions in relation to Fiji’s tourism industry (Gravelle and Mimura, 2008) and create a situation of increasing food insecurity. Impact on coral health due to rising temperatures and sea-level rise will affect Fiji’s natural defence mechanism, the fringing and barrier reefs, and increase vulnerability of coastal flats to sea-surges and events like tsunamis.

According to a World Bank (2000) assessment of impacts of climate change on Viti Levu, coastal erosion may claim 2-4% of the land below 10 m altitude by 2050. By 2100, total land eroded could reach 5-10%. Given new scenarios of sea-level rise, which project increases as much as $1.2 \pm 0.5$m by 2100 (Rahmstorf et al., 2007; International Alliance of Research Universities, 2009), the total amount of land claimed by erosion would most probably be more than the 5-10% estimated earlier by the World Bank.
Likewise, rainfall variations projected for the future are expected to strain the current food and water demand of Fiji further (Fig 3.7). During El Niño years, a warmer and possibly drier climate could lead to intense droughts which could result in a 9% average drop in sugarcane production levels, and associated losses averaging US$13.7 m a year by 2050 (World Bank, 2000). The country is currently in an El Niño stage which is forecasted to decrease precipitation and strain water resources in Fiji. Although the Fiji Meteorological Service has on a number of occasions issued warnings for the state and the public, no major risk management strategy is in place. Most of the local communities still do not know or understand the risks associated with such phenomena.

![Diagram showing the impacts of climate change on agriculture](image)

**Figure 3.7**: Likely impacts of climate change on agriculture on Viti Levu Island, Fiji. Modified by the author from World Bank report (2003) to depict future risk scenarios for Fiji.

With projected intensified tropical cyclones in the region (Levinson, 2005), precipitation is likely to increase. This would intensify the magnitude and frequency of floods which towns and cities in Fiji currently face and thus intensify the risk for susceptible communities. With a majority of the poorer people engaged in the primary sectors, future climate extremes and variability will impact livelihoods greatly if effective adaptation options are not implemented.

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Taro\(^1\) (*Colocasia esculenta*) is a tropical plant grown primarily for its edible corm and leaf. It is a staple in Pacific Island countries.

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\(^1\)Taro
3.4. Environment policy and decision making

The governance structure in Fiji is threefold, this being central, provincial and local. The central authority has ministries which have their respective roles and responsibilities. A number of ministries oversee activities relating to the environment. The Department of Environment has the central responsibility for developing programs and policies related to environmental issues in Fiji. Other ministries which are in some way involved in dealing with environment management and protection include agriculture, fisheries, forestry, lands, mining and energy. Provincial councils are government-appointed units in charge of looking after the respective provinces (14 altogether in Fiji). Local governments or municipalities are responsible for looking after towns and cities in Fiji.

Irrespective of specific challenges, the Ministry of Environment, in partnership with other government ministries and departments, NGOs and donor agencies has implemented various environment programmes throughout Fiji. But how sufficient and effective government outreach has been is questionable, especially with respect to an issue like climate change. The argument by Lasco et al (2009), that mainstreaming of climate change adaptation in most developing countries is limited although most of these countries are signatories and active participants to multilateral environmental development agreements applies to Fiji. In a paper on environmental management in Fiji, Turnbull (2004) argued that socio-political and cultural factors influence environmental policy making in the country. The author found that although environmental planning and Environment Impact Assessments are present in state-managed development in Fiji, there is virtually no recognition of the concept of encouraged public participation in environmental management. This causes the widespread failure of implementation of environmental planning.

Government outreach to its community on environmental issues like climate change is limited in Fiji (Nunn, 2009). More action is seen on paper with limited action on the ground involving the local communities. The biggest challenge is getting policy makers in Fiji to understand that working with local communities is essential. Working with vulnerable communities will open up new avenues of tackling the issue of climate change, in terms of successful adaptation, as a better understanding of the people’s perception will be known.
3.5. The Case study area

The case study area for this research is the Rewa Delta, in South-East Viti Levu Island. The sample sites are Nausori town and Vutia village. The Rewa is the largest fluvial system in Fiji. It originates from Fiji’s peak at Tomaniivi and has a catchment area of 2920km$^2$. It is formed from the convergence of the Wainibuka and Wainimala rivers and is fed by two other major tributaries, the Waidina and Waimanu. Being located on the windward side of Viti Levu, this area receives an annual rainfall of 5000-7000 mm. Monthly mean temperature varies from 22-27°C. The Rewa delta area is mainly composed of alluvial deposits, fertile and well-drained, supporting diverse vegetation.

Nausori town is a farming centre physically located on the banks of the Rewa River (Fig 3.8). It is 19 km North-East of the capital city of Suva, on flat delta land. According to Bryce (2010), Nausori was declared a town in 1931. The town is historic in the sense that it had the first sugar mill in Fiji which was established in 1881 by Colonial Sugar Refining Company of Australia. Over the years, Nausori has come to be known for many things including Nausori airport, Syria Park, Ratu Cakobau Park, and the Rewa Bridge.

Figure 3.8: Map of Viti Levu Island showing the location of Nausori town and the Rewa Delta. Source: Google Earth 2009.
Today the population if Nausori town stands at 24,630 making it the third most populous municipality in Fiji. It also identified Nausori, as the fastest growing urban centre during the 1996-2007, period with an annual average growth rate of 7.1% (Fiji Islands Bureau of Statistics, 2008). The major businesses operating in the town include supermarkets, a vegetable market, restaurants, small businesses, service stations, and taxi operators. Nausori was incorporated as a town in 1931, and is governed by the Nausori municipal council. Currently (2009) a special administrator is in charge of the functions of the town council. The council controls the running of the town overseeing development, town rates, traffic, infrastructure, environment and health issues.

The river banks in the delta are occupied by many traditional Fijian villages. The Vutia tikina\(^2\) (Fig 3.9) is one of them. Vutia is the collective name given to the villages of Muanaicake, Muanaira and Laucala Island. While the first two are on the same contiguous piece of land, the other (Laucala) is a separate island in itself. It is used as an agricultural area by the villagers.

Figure 3.9: Map showing the location of Vutia in the Rewa Delta. The red arrows show Muanaicake and Muanaira where interviews were done while the blue arrow shows Laucala Island which is part of Vutia and mainly used for agricultural purpose. Scanned topographic map courtesy of Fiji Lands and Information System (FLIS)

\(^2\)Tikina is the general term given to a number of villages which combine to form a district in a Fijian society.
Since the majority of people of Vutia reside in the first two villages, they were the prime focus of this study. For the purpose of this study, the case study site is referred to as Vutia. The approximate total number of households in Vutia is estimated to be 300. The traditional chief is the head of the village and with the turaga-ni-koro\(^3\) controls the daily operations of the village. Vutia has a school, a community hall, a church and a health station. Most houses are concrete, tin and wood with electricity and piped water (since 2008). Since there is no road access to Vutia, the mode of transport for the people of Vutia is boat, commonly referred to as water taxis.

Located along the bank of the Rewa River, most villages rely on the river as a daily source of food and income. With the sea nearby, villagers rely on marine food as well. Agricultural and plantation production including Yaqona\(^4\), taro, sweet potato, banana, citrus and other vegetables are economic outputs of the Rewa Delta.

The Rewa Provincial Council, which governs the whole Rewa province, is responsible for looking after Vutia. The Council was established in 1874 and is headed by the Roko Tui, a civil servant appointed by the Fijian Affairs Board. The Council is responsible for hearing grievances of the local people and providing possible solutions. The Roko Tui serves the same purpose as a mayor or administrator as in Nausori. Both the urban and rural authorities are responsible for the looking after of their area. The local authorities report to the ministry of local government on issues facing the people needing government intervention.

The issue of floods has always been a concern for local authorities in the area. Due to the location of both sites beside the Rewa River, floods have always been a risk to businesses and residents in the past. Cyclone Kina in 1993 caused massive destruction in the area. Figure 3.10 shows the flood waters during the cyclone in the Rewa River.

\(^{3}\)Turaga-ni-koro is a village headmen appointed by the villagers and is responsible for looking after the village and also acts the mediator between the provincial council and the village.

\(^{4}\)Yaqona (kava) drinking is a tradition in the village and is consumed in the evenings by men of the village.
Two recent devastating floods occurred in 2009 in the area, one in January due to a tropical depression and the other in December due to tropical cyclone Mick (Fig 3.11-3.14). Some pictures taken during the December 2009 floods show the extent of damage it caused. Some houses beside the river bank were under water for more than a day.

Figure 3.10: Flood waters in The Rewa River during Cyclone Kina in 1993.

Figure 3.11: Flood waters during December 2009 floods in Nausori

Figure 3.12: Syria Park, Nausori underwater in December 2009 floods
Due to its location and elevation, less than 2m above high tide level, the Rewa Delta is particularly vulnerable to flooding and future sea-level rise. Due to a large discharge of freshwater and sediments, the barrier and back reef lagoon fronting the Rewa River has several reef openings and with no fringing coral reefs. This allows significant wave energy to enter the lagoon, especially during storm surges.

The environment of the Rewa Delta is fragile and vulnerable like any other Pacific island environment. Changes relating to the environment have always impacted the livelihoods of people in the area. With recent climate change projections, the impacts of these issues are likely to intensify in the future. According to Terry et al (2002) climatic change in the tropical South Pacific region may be associated with greater tropical cyclone intensities, which will probably increase the size of floods in the Rewa Basin in the future.

The question is whether people in this community or any other Pacific Island community for that matter realize the future implications of the climate change phenomenon. To answer this question and to see the nature of changes which have already occurred and impacting the lives of the people of the Rewa Delta, this study is important. It will reveal the shortfalls in environment management policies of the country from the people’s perspective which can help decision makers in future policy planning appropriately.
CHAPTER 4

METHODOLOGY
4.1. Introduction
This chapter outlines the research methods used in the compilation of this research project. First, a general overview of quantitative and qualitative research approaches is taken. This is followed by a breakdown of various research methods used in data collection and a description of the methods used for data analysis. Finally, a general overview of the study is provided in the form of a model followed by a layout of major research constraints.

4.2. Quantitative vs. Qualitative Research Methods
The topic of climate change risk perception has in the past been addressed through several methodologies, both quantitative and qualitative. Quantitative research focuses on measuring variables through statistical analysis on data, which is usually numerical (Thaman and Pene, 2004). This method presents findings in the form of graphs and tables. On the contrary, the qualitative research approach involves a more descriptive form of data presentation. This method is based primarily on case studies, questionnaires, in-depth interviews, focus groups and participant observation.

It is agreed that both research methods make important contributions to research. While quantitative research describes quantity and tests relationships between variables, qualitative research provides information regarding individuals, values, beliefs, understanding and interpretations (Danya Inter, 2002). According to Mack et al. (2005), qualitative research methods are important within applied research as they provide valuable insights into the local perspectives of the population involved.

To achieve the goals and objectives of this study, both qualitative and quantitative methods are used.

4.3. Research Methods
4.3.1. Literature Survey
Extensive review of the literature on the topic was carried out prior to the initiation of data collection. The secondary sources of information mainly composed of archival research. These sources included books, government documents, conference papers, and reports from the University of the South Pacific library from both the general and Pacific collection. The universities online thesis collection was also a useful resource in the compilation of this
project. A wide range of environmental science journal articles were consulted for the review. Most of these were obtained from the on-line databases available on the USP library website. The most helpful databases included Proquest and On-line Access to research in the Environment (OARE). Finally the World Wide Web was utilized to download important reports and articles on the topic. The websites of various NGOs, both regional and international, were visited to obtain background to the topic.

4.3.2. Case-Study Approach

Since case studies typically examine the interplay of all variables to provide a complete understanding of an event/situation (Colorado State University, 2009), this study used a case study approach. Researchers in the past have presented results using a case study approach on climate change risk perception (Vedwan and Rhoades, 2001; Patt and Grothmann, 2005).

For this research the case study area (Rewa Delta) was chosen keeping several factors in mind. These included: the duration of the project, the location of the area and accessibility to the area. To make the case study possible, various primary research methods for data collection were used, as follows

- **Field Research**

  **Sample site 1 (Nausori):**- upon choosing this location for the study, Google Earth 2007 was used to mark the boundaries of the study area, 1km × 1km (Fig 4.1).

![Figure 4.1: Google image of sample site 1, Nausori](image-url)
A preliminary visit was made to observe the area and to identify key informants for the interview. Key informants identified were then contacted through telephone to explain the purpose of the study and to set-up a convenient date and time for an interview. Several visits were made within a 2-3 week period to the area to collect the research data.

**Sample site 2 (Vutia):** First the Rewa provincial council was visited as it is the governing body of the province. The council was presented with a formal letter of request to allow research to be carried out in one of the villages. With permission granted, first the Roko-Tui-Rewa was interviewed with a pre-set questionnaire. Following this, a boat was hired and a preliminary visit was made down the Rewa Delta. Vutia, being an important part of Rewa and situated in a vulnerable location was chosen as the sample site. Since, Vutia is a traditional Fijian village; an I-sevusevu (Yaqona presentation) was made to the village elders prior to the research (Fig 4.2). Following this, households were sampled and surveys were carried through a 1-2 week period.

![Image of village elders presented with Yaqona during an i-sevusevu ceremony](image)

**Figure 4.2: Village elders presented with Yaqona during an i-sevusevu ceremony**

**4.3.3. Questionnaire Design**

After study sites were chosen, a questionnaire was designed for data collection. Sample questionnaires used in previous studies on the topic were studied carefully before one was designed (Leiserowitz, 2006; Bryan et al., 2008). It was ensured that the questions collected data to answer all aims and objectives of the study. The questionnaire was divided into three parts (Appendix 2). The first part was formulated to collect background data like name, age, race, occupation and duration of stay in area. The second part was designed to ascertain...
informants’ knowledge of climate change information. The participants were asked to identify the principal source of climate change information from a choice of:

- Radio
- Newspaper
- Television
- Community awareness brochures
- Village meetings
- Church
- General conversation with people
- Community climate workshop
- others

The prompts were selected based on the knowledge of common information dissemination media in Fiji. Likewise other closed and open-ended questions were used in this section for data collection on climate change understanding and recent environmental changes in the area. The second portion of the questionnaire contained questions on decision making in the area and the final section had questions on perception of future climate change and adaptation implications.

The questionnaires for both sample sites were kept the same except for a few minor differences. As required by the University’s research ethics procedures, an information sheet and consent form was attached to each questionnaire. Details in the information sheet included brief project description, an invitation to participate in the survey, project procedures, participant’s rights and roles. The interviewee prior to each interview/discussion was asked to read the information and give consent. In cases where the respondent could not read or understand the information sheet, an explanation was done in the vernacular before inviting them to sign the consent.

4.3.4. Interview survey

Firstly, sampling was done to select a smaller portion of the whole population. In Nausori the target audiences were the local council administrators, prominent business owners, a few small business operators, and local residents. It was ensured that a fair distribution is done in terms of ethnic composition of the sample. In Vutia, the target audiences were the village
chief, village headmen, church leader, women groups’ leader, farmers, fishermen, and a few village elders. A breakdown of occupational background of the total sample is given in Figure 4.3. The guideline of having a fair gender balance was also closely adhered to during the survey; a representation of this provided in Figure 4.4. To obtain a result characterizing the whole population the respondents were selected across five age bands, these being 18-30; 31-45; 46-55; 55-70; and a 70+ category; a summary of which is provided in Figure 4.5.
On few occasions snowball sampling (Mack et al., 2005) was used whereby participants who already were interviewed were asked to refer the researcher to other people suitable to participate in the study. For stakeholders a pre-set questionnaire was used for a structured interview. The stakeholders’ questionnaire was designed to ascertain informants’ knowledge on climate change understanding, environmental concerns in the area, decision making and future adaptation. For interviewing residents and business owners who were mainly not fluent in the English language, a semi-structured interview format was used. This allowed informants to expand on topics and use their vernacular to make statements. While the author is fluent in Fiji Hindi, an interpreter was used for translation while interviewing indigenous Fijians. The advantage of using a semi-structured interview provides a framework for analysis while at the same time allowing the respondents to articulate their views and experience in their own words (Featherstone, 2008).

4.3.5 Household surveys

For the traditional village of Vutia an unstructured and informal survey approach was taken. Although there was a pre-set questionnaire this could not be adhered as expected due to communication barriers. As it is disrespectful to interrupt elders speaking, informants were allowed to express views freely on all the things they related the study to. Since indigenous
people have been living in the same environment for a long period their experiences and memories are an important source of information (Mimura, 1999). Keeping this in mind all tradition was obtained through informal conversation and discussions with key informants (Fig. 4.6). During both the interview and overall survey, the author’s own reactions were controlled so that they did not influence the views of the informants. Since recording the data in note form increases bias (Featherstone, 2008), interviews were recorded electronically. This allowed better focus on respondent during the interview.

![Figure 4.6: one of the key informant reading the information sheet during the household survey.](image)

4.4. Methods of Data analysis

4.4.1. Laboratory Analysis

Research pertaining to coastal inundation and flood risk assessment have been done in various regions including Europe, West Africa and Asia for example King and Xu (2008), King and Gemmer (2001), Kumar (2008), and Nichollos and Mimura (1998), which has used GIS and has provided a platform for the development of the methodology.

GIS are computer-based systems used for collection storage, analysis, and communication of geographic data and information. Tools like GIS are a cost effective and useful method in simulating areas of potential inundation for a small country like Fiji (Gravelle and Mimura,
To answer the final aim of this thesis, the Geographic Information System (GIS) laboratory of the University was used.

A digital elevation model (DEM) of Viti Levu Island was used for this study. A DEM is a digital representation of surface topography. The DEM was obtained from Fiji Land and Information System (FLIS), with a cell size of 50m*50m cell size. The sea-level rise scenarios (table 4.1) were initially tried with ArcGIS software. Due to the incompatibility of the MapInfo data into ArcGIS, the software Global Mapper, version 11.01 was used.

Global Mapper is a GIS program with various functionalities. It has the ability to display the most popular raster, elevation, and vector datasets. It converts, edits, prints, and allows you to utilize GIS functionality on your datasets in one low cost and easy to use software package (Digital Data Services, 2005). Once the data was loaded into the program the zoom tool was used to magnify the DEM to Rewa Delta (Fig 4.4).

<table>
<thead>
<tr>
<th>Year</th>
<th>Projected sea-level rise</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>0.4m ± 10cm</td>
</tr>
<tr>
<td>2060</td>
<td>0.8m ± 10cm</td>
</tr>
<tr>
<td>2100</td>
<td>1.2m ± 10cm</td>
</tr>
</tbody>
</table>

Table 4.1: Projected sea-level rise scenarios for the respective years based on Rahmstorf et al (2008) and International Alliance of Research Universities (2009).

To show the scenarios in this map the Global Mapper tools menu was used. The path followed was: Tools> Configure> Vertical options> water level> and the water level was put in. Figure 4.8 shows the configuration tool window used to generate sea-level scenario maps.

Following this, the custom shader was used to shade out individual sea-level rise scenarios in the GIS maps. The path followed was: Custom Shader> Add custom shader> New elevation height> Add> color assigned. Figure 4.9 is copied from the map window to show how this was done. Each scenario was added into the new elevation field (shown with blue arrow). The ‘add’ function was used to select individual colors for each scenario.
Figure 4.7: The DEM of the Rewa Delta zoomed in from the original Viti Levu layer. The black outline depicts the actual area which will be used for GIS analysis.

Fig 4.8: The menu option of the configuration tool used in mapping. The orange arrow shows the new water level mark.

Fig 4.9: Custom shader window showing the function used to generate the GIS maps.
4.4.2. Microsoft Excel

The data obtained through qualitative survey was analyzed quantitatively using Microsoft Excel. This is an electronic spreadsheet program used for storing, organizing and manipulating data. First the spreadsheet was planned based on the purpose, information needed, headings and layout. The Microsoft online help tool was used to familiarize the author with the functioning of the spreadsheet. Following this, all the data obtained during the household surveys was entered into the worksheet cells.

The first stage in the analysis involved an examination of the responses for frequency distribution and rating of important parameters using counts and percentages. Since charts are visually appealing and make it easy for users to see comparison, patterns, and trends in data. Most of the results from this study are presented in detailed charts and graphs in the next chapter. To generate these graphs which are mainly pie and bar-graphs, Excel’s chart wizard (Fig. 4.10) was used.

![Chart Wizard - Step 1 of 4 - Chart Type](image)

**Figure 4.10:** A window copied from the Excel program to show the chart wizard functionality.
4.5. Overall model of study

Background data collection
- Global climate change
  - Nature
  - Impacts
  - Vulnerability
- Climate change in Pacific
  - Nature
  - Impacts
  - Vulnerability
  - Adaptation
  - Risk perception
- Climate change risk perception in Fiji
  - Rewa Delta
  - Nausori
  - Vutia

Local community and stakeholder engagement
- Stakeholder Perception
- Observation
- Interview
- Household Survey
- Community Perception

Data Analysis
- Dialogue Analysis
- Charts and Graphs
- GIS Maps

Conclusions
- Research Findings and Key messages

Figure 4.11: An overall model of the study
4.6. Constraints

While carrying out this research project, some limitations were encountered. It is important that a note of these limitations be made before the results of the study are presented. These constraints include:

- Language barrier--- since many of the respondents were indigenous Fijians, who used the Fijian language, it was difficult for the author to communicate during interviews. This barrier was overcome by hiring a Fijian-speaking research assistant, who acted as a translator between the interviewer and the interviewee.

- Co-operation--- Most people approached were co-operative and willing to participate in the survey except for a few. A lot of time was wasted to identify new respondents for the survey when some initially approached people refused.

- Informal interviews--- the use of informal discussion in the village was quite useful as it helped in the acquisition of the necessary data. This had consequences as interviews took long to complete as people kept on talking and most of the time deviated from the issue of discussion. Since interrupting elders is regarded as disrespectful in the Fijian society, they were allowed to talk even though interviews ran behind schedule.

- Lack of quality data--- for the portion on GIS mapping, poor quality data was a major barrier. A lot of running around had to be done to obtain data for GIS mapping. The best topographic data to show sea-level scenarios is that obtained through the LIDAR (Light Detection and Ranging) remote sensing system. This data is capable of recording elevations at a vertical precision of 15cm, which can be very useful to model sea-level rise scenarios. Unfortunately such data is not available for Fiji, and thus the FLIS data was used which was useful in showing sea-level rise scenarios but it makes the precision of output maps questionable.
CHAPTER 5

RESEARCH FINDINGS
5.1. Introduction
This chapter presents the results and gives their interpretation. The chapter is organized according to the aims and objectives of the study. The first section reports the results of climate change perception at both the study sites. Results have been presented in the form of graphs and tables followed by interpretations. This is followed by the outcome of results on recent environmental changes in the area and environmental decision making. The next section discusses future climate change and adaption results from the study. Finally GIS results for future sea-level rise scenarios are presented.

5.2. Current Environmental Stresses
5.2.1. Sample Site 1: Nausori
To understand how communities affected by global change perceive and understand current environmental stresses and evaluate possible solutions it was important that recent environmental stresses in the area be assessed. Since the locals have been living in the environment for a long time, they were the best people to know about changes in the past. Therefore, each interviewee was asked to identify at least five major environmental issues in the area together with its link to climate change. Table 5.1 is a summary of the outcome of this assessment. Rating in the table is a showing the frequency and percentage of the sample mentioning the issue. The possible causes and the link of the issue to climate change as identified are also summarized in this table.

The outcome (Table 5.1) shows that when asked to identify environmental issues facing their locality, most of the respondents frequently mentioned social issues (population, housing, politics and crime) as a major problem. Squatter settlements; rural-urban drift; increasing population; negligence by council; political situation; lack of education were perceived as causes of the problem by the respondents. Most did not suggest that the issue was linked to climate change.

The second most frequent issue identified was of pollution. The possible causes of the issue were identified as Industrial emission in the area; business waste; vehicles and lack of understanding in people. Most respondents believed the issue was linked to climate change. One did believe there was a link while one of the respondents was not sure.
<table>
<thead>
<tr>
<th>Environmental Issue</th>
<th>Frequency</th>
<th>Possible causes</th>
<th>Link to climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social issues (population, housing, politics, crime)</td>
<td>12</td>
<td>Squatter settlements; rural-urban drift; increasing population; negligence by council; political situation; lack of education</td>
<td>Yes (1); No (10) Not sure (1)</td>
</tr>
<tr>
<td>Pollution (waste management)</td>
<td>9</td>
<td>Industrial emission in area; business waste; vehicles; lack of understanding in people</td>
<td>Yes (2); No (6) Not sure (1)</td>
</tr>
<tr>
<td>Change in rainfall</td>
<td>8</td>
<td>High humidity; changing weather patterns; about 80% could not relate the cause.</td>
<td>Yes (3); No (1) Not sure (4)</td>
</tr>
<tr>
<td>Flooding</td>
<td>7</td>
<td>Heavy rain; flood prone area; drainage problem; natural phenomenon</td>
<td>No (5) Not sure (2)</td>
</tr>
<tr>
<td>Change in temperature</td>
<td>6</td>
<td>Respondents not sure</td>
<td>Yes (3); No (2) Not sure (1)</td>
</tr>
<tr>
<td>Change in water level in Rewa river</td>
<td>3</td>
<td>More rain; sea-level rise; tides</td>
<td>Not sure (3)</td>
</tr>
<tr>
<td>Diseases/ sickness</td>
<td>3</td>
<td>Unhealthy eating; hygiene; people not farming; high food price</td>
<td>Yes (1) No (2)</td>
</tr>
<tr>
<td>Drinking water</td>
<td>1</td>
<td>Shortage of water</td>
<td>No (1)</td>
</tr>
<tr>
<td>Development (construction near waterways)</td>
<td>1</td>
<td>Respondent not sure</td>
<td>Yes (1)</td>
</tr>
<tr>
<td>Deforestation (including mangrove)</td>
<td>1</td>
<td>Clearing land for development</td>
<td>No (1)</td>
</tr>
<tr>
<td>Inundation</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hurricane/ cyclones</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Droughts</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.1: A summary of environmental issues facing Nausori, as identified by the respondents (n=54)

The third major environmental issue identified by the locals was change in rainfall. A few people were able to identify the possible causes of changes in rainfall which they thought was high humidity and changing weather patterns while the majority (about 80%) did not know the cause. Flooding was the next common issue identified by the interviewees. Most of the respondents thought that the issue was caused by heavy rain, drainage problems and a
consequence of their location in a flood-prone area. It was also a common perception that the issue of flooding is not linked to climate change.

Another frequent issue, mentioned by 11% of the respondents, was change in temperature. When asked to explain the possible cause of changes in temperature, none could identify. 3 out of the six respondents did think that there was a link between climate change and changes in temperature while the rest thought otherwise. As shown by table 5.1, some other environmental issues which came up less frequently during the interviews include development, diseases/sickness, change in water level in Rewa River, erosion, de-forestation, drinking water, and terrestrial food availability.

Data in the form of original pictures (Fig 5.1-5.4) are a better representation of some of the environmental issues identified by the respondents in the area. Fig 5.1 and 5.2 show the issue of solid waste management in the area. This waste dump is on the periphery of the town, on the banks of the Rewa River. As shown a large quantity of waste is dumped in this area, which is fully exposed and can be carried away during heavy winds and rain into the river and roads.

Figure 5.1: The environmental issue of solid waste management, identified as a major concern by residents and stakeholders of Nausori.

Figure 5.2: Picture captured on camera to show the mismanagement of solid waste in Nausori, this rubbish dump is situated on the bank of the Rewa River. Although some rubbish is being disposed properly in garbage bags, most are just dumped as they are and are an environmental hazard.
5.2.2. Sample Site 2: Vutia

The results obtained about the nature of recent environmental changes in Vutia are summarized in Table 5.2. The results show that the highest portion of the respondents identified river-bank and shoreline erosion as a major current environmental issue. It came up 13 times during the survey. When asked to identify the possible causes of the increased erosion they are facing, most thought it to be a cause of more high tides, heavy rain, the river, and mangrove cutting. Most perceived the issue not to be linked to climate change (4), while 8 of the 13 were not sure about the linkage.

The next common issues mentioned were pollution and inundation. Both were mentioned 12 times during the survey. The possible causes of pollution identified by the people of Vutia are the Kinoya sewage outfall, pig-pens on the river bank, and ignorance by villagers as they dump waste into the river. All the respondents viewed the issue not to be linked to climate change. For inundation, most (83%) perceived the issue to be extreme and caused by high tides, poor drainage and shallow river mouth. 9 out of the 12 who did mention inundation as a concern, were not sure if the issue was linked to climate change. A low 3 out of 12 did believe that there was a link.
<table>
<thead>
<tr>
<th>Environmental Issue</th>
<th>Frequency</th>
<th>Possible causes</th>
<th>Link to climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion (shoreline/riverbank)</td>
<td>13</td>
<td>More high tides; heavy rain; river; mangrove cutting</td>
<td>Yes (1); No (4); Not sure (8)</td>
</tr>
<tr>
<td>Pollution (waste management)</td>
<td>12</td>
<td>Kinoya sewage; pig pens on river bank (Fig 5.16); ignorance by villagers as they dump waste into river</td>
<td>No (12)</td>
</tr>
<tr>
<td>Inundation (land being covered with water at high tide)</td>
<td>12</td>
<td>Higher than normal tides (king tides); poor drainage; shallow river mouth</td>
<td>Yes (3); Not sure (9)</td>
</tr>
<tr>
<td>Flooding</td>
<td>10</td>
<td>Heavy rain; high tides; poor drainage</td>
<td>No (6); Yes (2); Not sure (2)</td>
</tr>
<tr>
<td>Marine food availability</td>
<td>9</td>
<td>Pollution including sewage discharge; cutting mangrove; dredging; overfishing; fish poison.</td>
<td>No (6); Not sure (3)</td>
</tr>
<tr>
<td>Social issues (population, housing, politics, crime)</td>
<td>8</td>
<td>Growing population; less land; politics; not growing own food; high food price</td>
<td>No (8)</td>
</tr>
<tr>
<td>Change in water level in Rewa river</td>
<td>4</td>
<td>Heavy rain; rubbish dumped into river</td>
<td>No (1); Not sure (3)</td>
</tr>
<tr>
<td>Irregular crop seasonality</td>
<td>4</td>
<td>Change in weather; too much sin (mangoes not growing anymore)</td>
<td>No (1); Not sure (2)</td>
</tr>
<tr>
<td>Change in temperature</td>
<td>3</td>
<td>Change in weather; change in climate</td>
<td>No (1); Not sure (2)</td>
</tr>
<tr>
<td>Terrestrial food availability</td>
<td>3</td>
<td>Too much rain; cyclones and floods; salt water coming into land</td>
<td>Yes (2); Not sure (1)</td>
</tr>
<tr>
<td>De-forestation (including mangrove)</td>
<td>2</td>
<td>For money; for firewood</td>
<td>No (2)</td>
</tr>
<tr>
<td>Hurricane/ cyclones</td>
<td>2</td>
<td>Too much sin on earth</td>
<td>Yes (1); Not sure (1)</td>
</tr>
<tr>
<td>Diseases/ sickness</td>
<td>1</td>
<td>Not proper diet</td>
<td>Yes (1)</td>
</tr>
<tr>
<td>Drinking water</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Droughts</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development (construction near waterways)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in rainfall</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.2- A summary of environmental problems facing Vutia, their perceived causes and links to climate change as identified by the respondents (n=83)
Flooding was the next common environmental concern. The common cause of flooding according to the villagers was heavy rain, high tides and poor drainage. Most (6) believed flooding to be not related to climate change while 2 though it was linked. Another issue identified as a current environmental stress was marine food availability. Most perceived the issue to be caused by pollution, mangrove cutting, dredging, overfishing and duva (fish poison). When asked if the issue was linked in any way to climate change most of the respondents thought that there was no link.

Social issues are rated next with a frequency of 8. The possible causes identified included growing population; less land; politics; not growing own food; and high food price. None of the respondents perceived this issue to be linked to climate change. Other less frequently mentioned but important environmental issues facing the area including irregular crop seasonality, change in water level in Rewa River, change in temperature, hurricane/ cyclones and de-forestation.

Results in the form of original pictures (Fig 5.5-5.13) provide a better view of some environmental issues currently impacting the people of Vutia. The first four figures 5.5-5.8 are showing the issue of inundation in the area. Inundation, the covering of land with water, as shown, is threatening the livelihood of households in Vutia. Figure 5.5 shows the ground near the bathroom of a household at low-tide. Although the ground is not covered with water it is swampy and muddy. According to the family when this house was built some 30 years ago, this ground was always dry and until recently it has started to fill up with water (Fig 5.8) causing the land underneath the building to wash away. The drain through the village overflows every time there is a high tide, releasing brackish water onto village yards and farms.
Fig 5.5 (left): Picture showing the effects of inundation.
Fig 5.6 (right): Picture showing damage to infrastructure as a result of inundation and soil erosion.

Inundation has caused soil from beneath this infrastructure to wash away. This land which used to be dry, is swammy now.

Figure 5.7 and 5.8: Pictures showing the effects of inundation in Vutia. These pictures were taken during high tide.
Figure 5.9 (left): Land erosion in Vutia, as seen inundation is causing washing of soil making the land muddy and swampy.

Figure 5.10 (right): Picture showing erosion of river bank in Vutia

Figure 5.11: Pig pens situated along the river bank in the mangrove area. Owners see no harm in this saying that it is a convenient approach as the water washes all the waste away.
5.4. Environmental Decision Making in Nausori

Research on environmental decision-making in the study area showed that for an urban community like Nausori, the central authority controlling the operations of the town is the Nausori Town Council. The council oversees development and running of the town and deals with any issues facing the municipality. As shown (Fig 5.14), the functional structure of the council is divided into three sections. The administrator is the highest authority and looks
after the running of the finance, field, rate, health and planning, and library departments. There is not a separate department for environment, but issues related to environment are handled by health and planning.

With a lot of businesses and residents in this urban centre, business owners were asked to identify the process they follow to voice grievances. Figure 5.15 has summarized the process of decision-making. An issue facing the community is first raised with the advisory councilor (a government elected person) who then reports the matter to the municipal council. A business owner usually reports the issue to the local chamber of commerce, which is than raised to the municipal council and if need reported to the central government.

![Organizational Structure of the Nausori Town Council](image1)

**Figure 5.14:** The organizational structure of the Nausori town council.

![Hierarchy of Decision-Making](image2)

**Figure 5.15:** The hierarchy of decision-making in an urban centre like Nausori from lowest to highest.
The results obtained through one-to-one interviews with local decision makers in Nausori show that only few environmental issues like flooding and pollution have been responded to by the council. For flooding, upgrading of drainage within the area and dredging of the Rewa River have been done. For the issue of pollution, the planners have tried to create awareness and trying to implement the litter decree and the national litter promulgation.

According to informants, the implementation of current local and national environment laws in the community is ineffective. The council has not taken any step to raise awareness on environmental issues and future climate change in the locality. It feels that it is the responsibility of the government of the day to address the issue of climate change. It is believed that community-level participation is important in environmental decision making. Some barriers identified for implementing adaptative measures for climate change include, shortage of manpower, less expertise in the area of environment management, finance, and lack of awareness.

5.4. Environmental Decision Making in Vutia

Like, any traditional Fijian village, Vutia has a social hierarchical structure (Fig 5.16). The chief holds the highest rank in the village. The leaders of each clan/ mataqali rank below the chief. The Turaga-ni-koro, commonly known as the headman (mayor) is a government representative, ranks next and is responsible for the functioning of the village. Village elders rank below the Turaga-ni-koro, followed by the common villagers.

![Hierarchical structure of decision-making in Vutia](image)

Figure 5.16: Hierarchical structure of decision-making in Vutia
Since environmental decision-making is important in an understanding of climate-change risk perception, informants were asked to identify the decision-making process in the village. Based on the data obtained, a flowchart (Figure 5.17) was produced. Decision-making to issues in the village usually follow the following trend.

According to the results, environmental concerns facing the village are raised to the committee. This is a general committee looking after all kinds of issues as the village does not have an environment committee. This is taken up to the village meeting which is held every month. Every villager is allowed to attend the meeting but it is the elderly men who make decisions. Issues which are in the capacity of the village council are addressed in these meetings and concerns which need external assistance are put forward to the provincial council. This is done through the Turaga-ni-koro, who attends provincial meetings once every three months. The provincial council addresses issues which are in its capacity to solve while for major issues a report is made to the respective government ministries. The onus is then on the government to respond to grievances and provide aid accordingly.

Results from interviews with local decision makers in charge of Vutia, show that national rules and regulations for the environment are ineffective in a rural community like Rewa as most lack enforcement. According to the results in the past, the council has provided assistance to villagers in the form of water tanks, river bed protective structures and dredging in conjunction with the central government. External assistance in the past was provided by South Pacific Regional Environment Program (SPREP) in implementing the International Waters Project in parts of Rewa, Latter-day Saints (LDS) church in donating water tanks, and Vodafone (mobile phone Company) funding for cyclone recovery some years ago.
Government assistance is minimal with most of the time assistance coming only once the damage is done.

The council feels that the community of Rewa does not regard the issue of climate change seriously. Although the council feels that the lack of awareness amongst people is a major barrier to implementing adaptive measures for current and future climate change, it has not initiated any awareness raising program about the issue.

Figure 5.18 (left) and 5.19 (right): Pictures of water tanks seen in Vutia. These are through a joint initiative of villagers, provincial council, and the LDS church.
5.5. GIS Mapping

5.5.1. Future sea-level rise scenarios for the Rewa Delta

The results of analysis of the Digital Elevation Model (DEM) of Rewa Delta depict the risk of future sea-level rise. The first map which is part of a scanned topographic map of eastern Viti Levu (Fig. 5.20) is presented to provide a better picture of the study area. The portion marked by the black box is the case study area used for the GIS analysis.

Figure 5.20: Scanned topographic map showing the area used for GIS analysis outlined by black box.

A DEM, a digital elevation representation of the Rewa Delta is inserted (Fig 5.21), to show the area in the being used for GIS analysis. This map has been simplified as much as possible for the reader with elevation and distance scales, orientation, digitization and label of essential features. The two important areas for this study, Vutia (in yellow) and Nausori (in pink) have been marked on the map. The coastline which is the 0m elevation and is the current mean sea level has been digitized as a point feature in red in Fig.21. The DEM layer representing sand covered reefs below sea level is also labeled (in purple in Fig. 5.21).
Figure 5.21: A DEM showing the Rewa study area. The black outline shows the actual portion which will be used from here onwards for GIS analysis. The coastline is digitized in red, the approximate location of Vutia village is marked in yellow and Nausori in pink. The purple coloured layer, which will be continuously appearing in GIS map output is a DEM layer less than 0m, which is mainly sand covered reef.

The results obtained following GIS analysis of part of the DEM in Fig 5.21, under the three sea-level rise scenarios are presented in figures 5.22-5.25. These set of maps have been produced based on international sea-level rise scenarios by 2100, which are 0.4m by 2030, 0.8m by 2060, and 1.2m by 2100. The first map (Fig 5.22) depicts the current situation in the area. It is a digital representation of the mean sea level of 0 meters. Increasing the water-level by 0.4m, which is projected for 2030, produced the map as in Fig.5.23. Under a sea-level rise scenario of 0.8m, by 2060, (Fig. 5.24), the areas at risk increase further. Finally with a worst case scenario of sea levels rising by 1.2m, by 2100, is depicted by figure 5.25. The results show that under each scenario the coastline (shown earlier in red) is retreating causing at risks areas to increase.
Fig. 5.22: Present situation in the Rewa delta area, mean sea-level = 0m

Fig. 5.23: Median projection sea-level rise [0.4m] high risk areas

Fig. 5.24: High projection sea-level rise [0.8m] high risk areas

Fig. 5.25: High projection sea-level rise [1.2m] high risk areas
Results obtained using colour-shader pointing out the three sea level scenarios are shown in Fig. 5.26-5.28. In the first map (Fig. 5.26), colour green is used to shade out the high risk areas with a future sea-level rise of 0.4m by 2030. In figure 5.27, orange has been used to point high risk areas by the year 2060, when sea-level is expected to rise by 0.8m. Finally Figure 5.28 is showing high risk areas in the Rewa Delta under a 1.2m sea-level rise scenario by 2100. Arrows have been used in each map to show the high risk areas under each scenario. The layer below this is the below 0m sand covered reefs, as shown earlier.
The following figure (5.29) was produced by merging the three individual three sea-level rise scenarios shown in earlier maps. This map shows the total effect of sea-level rise in the Rewa Delta by 2100. The approximate location of Vutia is depicted by the yellow solid shade and Nausori by the pink solid shade.
When interpreting the overall GIS maps it is evident that the Rewa Delta will come under increasing stress in future as a result of sea-level rise. The coastal community of Vutia will especially be at risk from continuous inundation and sea flooding. As the coastline continues to retreat through 2100, massive land loss is expected in the area. Continuous inundation will affect agriculture and water resources severely. The marine ecosystem is also likely to be stressed as sea-levels rise. Damage of these systems will affect human livelihoods adversely as most of the people in the area are dependent upon these resources.

According to the maps obtained the community of Nausori will not be under direct threat from sea-level rise. It will be affected indirectly in terms of more freshwater flooding. Freshwater flooding which already is an issue in the area will worsen in the future. Sea-level rise is expected to shorten the length of the Rewa River which means that the incidence of flooding in the Nausori area will be high especially during prolonged periods of rain in the future. This poses serious risk to people and infrastructure for the area in future.
5.6. Perception of the local community to climate change

5.6.1. Sample site 1: Nausori

One of the very first questions in accessing the perception of the public to the changes in climate was: Have they heard or come across information on climate change and the source of the information. Based on the interviews, statistical analysis was performed on the data and the following graph was generated.

![Graph showing percentage (%) of respondents in Nausori town, who have heard or come across information on climate change (number of responses (n) =32).](image)

According to the results (Fig. 5.30), a majority of the informants in sample site 1 have heard or come across information on climate change (87%). The most common principal source of the information for the people was the mass media, with 31% having heard about climate change from the radio, 25% from newspapers and 22% through television. A low 4% have heard about it from prayer meetings and another 5% had heard about it through general conversation with people, making a total of 9%.

To access the perception of the causes of climate change, a list of close-ended options were provided for the respondents to see and identify what they thought to be the possible cause. The data obtained was analyzed to produce Figure 5.31, which is a
representation of the perceived cause of climate change by the people of Nausori. Based on the outcomes it is obvious that God’s/divine will (45%) is perceived as the major cause of climate change. 37% of the respondents believed increases in industrial emission to be the cause, while 15% attributed it to deforestation. A final 3% of the sample did not know what the cause of climate change was.

To access the understanding of the respondents to climate change, they were asked to define or tell something about the terms ‘climate change’, ‘global warming’ and ‘sea-level rise’. The results were then compared with expert definition of the terms which is summarized in the following Table (5.3).

The results for the first term show that most respondents (85%) understood something about climate change. Having evaluated the responses it was seen that most of these informants were confused and incorrectly matched climate change. 33 out of the 87% who knew about climate change matched it with changing weather patterns, 13% with ozone layer, 20% with floods, 7% with growing world population and migration and 13%
thought that climate change is something good. The other 15% of the respondents had no idea of what climate change was.

<table>
<thead>
<tr>
<th>Definition</th>
<th>Expert definition</th>
<th>Average % correct matching</th>
<th>Most commonly matched with</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change</td>
<td>Change in global weather patterns: long-term alteration in global weather patterns especially increases in temperature and storm activity, regarded as a potential consequence of the greenhouse effect (Encarta, 2009).</td>
<td>15% of the respondents had no idea on what climate change was. 85% showed some understanding of the topic.</td>
<td>-changing weather patterns (33%) -Ozone layer (13%) -floods (20%) -Growing world population and migration (7%) -saying changes are good (13%)</td>
</tr>
<tr>
<td>Global Warming</td>
<td>Global warming is an average increase in the Earth’s temperature, which can contribute to changes in global climate patterns (US EPA, 2008).</td>
<td>38% of the respondents had no idea on what the term meant. 62% showed some appreciation of the term, 8% of which matched expert definition.</td>
<td>-pollution (8%) -Ice-melting (23%) -natural disasters (8%) -ozone layer (8%) -global crisis and warfare (15%)</td>
</tr>
<tr>
<td>Sea-Level Rise</td>
<td>An increase in the mean sea level from the melting of land-based snow and ice, and changes in water density from an increase in ocean water temperature (IPCC, 2007b: 86).</td>
<td>38% had no idea on what the term meant. 62% of the respondents showed some appreciation of the term, 39% of which matched expert definition.</td>
<td>-Rewa river and cyclone Kina flood (8%) -water level rising due to ice-berg melting (39%) -situation of Kiribati (8%)</td>
</tr>
</tbody>
</table>

Table: 5.3. Summary of the understanding of climate change related terms amongst residents and business owners of Sample site 1.

After evaluating the response obtained for the term ‘global warming’ it was seen that while 62% of the respondents showed appreciation of the term, 38% had no idea on
what the term meant. It was also interesting to note that 8% of the respondents described global warming along similar lines to expert definition. The term was most commonly matched with pollution, ice-melting, natural disasters, ozone layer, global crisis and warfare. The results for the term ‘sea-level rise’ show that most of the respondents (62%) knew about the term, 39% even matched expert definition. The other 38% had no idea on what the term meant. Sea-level rise was seen to be most commonly matched with the Rewa River, cyclones, floods, icebergs, and the situation in Kiribati.

5.2.2. Sample Site 2: Vutia
To access the extent to which perceptions of climate change vary amongst the two sites, a similar analysis was performed on the data obtained from the Vutia household surveys. The following graph (Fig. 5.32) depicts the results obtained through the analysis of data on climate change knowledge and causes.

The results show that almost half of the population sampled had not heard about climate change. The other half claimed to know about climate change with the most common source of information being television (22%) and radio (19%). The rest had heard about climate change through other sources including newspapers, church and through general conversation with people.

The major cause of climate change as shown in figure 5.33, through close-ended questions was identified to be divine/god’s will, which 55% of the respondents believed to be the cause. Increase in greenhouse gas emissions was believed to be the cause by 28% of the population while 17% of the population attributed de-forestation to be the cause.
To access the perception of some climate related terms like ‘climate change’ ‘global warming’ and ‘sea-level rise’ respondents in Vutia were asked to describe their understanding of these terms. The data obtained was than summarized and compared with expert definition (table 5.4). This table has been used to categorize the responses of the sample population matching it with the expected description and picking out
commonly matched answers. In some cases respondents who had not heard about climate change at all opted to describe it from their own understanding.

According to the results, 53% of the sample showed some understanding of the term climate change. This was seen to be most commonly matched with changing weather patterns, big waves and the level of the village. On the other hand, 47% could not relate climate change in their own words and thus no answers were recorded. For the term global warming, a majority of the respondents (80%) did not understand anything. Only a low 20% showed appreciation of the term and most commonly matched it with water level in Rewa River, cool-dry season and weather.

<table>
<thead>
<tr>
<th>Definition</th>
<th>Expert definition</th>
<th>Average % correct matching</th>
<th>Most commonly matched with</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change</td>
<td>Change in global weather patterns: long-term alteration in global weather patterns especially increases in temperature and storm activity, regarded as a potential consequence of the greenhouse effect (Encarta, 2009).</td>
<td>47% of the respondents had no idea on what climate change was. 53% showed some understanding of the topic.</td>
<td>-Change in seasonal weather pattern (20%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-big waves coming into land (7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-The level of the village (7%)</td>
</tr>
<tr>
<td>Global Warming</td>
<td>Global warming is an average increase in the Earth's temperature, which can contribute to changes in global climate patterns (US EPA, 2008).</td>
<td>80% of the respondents had no idea on what the term meant. 20% showed significant appreciation of the term.</td>
<td>-cool dry season these days (7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-hot weather (7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-water level going up (7%)</td>
</tr>
</tbody>
</table>
When asked to describe their understanding of sea-level rise, 53% of the respondents in Vutia did not have any idea on what the term meant. 47% of the respondents were familiar with the term most commonly matching it with iceberg melting, tidal waves, high and low tides, and floods.

### 5.7. Belief on nature of future climate change

In investigating the perception of the likely trend of climate change in the area over the next 50-100 years, a close ended approach was used. Each respondent was required to identify the changes as one of these: changes will be minimal, changes more severe in the future, no changes, I don’t know. Based on the data obtained a bar graph was generated which merged the results for both sample sites which has made it easier to relate the variations in perception.

The results (fig. 5.34) show that most respondents perceived changes to be more severe in the future. More of the informants in Vutia perceived it to be severe (87%) than in Nausori (62%). (23%) in Nausori, thought changes will be minimal. 8% of the sample in Nausori perceived no changes for the future. Finally 13% in Vutia and 8% in Nausori did not know how likely trend of future changes would be.
5.8. Stakeholder participation

To gauge the opinions of planners and community decision-makers to climate change, they were asked to identify issues which they thought were a concern for their community and in need of urgent action and priority by government. The following table (5.5) summarizes the high and low concern issues for the two localities.

The planners in Nausori perceived pollution, development, erosion, and social issues to be a major concern. On the contrary, planners in charge of Vutia, identified erosion, inundation, drinking water, rainfall and floods as major environmental ills. Climate change as an issue was not identified at either site.
<table>
<thead>
<tr>
<th>Environmental issue: Nausori</th>
<th>Environmental Issue: Vutia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution (solid and liquid waste management)</td>
<td>Erosion (river bank)</td>
</tr>
<tr>
<td>Development (near waterways)</td>
<td>Inundation</td>
</tr>
<tr>
<td>Erosion (river bank)</td>
<td>Drinking water</td>
</tr>
<tr>
<td>Social issues (population, housing, poverty)</td>
<td>Change in rainfall</td>
</tr>
<tr>
<td>Flooding</td>
<td>Flooding</td>
</tr>
<tr>
<td>Drinking water</td>
<td>Unsustainable resource use</td>
</tr>
<tr>
<td>Sickness and diseases</td>
<td>De-forestation</td>
</tr>
<tr>
<td></td>
<td>Pollution</td>
</tr>
<tr>
<td></td>
<td>Social issue (population, housing, poverty)</td>
</tr>
</tbody>
</table>

Table 5.5: A summary of environmental issues and their level of concern as identified by stakeholders in the two sample sites.

5.9. Anticipated Future Climate Changes in Nausori

To identify perceptions of future climate risks, the respondents were asked to identify changes in climate they expect for the future. The results for Nausori (Fig 5.35) show that actual changes that climate change is expected to bring are unknown to most of the people in the area. A large percentage of the population (31%) was not sure that any future change would occur while 8% did not anticipate any changes. 6% of the sample thought changes will be good and another 6% could not relate future changes because for them it was difficult to judge. Another 6% each anticipated more land issues and higher food prices. It was interesting to note that 12% of the sample anticipated both more floods and cyclones in the future.
To understand the link between climate change risk perception and future adaptation, respondents were asked to identify common responses to the anticipated future changes. Based on the data obtained, Table 5.6 was created. This table summarizes the anticipated changes for the future together with the common responses being taken.

According to the results for changes in cyclone and flood frequency, no preparation was seen at individual level but some business owners identified offshore insurance as a possible future strategy. Informants who identified land-lease problems as a future issue were planning to visit government officials for assistance. It was interesting to note that this percentage of respondents thought climate change to be a manageable issue. They perceived it as an issue of no major concern and they could handle it in the future and there was no urgent need to prepare.

For high food prices, the response planned was to do more backyard farming. The other portion of the population who, did not anticipate any changes for the future or those who did not know about future changes were not preparing in any way. Most of
these people were seen not to perceive climate change seriously and left things to god.

<table>
<thead>
<tr>
<th>Anticipated changes</th>
<th>Common Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>More cyclones and floods</td>
<td>Not preparing individually but as a business community thinking of taking offshore insurance for future tropical cyclones and floods.</td>
</tr>
<tr>
<td>More land lease problem</td>
<td>Thinking of going to government officials about land lease. Feels that climate change is not an issue and can be managed.</td>
</tr>
<tr>
<td>High food price</td>
<td>Own planting in backyard</td>
</tr>
<tr>
<td>Changes will be good</td>
<td>Feels that whatever happens has to be accepted.</td>
</tr>
<tr>
<td>Difficult to judge</td>
<td>Not preparing</td>
</tr>
<tr>
<td></td>
<td>Since cannot predict future not much can be done</td>
</tr>
<tr>
<td>Not sure</td>
<td>Not preparing</td>
</tr>
<tr>
<td></td>
<td>Changes in climate is not a very serious issue</td>
</tr>
<tr>
<td></td>
<td>Praying to god</td>
</tr>
<tr>
<td>I don’t know</td>
<td>Not preparing</td>
</tr>
</tbody>
</table>

Table 5.6: Preparation/ adaptation to anticipated changes in future by residents and business owners of Nausori. A summary of the changes respondents expect for the future to be a result of climate change and the consequent responses to these changes.

The barriers to future climate change adaptation in Nausori, identified by the informants are summarized in figure 5.36. According to the results, the majority of the people (46%) who were seen not do be making any adjustments for future had no problems. 15% of the sample did not opt to mention the problems they were facing in adapting to future climate change. 23% viewed lack of information/ knowledge as a major problem while 8% thought lack of resources to make changes and build adaptive capacity was a barrier.
5.10. Anticipated Future Climate Changes in Vutia

As for sample area 1, respondents in Vutia were asked for their perception on future climate change. The data obtained is summarized in figure 5.37. According to Fig. 5.37, most of the people in Vutia were not sure about future climate change (33%). 7% responded to the question saying they did not know about changes to come while another 7% did not anticipate any changes. 15% of the sample identified more water coming onto land (inundation) as a likely change in future. Sea-level rise was perceived as a likely future change by 10% of the population. Other changes identified during the survey by 5% each of the sample are more land for agriculture and housing, more soil erosion, more rain and changes in weather pattern.
The following table (5.7) is a summary of the data obtained on responses to the perceived risk which informants in Vutia anticipate for the future. According to the results, for the issue of more future inundation, villagers have raised the floor of houses for now. Some feel that nothing can be done about this issue and that they just have to live with any changes. For the issue of future sea-level rise, one informant was thinking of moving to Namosi, in the highlands of Viti Levu. Another common response was that they are waiting for changes to happen and then they will decide what to do.

For the anticipated change in weather patterns, nothing is being done currently as an adaptation response. Respondents who anticipate more rain for the future plan to plant more. For the likely increase in soil erosion in future, one informant has planned to re-locate if land is provided while the others have tried to stop erosion by using some traditional techniques like putting sticks in a pattern on the river bank and filling the area behind with bio-degradable matter to reduce washing away of soil. For those who perceived flood as a future change, no preparation is being done. They responded by saying that when warnings are given then they would act.
For those who did not anticipate future changes, no alarm was registered in their behaviour. Most are still waiting for changes to happen and feel that things are alright for now and there is no need to panic. Some thought that there is no need to make any changes in their way of life and that they were born in Vutia and would prefer to die there.

<table>
<thead>
<tr>
<th>Anticipated changes</th>
<th>Common Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>More water coming onto land</td>
<td>Nothing being done at the moment, some house floors raised.</td>
</tr>
<tr>
<td></td>
<td>Can’t do much, just going with the changes.</td>
</tr>
<tr>
<td>Sea-level rise</td>
<td>Thinking of moving to Namosi where they originally from.</td>
</tr>
<tr>
<td></td>
<td>Waiting for changes to happen-feels everything is okay for now</td>
</tr>
<tr>
<td>Changes in weather pattern</td>
<td>Not preparing in any way for now- just going with the flow</td>
</tr>
<tr>
<td>More rain</td>
<td>Plant more</td>
</tr>
<tr>
<td>More soil erosion</td>
<td>Thinking of re-locating if land is provided</td>
</tr>
<tr>
<td></td>
<td>Trying to prevent erosion using sticks and piling debris near river bank.</td>
</tr>
<tr>
<td>Floods</td>
<td>Nothing planned as for now, waiting for future warnings than would act.</td>
</tr>
<tr>
<td>More land for housing and agriculture</td>
<td>Waiting for drainage to be improved by government</td>
</tr>
<tr>
<td>Not sure</td>
<td>Still waiting for changes to happen than will see what is to be done.</td>
</tr>
<tr>
<td></td>
<td>Nothing has to be done ‘we born here, we stay here and die here’</td>
</tr>
<tr>
<td>I don’t know</td>
<td>Things are alright now so not thinking of doing anything as yet.</td>
</tr>
</tbody>
</table>

Table 5.7: Table summarizing the response to preparation/ adaptation to anticipated changes in future by villages in Vutia.

The barriers to future climate change adaptation identified by the people of Vutia are presented in figure 5.38. According to this graph, the majority of the sample (32%) views the lack of information/knowledge on the topic as a major barrier. Another 23% identified lack of resources to make changes as a barrier. An equal 10% of the
population thought that cultural beliefs, no/less land to re-locate, poverty and people of the village themselves who were against changes of any kind were barriers for climate change adaptation.

Most informants viewed lack of land as a major barrier, because the other piece of land most of them own on Lauca Island is also experiencing severe transformation. This land which is currently being used for agriculture is eroding at a high rate as king tides periodically sweep through it inundating land and vegetation.

Figure 5.38: Barriers to climate change adaptation in Vutia as identified by the respondents (n=27)

The following pictures (Figure 5.39-5.41) reflect the environmental concerns on the island which are indirectly impacting the people of Vutia. Washing away of large portions of the shoreline (Fig. 5.39) has resulted in massive destruction to vegetation and farmland (Fig 5.40 and 5.41). Villagers on the island revealed that king tides and water filling their land is happening more frequently in recent times.
Figure 5.39: Part of the eroded shoreline on Laucala Island

Figure 5.40 (left) and 5.41 (right): The impact of king tides have caused land to wash away and are affecting vegetation on Laucala Island.
CHAPTER 6

DISCUSSION
6.1. Introduction
This chapter discusses the major findings of this research. The aims and objectives laid out in chapter 1 are answered in this chapter. Based on the research findings; this chapter illustrates the risk perception to climate change, environmental decision making, future vulnerability and adaptation, and barriers to climate change adaptation in the Rewa Delta. This chapter summarizes findings presented in the results, presenting personal interpretation, perceptions and insights and linking it or contradicting findings to literature.

6.2. Risk Perception to Climate Change
Most research over previous years especially in the developed world identified the importance of climate change risk perception for future environmental management in the face of global climate change. The present research is reflective of a first local assessment of climate change risk perception in Fiji. It has provided an improved understanding of how climate change risk is perceived in the Rewa Delta. The results show that climate change risk perception is based on a number of interrelated factors. These include socio-economic status, cultural and traditional norms, rural-urban location, and level of education or knowledge about the issue amongst local communities.

When comparing the results of the two sample sites of this study, Vutia and Nausori, variations were noted. The respondents of Nausori had heard about climate change more (85%) than the people of Vutia (52%) with the most common source of information being the news media. Easy accessibility to all forms of news media in an urban area like Nausori is most likely the reason for most respondents having heard about climate change compared to the rural Vutia village. According to Boykoff, 2008, media can play a role in shaping people’s perceptions of climate change either by strengthening or undermining faith in the science behind it (Byg and Salick, 2009). This Tibetan study showed that due to lack of media in the issue, the observations reported in the study were not influenced by external sources of information.
Since knowledge about the causes of global climate change is a powerful predictor of behavioral intentions, independent from believing that climate change will happen and have bad consequences, Conner et al (1999), detailing the understanding of climate-change related terms and its cause amongst respondents was important. It was found that although people in both communities had heard about climate change and perceived change to be severe in the future, their understanding of climate change suffered from several misconceptions. For one, there was uncertainty about the cause of climate change. Although greenhouse gas emission is the cause of climate change, the results show that the most common cause of climate change perceived by the respondents was divine will.

Similar conclusions were reached by Schmuck (2000) in a study in Bangladesh where religious people regarded cyclones and floods as an act of god against which they cannot and indeed should not do anything (Patt and Grothmann, 2005). In another study of risk perception amongst the American public, Kempton et al. (1995) found that stratospheric ozone depletion was commonly misperceived to be a cause of climate change (Leiserowitz, 2006).

Another common misconception identified by this study was confusion amongst both rural and urban respondents between short-term climate changes (climate variability) and long-term changes. Climate variability/weather was used frequently by respondents in explaining recent environment changes. It was noted that people used terms like weather, season, and recent events like December 2009 floods when referring to climate changes. This shows that people’s views are more related to recent observable variability in climate compared to long term changes in climate.

For example, although literature has noted increased tropical cyclone activity in the South-West Pacific in the past 50 years (Levinson, 2005), which consequently has caused widespread damage in the past, very few respondents did identify tropical cyclones as a recent environmental issue. Floods were identified as an environmental issue frequently than tropical cyclones. This could be largely due to the nature of observation of environmental changes in the area. It is most likely that events like flooding which are more frequent in the area, the most recent in January 2009 are
fresh in the minds of the people. A long term climate change trend like increase in tropical cyclone activity in the region is not known or observed by the respondents. This could be because no major tropical cyclone has occurred in the area recently.

These results support other studies which also found confusion between climate change and variability (Rebetez, 1996; Vedwan and Rhoades, 2001; Bryan et al., 2008; Byg and Salick, 2009). These studies found that usually people perceive climate change as same as weather. Observation of climate changes in Tibet showed that people detailed recent short-term changes more, qualifying their responses with statements such as ‘since the 1990’s’ or in the ‘last 2 years’ (Byg and Salick, 2009). Patt and Grothmann (2005) in a study in Germany found misconceptions among respondents and identified that adaptation to short-term climate variability is a barrier to adaption to climate change as a long-term phenomenon.

Another key finding from this research is that socio-economic and environmental problems in the area are great. The range of recent environmental changes in the Rewa Delta was identified in present work. Major socio-economic issues identified by the respondents include poverty, high populations, politics, and transportation and diseases and sickness. Major environmental issues both identified and observed are high rates of pollution, flooding, erosion and inundation, lack of marine food, and irregular crop seasonality.

Multiplicity of recent environmental issues is the reason for respondents perceiving socio-economic issues more significant than risks from climate change. Similar conclusions were reached in a national survey of American public to global climate change (Leiserowitz, 2006). In Nairobi and South Africa, in a study of risk perception to climate change, unemployment was identified as more of a concern than climate related risks. Similarly, in Mozambique, climate related events were viewed as less likely than non-climate related events (Patt and Schroter, 2008).

This study thus found that climate change is not currently given the prominence it needs for successful and sustainable adaptation. For the people of the Rewa Delta, challenges of everyday life are causing them not to worry about changes in their
environment. Although they see changes happening in the environment, they are unable to link these to climate changes or perceive them as a risk to livelihoods in the future. Consequently not much is being done to address current environmental issues, which will be responsible for exacerbating future climate change impacts.

6.3. Environmental Decision Making

The study found that not only the people but the local authorities in the area do not regard climate change and its effects as a major concern. The major environmental issues identified by stakeholders in the area of concern include pollution, development, social issues, and erosion, inundation, flooding and water problems from time to time. These issues were not perceived to be a result of climate change by the local authorities.

The overall result of risk perception by the local authorities in the area was found to be low. A similar conclusion was reached in a study of risk perception to floods in Navua, Fiji which found that policymakers seldom regarded climate change as a priority issue, usually perceiving it as a future and somewhat unlikely phenomenon (Mataki et al., 2007). This is in contrast with a study in the United Kingdom which found that local governments had a general interest in climate change as part of a wider sustainable development portfolio. Stakeholders in this sample were generally very well informed about policy processes, mechanisms and initiatives which were taking place at the local and regional levels, with which the climate change issue could be integrated.

This was unlike the behaviour and knowledge of the stakeholders’ participation in the present survey. Local authorities in this study were seen to play the “blame game” when it came to taking responsibility for addressing the issues facing their communities. An issue like climate change awareness was thought to be the responsibility of the central government and not one of their functions.

The outcome also shows that community-level decision making remains an influential system in traditional Fijian societies. The hierarchical system of decision making was intact in the rural site but was ineffective concerning climate change action and decision making. Traditional leaders cannot be blamed for this ineffectiveness in
addressing environmental issues and the implementation of adaptation responses as they themselves do not understand the changes happening in their environment and the risks these pose for their community. This is primarily because of minimal community level consultation or awareness on climate change issues in the area. In some cases, external assistance by church or NGOs was greater than internal assistance. In actuality, local people need to be included in understanding climate change risks as this would help in designing efficient strategies to respond (Tompkins et al., 2005; Patt and Schroter, 2008).

Studies in the past have highlighted that it is not necessary that community leaders be educated and know climate change science thoroughly to be able to make informed decisions. Traditional knowledge and past experiences can be used to strengthen adaptive capacity and resilience (Mimura et al., 2007). Local communities through their leaders can use historic events such as an extreme high tide as an analogue to assess the extent of coastal erosion for instance and discuss coping strategies (Bettencourt et al., 2006). An example is the Safata district in Samoa, where traditional chiefs prohibited sand mining after realizing that they had lost 50m of coastal land in half a century.

In the same way, local authorities being most familiar to local conditions have a key role to play in enabling local communities adapt to climate change (EU, 2008). For example in Southern Europe, local authorities have co-operated with farmers on water-saving initiatives through electronic management and distribution systems for crop irrigation. For the Rewa Delta, although local authorities have in the past tried to address some environmental issues like water (by providing tanks) and requesting for dredging for floods, these efforts are inappropriate.

These options have not been able to minimize the early effects of changes in climate for the community and thus can be labeled as short-term solutions. Overall, the study found that local authority participation in climate change adaptation was minimal in the area. Due to the limited scope of this analysis, the same cannot be said for whole of Fiji. More studies accessing stakeholder participation would reveal the situation in other parts of Fiji.
6.4. Future Adaptation

Sustainability has been argued to be achieved only by recognizing risks and pooling resources to reduce these risks (World Bank, 2003; Hay et al., 2003; Gravelle and Mimura, 2008). Thus this study attempted to examine perception of future climate change and its link to future adaptation.

The results in this section of the study show that climate change risk perception and adaptation are interlinked. A major pattern in adaptive behaviour of respondents emerging through the survey was that preparedness/adaptation options were considered only when there was anticipation of a risk (Table 5.8 and 5.9). Most respondents who did anticipate changes or risks for the future planned on changes. For example, a villager in Vutia revealed that he was thinking of re-locating, if land was provided, as he was anticipating more land loss due to sea-level rise. In contrast people who were not sure or did not know about risks thought that things were alright for now while some were waiting for changes to happen and then they would think of acting.

6.4.1. Barriers to adaptation

The major barrier to adaptation to climate change identified through the study was lack of information/knowledge on the issue of climate change. Studies in the past have identified information options as an integral part of adaptation as people’s proper understanding of future threats will help in the implementation of planned countermeasures (Mimura, 1999; Nunn, 2009).

Other barriers to climate change adaptation identified through the study are lack of resources and lack of land. The communities involved have no significant funding from the government to make changes. Lack of land is also an issue for a small portion of the population who are planning on re-locating as the situation worsens in future. Similarly, lack of land in Ethiopia, and lack of access to money in South Africa, was identified as barriers to climate change adaptation in similar situations (Bryan et al., 2009).
A key finding from the research is that culture and strong traditional beliefs are a barrier to practical adaptation options to climate change. The study found that cultural beliefs of respondents were interfering with their ability to think rationally. For example, a respondent with strong spiritual beliefs thought that changes that were happening were for the better and stated that nothing has to be done; ‘we born here, we stay here and die here’. Many other respondents both in rural and urban sites were not preparing for climate change in any way as it was their cultural belief that change which is happening is due to god punishing them for their sins. According to Takesy (2004), this is not to undervalue the efforts churches in the Pacific Islands to understand climate change, but there is a problem with disseminating that understanding using top-down approaches (Nunn, 2009).

A strong cultural tie was also found among the traditional respondents of Vutia with the ancestral land they occupy. Traditional villages were seen to be very territorial when it came to their land. Although a detailed of cultural influences on climate change adaptation has not been done in the past, some studies did identify cultural beliefs as a barrier to climate change adaptation. In documenting local perspectives on climate change in Tibetan villages, Byg and Salick (2009) found that climate change was seen as a moral and spiritual issue. Villagers interpreted adverse conditions like droughts as a sign of the deities’ anger caused by neglect of religious duties and breach of taboos. Similar was suggested in a study by Donner (2007), who argued that the commonly held belief that the Christian God controls the weather is the greatest obstacle to educating people about climate change.

Ignorance was also found to be a factor limiting climate change action in the study. The wait-and-see option was common amongst respondents. It was noted that although some respondents anticipated future changes like floods, they were not planning on any action, and waiting for changes to happen and then they will see what to do. This behaviour of the community is probably because the people know that the government will provide relief after an event like a flood. This creates expectations amongst the community to depend on the government and not adapt/prepare for changes beforehand.
There is also an observable trend of shifting the blame and denying personal responsibility amongst both rural and urban communities and authorities. Households and businesses shifted the blame on local authorities while the local authorities said that it was the responsibility of the central government. It is important that the community realizes now that the blame game will intensify risks for them in the future. There is no benefit in waiting to see if the projected changes will have effects.

Effective action towards reducing vulnerability has shown to be more effective when carried out in the initial stages (Bettencourt et al, 2006); in other words, when it is anticipatory not reactionary. Similarly for policy makers it is suggested that climate change adaptation policies, will generate valuable co-benefits only if implemented in a timely and efficient manner (Stern, 2007).

6.5. Future Vulnerability

‘Risk’ is when an environmental hazard has the potential to inflict harm (Tompkins et al., 2005). This assessment of climate change risk perception, results and findings would have had no significance if the community involved was not at risk from climate change. To prove that the community was at risk, this research aimed to show potential risks from future sea-level rise using a GIS assessment.

Based on the GIS maps generated, it is evident that the Rewa Delta will come under increasing pressure and risk in future. Future in this context is 20 years from now (2030) to 2100, the time through which effects of sea-level rise are expected to increase. As discussed earlier, the Rewa Delta is already facing environmental problems from king tides, frequent inundation, massive erosion, and devastating floods. With the GIS output maps as evidence, it can be stated that all current risks will intensify in future.

The Vutia area due to its coastal location will be most adversely affected by future rise in sea levels. It is no misjudgment to claim that all other effects of sea-level rise like stress on agriculture, forestry and ecosystems, water resources, human health, industry settlement and society (IPCC, 2007), will be a major concern for the area in 50-100 years. It is important to note here that with the projected high frequency of
tropical cyclones for the region or in case of an extreme sea-level rise scenario of more than 1.2m, risks will further intensify for the area (Mimura et al., 2007).

For the community of Nausori, risks from sea-level rise will be indirect and gradual. Indirect effects mean the threats from frequent freshwater flooding, and food and water security issues. Loss of land which was seen to be an issue already along the banks of the Rewa River will exacerbate in the future. This poses a risk to vital infrastructure along the river bank. Most people in the area depend upon the local market for fresh food source sold by the vendors most of who farm along the banks of the Rewa River. With future sea-level rise, agriculture in these areas will be affected by flooding and inundation which will deprive the people of Nausori off fresh food and vegetables. The effects of future sea-level rise on marine and freshwater ecosystems will also result in less seafood being sold in the market in the future. These changes are expected to stress the normal pattern of livelihood in the Nausori area in future.

The mapping of future sea-level rise scenarios for the Rewa Delta pointed to some major shortcomings in the area of GIS in Fiji. Limitations in quality GIS data is a requirement for producing precise outputs and is a challenge in visualizing climate impacts for the country. This could be the reason for very little research on climate change risk assessment using GIS in Fiji. The only recent literature available assessed vulnerability for the whole of Viti Levu to future sea-level rise (Gravelle and Nobou, 2008) with the previously underestimated scenario of 0.88m by 2100.

6.5.1. Overcoming the barriers to climate change adaptation

Based on the results obtained under an improved sea level rise scenario, the sustainability of the approximately 12,000 people of the Rewa Delta can be argued to be at stake in the absence of early anticipatory action. Community initiated adaptation options are a must in places like the Rewa Delta as reliance on government is most likely not going to bring the needed incentives. For areas which are important landmarks for Fiji like Suva City, funds are likely to be secured by government to protect it from future sea-level rise (Gravelle and Mimura, 2008). Since the Rewa Delta area is not a high-tech urban centre, it is now and will surely in the future be deprived of government funding for implementation of technical adaptive solutions.
Implications in the future for the people of the Rewa Delta is certain as people and local authorities still place more emphasis on short-term solutions like dredging and artificial structures. A case in Qoma, Fiji saw the community experiencing more inundation after construction of a seawall (World Bank, 2000). Thus the report suggested that strategic replanting of mangroves might well have been a more efficient solution to guard against periodic inundation. Similarly, Gilman et al. (2006), also suggest that a 30m mangrove fringe is an effective barrier to shoreline erosion. The only drawback to this is that for full development of a mangrove fringe, a period of 25 years will be taken (Nunn, 2009).

For a vulnerable community like the Rewa Delta, options like mangrove restoration, coral-reef health, and resource management, will reduce risks from climate change effects. In the long run, the best long-term adaptation option for the people will be retreating. Studies in the past have emphasized the importance of considering retreat which means the abandonment of vulnerable areas and re-location of the activities to planned sites in less prone areas (Bettencourt et al., 2006; Veityaki et al., 2007; Nunn, 2009). The same has been recommended by Nunn (2007) for Fiji towns of Nadi, Labasa, and Navua for fear of submergence by 2100 (Pareti, 2007).

Re-location is not seriously considered by the people and the government of Fiji. This is possibly due to the many unpalatable implications associated with it. For the Rewa Delta, it would have been a more practically possible response 20-30 years from now as the population in the area was low. Just as now, the effects of climate change were underestimated in the past. Even after devastating tropical cyclones like Bebe (1972) and Kina (1993) no-one realized future risks of occupying a low-lying highly exposed environment like the Rewa Delta. What is important for now is that local authorities and communities realize that not considering an option like re-location will result in loss of opportunities which may not be present in the future.

Some useful ways of bringing about effective changes have been adopted in the past by researchers globally. The Atlantis study which considered an extreme climate scenario of sea-level rise of 5m in Netherlands, the Thames estuary in the UK, and the
Rhone Delta in France, proved to be an effective way of raising awareness and producing stakeholder responses (Olsthoorn et al., 2005; Lonsdale et al., 2005; Poumadère et al., 2005).

Extreme sea-level rise scenarios in the study had the purpose to sensitize the public and the community of coastal zone and hazard management (Olsthoorn et al., 2005) which proved to be successful as the audience were seen to take heed of the risk and make changes. These concerns about effective ways of coping with an extreme scenario help to create a ‘windfall’ opportunity - to gain or be prepared when the (likely) reality of the in-between scenario occurs (Lonsdale et al., 2005).

The effectiveness of this methodology developed through these Atlantis studies suggest that it can also produce action if applied to the Rewa Delta. Being in contact with an extreme event in the past has shown to instigate quicker response in affected communities. Fear and concern for a risk has seen people leave traditional land. A case in point is from Carteret Islands, a group of low-lying islets in the South-West Pacific Ocean, whose people have been forced to re-locate as rising sea-levels, are making the island inhabitable.

Culture and lack of awareness, which currently is a barrier to climate change adaptation, can be overcome by using the strong communal nature of human lives in the Rewa Delta. Research in the past has shown that the key to community empowerment is to provide information to the traditional and church leaders (Koshy, 2007). According to Conner et al. 1999, although risk perceptions and general environmental beliefs influence both voluntary actions and voting, there are significant differences among the demographic variables. The study found that women are more likely to intend to take voluntary actions.

The results for this study in the Rewa Delta show the importance of traditional leaders in the hierarchal system of decision making. As adapting to changes to climate change requires motivation, Bettencourt et al (2006), traditional leaders can be the best motivators to their communities. National decision makers and local authorities can choose to educate these leaders about the likely risks of future climate change based
on the assumption that they will be effective activists in educating their people. It was also found that women in cultural systems play a limited role in decision-making. It is arguable that women could play a key role in climate change adaptation under the necessary education and guidelines.

An effective traditional conservation management practice achieved through the bottom-up approach is the traditional marine social institution known as Raui in Rarotonga, Cook Islands (Bettencourt et al., 2006). Another comparable situation is known from Kabara Island in Fiji (WWF, 2004). Results from a survey in 2004 showed that 99% of the people surveyed on Kabara had never heard of climate change. In 2008, WWF worked with four local communities to develop action plans which identify measures that communities could initiate. Working through a series of workshops, Kabara villagers have now adopted a five-year action plan to address impacts of planting trees along coastlines, banning use of destructive poisoning practices and the dumping of waste in lagoons. These ground projects have been successful in other parts of the Pacific and have important lessons for decision makers of other Pacific communities like the Rewa Delta.

Community empowerment with incentive benefits could also bring about adaptation responses like re-location. For example, in Saoluafata, Samoa, even with a 30m recession in coastline no-one was willing to re-locate as it was culturally undesirable. Then with development of a new school and roads further inland, the community has voluntarily and slowly begun moving inland (Bettencourt et al., 2006). Koshy (2007) has also suggested that local authorities can develop incentives in consultation with local residents enabling them to afford flood-proof homes, take out insurance policies or re-locating to sites less vulnerable.

Thus the results reveal that to address climate change in a local vulnerable Pacific Island community like the Rewa Delta, it is necessary to address local climate change risk perceptions. This research did reveal the need of further research on the topic in other parts of Fiji. Future research on climate change perception, adaptation, and GIS assessments of sea-level rise are urgently needed for anticipatory climate change adaptation in Fiji and the Pacific.
CHAPTER 7

CONCLUSION
Climate change is a concern for low-lying vulnerable places and communities of the Pacific region. This study has attempted to understand the perceptions of future climate change by community decision makers and its implications for future adaptation in a vulnerable Pacific Island community.

The major findings of this research are that:

- The Rewa Delta area is at serious risk from future climate change particularly sea-level rise.

- There is limited understanding of the causes and solutions to climate change amongst both rural and urban communities.

- There is a common misperception that short-term climate variability is long-term climate change.

- Climate change is given less precedence than other social-economic issues by both local communities and district decision makers.

- Low-risk perception of future consequences of climate change is the reason for public and decision-makers not being concerned or placing any urgency in adapting to climate change.

- The current approach of top-down method of decision-making is not effective in addressing the issue of climate change.

- Lack of resources, limited public education and awareness, and traditional and cultural beliefs of people are major constraints to adaptation and limited risk perception in the Rewa Delta.

The Rewa Delta area was found to be vulnerable to the effects of climate change and in need of effective (anticipatory) adaptation, which is currently not happening. The results show a strong link between the perception of risk and vulnerability and actions taken for adaptation. The link is that when people fail to perceive a risk, as in this case study, minimal or no efforts are put in to address the issue.
The results highlight that public as well as decision-makers attitudes and behaviour about climate change needs to be addressed by national policy makers. It is due time that policy-makers realize that promotion of adaptation action at the national policy level (top-down) and at the community level (bottom-up) is needed. The decision-makers need to understand that stand alone policies and projects are useless unless the public see their importance and choose to implement them. For the community to understand the benefits of any such policy, policy makers need to create an enabling environment to support adaptation at the community level. This could be done by:

- Attempting to understand risk perception among vulnerable communities prior to development of climate-change adaptation solutions.

- Local authorities participating in climate change action through the localities they look after instead of relying solely on the government.

- Ensuring that local authorities take the stance in providing community leaders with information about climate change risks and concepts. Traditional leaders being influential people in the communal hierarchy will be useful in instigating positive attitudes and behaviour in communities.

- Regular up-to-date assessments of climate change impacts and community risk perceptions and ensuring that this information is accessible to the public in a form which is understandable.

- Using bottom-up approaches in traditional communities to empower and mainstream climate change adaptation using appropriate methods of risk communication; use of vernacular languages and indigenous concepts are essential.

- Placing more importance on long-term solutions to climate change like mangrove restoration and coral reef protection for coastal protection over short-term solutions like seawalls for coastal protection or dredging for prevention for floods.
- Re-location as an effective long-term adaptation option to future sea-level rise needs to be considered by local decision makers and communities.

Given similar challenges of climate change for the whole Pacific Islands region, these recommendations should bring benefits if applied in Fiji or elsewhere in the Pacific. The main aim is to implant the concern and urgency in both the Pacific Islanders and their leaders that climate change is real and the decisions and choices made today will have a profound impact on the future sustainability of the region.

The results of this study have revealed important findings not known previously in the area of climate change risk perception in Fiji. The literature revealed a shortage in similar kinds of community-based assessments in this region and that there is therefore a need for further research in this area. Better research and modeling of current and future impacts of sea-level rise and community and stakeholder participation in climate change adaptation is needed in all other vulnerable parts of the Fiji and the Pacific.

Given the usefulness of tools such as GIS in vulnerability assessments, more priority should be given to this area by national planners. This research has revealed significant limitations in GIS data in Fiji which is an issue for researchers in producing up-dated assessments of climate change effects like sea-level rise. More assessments of future sea-level rise scenarios with updated GIS data will be useful in helping decision makers develop strategies to reduce risks to long term climate change. More research on local observations amongst vulnerable communities and stakeholders is also needed. Further research on climate change risk perception could further elaborate on the implications of misconceptions about climate change and variability to adaptation.

Since the findings of this research have revealed the importance of community views and beliefs on climate change for designing risk management strategies, more research on other communities assessing their climate change risk perception and traditional knowledge will be useful. Such studies will help in addressing the underlying attitudes towards climate change in our society. This will also help policy
makers in getting a better view of societal, traditional and cultural factors that need to be considered for future environment management and planning.

The findings of this research and other recommended research in the area of climate change risk perception have a significant potential to promote sustainable development and better climate change and adaptation planning not only in Fiji but throughout the Pacific. It is hoped that the findings of this research would aid Pacific Island governments to see shortfalls in the current nature of governance in the region. Improving environmental governance would help in enhancing adaptive capacity of Pacific communities to current and future effects of climate change.


Poumadère, M., C. Mays, G. Pfeifle with A.T. Vafeidis (2005), Worst Case Scenario and Stakeholder Group Decision: A 5-6 Meter Sea Level Rise in the Rhone Delta, France, Atlantis Project FNU-76


WWF. 2003. Climate change in the Pacific. WWF South Pacific Programme, Suva.

APPENDIX A

QUESTIONNAIRE SURVEY ON COMMUNITY PERCEPTION OF CLIMATE CHANGE


Researcher(s): Shalini Lata, Verenaisi Lewatoro (Research assistant), Professor Patrick Nunn (supervisor)

Project description and invitation: This study is for my master’s research and is aimed at providing an improved understanding of perceptions of the local community of the Rewa delta in the face of current and future climate change. Being, part of a coastal Pacific community that has been exposed to a variety of environmental problems, a study of this nature would prove beneficial for future policy planning which will help in providing a sustained environment for your future generation.

Thereby I invite you to participate in this survey and provide the much needed data for the compilation of this project. You are required to answer the questions asked by the interviewer accurately with reference to past experiences and memory of living in the area. Each interview will at most take 30 minutes. Additional information will be welcome.

Participant’s Rights: “You are under no obligation to accept this invitation. If you decide to participate, you have the right to: decline any particular question; withdraw from the study at any time; ask any questions about the study at any time during participation; provide information on the understanding that your name will not be used; ask for the recorder to be turned off at any time during the interview.”

CONSENT FORM
I have read and understood the information sheet pertaining to the above named research project. On this basis I agree to participate as a subject in the project. I consent to publication of the results of the project on the understanding that my anonymity is preserved.

I understand that at any time I may withdraw from the project, as well as withdraw any information that I have provided.

I note that this project has been reviewed and approved by the University Ethics Committee at the University of the South Pacific.

Name (please print)........................................
Signature...........................................
Date................................................
### SECTION 1: GENERAL INFORMATION

Surveyed by: ___________ Date: _________ Time: _______ Location: ___________

<table>
<thead>
<tr>
<th>Name of interviewee</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>Gender (Male/ female)</td>
<td></td>
</tr>
<tr>
<td>Language used for interview</td>
<td></td>
</tr>
<tr>
<td>Religion</td>
<td></td>
</tr>
<tr>
<td>Household clan/ mataqali</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
</tr>
<tr>
<td>Main income source</td>
<td></td>
</tr>
<tr>
<td>Number of household members</td>
<td></td>
</tr>
<tr>
<td>Education level (primary/ secondary/ tertiary)</td>
<td></td>
</tr>
<tr>
<td>How long have you been living in the area?</td>
<td></td>
</tr>
<tr>
<td>Access to traditional land/ fisheries resources (Y/N)</td>
<td></td>
</tr>
<tr>
<td>Are you planning to move or live elsewhere in the next five years?</td>
<td></td>
</tr>
<tr>
<td>If yes, than reason for relocation?</td>
<td></td>
</tr>
</tbody>
</table>

### SECTION 2: CLIMATE CHANGE

1. Have you heard or come across information about climate change?
   Yes ___ No ___
   *(If yes: Go to Q2    If No: Go to Q6)*

2. Where did you hear about this information from? *(Tick the boxes that best matches answer. If “others”, describe them)*

<table>
<thead>
<tr>
<th>Radio</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Newspapers</td>
<td></td>
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<tr>
<td>TV</td>
<td></td>
</tr>
<tr>
<td>Community awareness brochures</td>
<td></td>
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<tr>
<td>Village meetings</td>
<td></td>
</tr>
<tr>
<td>Church</td>
<td></td>
</tr>
<tr>
<td>General conversation with people you know</td>
<td></td>
</tr>
<tr>
<td>Community climate change workshop</td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
</tr>
</tbody>
</table>
3. In your own words describe your understanding on climate change? At least three words you associate with climate change.

……………………………………………………………………………………………………………………………………
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……………………………………………………………………………………………………………………………………

4. What do you understand by the terms ‘global warming’ and ‘sea level rise’? At least three words you associate with the term.

……………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………

5. What do you understand by the term ‘sea level rise’? At least three words you associate with the term.

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……………………………………………………………………………………………………………………………………

6. What do you think may be causing the changes in the climate? (Tick the boxes that best matches answer. If ‘others’, describe them)

<table>
<thead>
<tr>
<th>De-forestation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in industrial emission</td>
<td></td>
</tr>
<tr>
<td>God’s will</td>
<td></td>
</tr>
<tr>
<td>I don’t know</td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
</tr>
</tbody>
</table>

7. How has the climate or the natural environment of this area changed in since you were young?

| Changed significantly |                  |
| Changed slightly      |                  |
| No change at all      |                  |
| I don’t know          |                  |

8. What do you think will be the likely trend for environmental changes in your locality in the next 50-100 years? (tick box)

| Changes will be minimal |                  |
| Changes more severe into future |          |
| No changes              |                  |
| I don’t know            |                  |

9. Which natural resource of the area are you dependent on?
……………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………
10. Identify at least 5 major environmental problems you have faced ever since living in the area. (If respondent not able to identify on own ask from those listed.

<table>
<thead>
<tr>
<th>Issue</th>
<th>When it started (approximate)</th>
<th>Change in frequency/ rate</th>
<th>Possible causes</th>
<th>Is the issue linked to climate change?</th>
<th>Steps taken to address this issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution (waste management)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Development (construction near waterways)</td>
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<td>Social issues (population, housing)</td>
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<tr>
<td>Diseases / sickness</td>
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<td></td>
</tr>
<tr>
<td>Change in temperature</td>
<td></td>
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<td></td>
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<tr>
<td>Change in rainfall</td>
<td></td>
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<tr>
<td>Hurricane/ cyclones</td>
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<tr>
<td>Change in sea level/ water level in Rewa River</td>
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<tr>
<td>Flooding</td>
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<tr>
<td>Droughts</td>
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<tr>
<td>Erosion (shoreline/ river bank)</td>
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</tr>
<tr>
<td>Deforestation (including mangrove)</td>
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<tr>
<td>Inundation (coastal land being covered with water at high tide)</td>
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</tr>
<tr>
<td>Drinking water</td>
<td></td>
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<td></td>
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<tr>
<td>Irregular crop seasonality</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Marine food availability</td>
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<tr>
<td>Terrestrial food availability</td>
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</tbody>
</table>
11. How have these changes affected the lives of you and your family?

..........................................................................................................................
..........................................................................................................................

12. How concerned are you about these changes which are happening around you?
Very concerned
Bit concerned
I don’t care
I don’t know about any changes

13. Who is responsible for making decisions to environmental problems which you face in the village?
..........................................................................................................................
..........................................................................................................................

14. How are concerns regarding environmental problems brought to discussion? (Village meetings/ person/ committee/ church meetings)
..........................................................................................................................
..........................................................................................................................

15. When the community as a whole is affected (e.g. Drought, inundation, rising sea level, etc.) or when the individual cannot cope on his/ her own; how does the community discuss their environmental problems?
..........................................................................................................................
..........................................................................................................................

16. Are all members and groups in the community (e.g. Women) able to participate in dialogue?
Yes
No
I don’t know

17. What are the traditional village-level strategies to address major environmental problems?
..........................................................................................................................
..........................................................................................................................

18. What kind of external assistance is available to help in addressing environmental problems?
..........................................................................................................................
..........................................................................................................................
19. Is this assistance enough to address the problems the village is facing?
   Yes  _____  No  ____  Yes & No  ____  I don’t know  ____

20. How often have council members or officials from the government made visits in the area to see or educate about the environment?
   Once a week  
   Once a month  
   Once a year  
   Never  
   Other (please specify)

21. Do you think changes need to be brought in your way of life for future climate change?
   Yes  
   No  
   I don’t know  

22. If yes to Q (16) than what changes do you plan on bringing on for the future?
   …………………………………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………………………………

23. How are you preparing for these changes?
   …………………………………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………………………………

24. What are some of the difficulties you are facing in trying to make the necessary changes?
   …………………………………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………………………………

25. Please provide any other comments you think is relevant
   …………………………………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………………………………………………………
**APPENDIX B**

**Questionnaire for Local Decision Makers**

**Project title:** Perceptions of future climate change in a vulnerable community and its implications for future adaptation: A case study of the Rewa Delta

**Researcher(s):** Shalini Lata, Verenaisi Lewatoro (Research assistant), Professor Patrick Nunn (supervisor)

**Project description and invitation:** This study is for my master’s research and is aimed at providing an improved understanding of perceptions of the local community of the Rewa delta in the face of current and future climate change. Being, part of a coastal Pacific community that has been exposed to a variety of environmental problems, a study of this nature would prove beneficial for future policy planning which will help in providing a sustained environment for your future generation.

Thereby I invite you to participate in this survey and provide the much needed data for the compilation of this project. You are required to answer the questions asked by the interviewer accurately with reference to past experiences and memory of living in the area. Each interview will at most take 30 minutes. Additional information will be welcome.

**Participant’s Rights:** “You are under no obligation to accept this invitation. If you decide to participate, you have the right to: decline any particular question; withdraw from the study at any time; ask any questions about the study at any time during participation; provide information on the understanding that your name will not be used; ask for the recorder to be turned off at any time during the interview.”

**CONSENT FORM**

I have read and understood the information sheet pertaining to the above named research project. On this basis I agree to participate as a subject in the project. I consent to publication of the results of the project on the understanding that my anonymity is preserved.

I understand that at any time I may withdraw from the project, as well as withdraw any information that I have provided.

I note that this project has been reviewed and approved by the University Ethics Committee at the University of the South Pacific.

Name (please print)..............................................

Signature..............................................

Date..............................................
1). Background information

a) What is your role in the Council?
..............................................................................................................................................................
..............................................................................................................................................................

b) For how many years have you been working for the Council?
..............................................................................................................................................................
..............................................................................................................................................................

c) When was the Council established?
..............................................................................................................................................................
..............................................................................................................................................................

d) Briefly discuss the organizational structure of the Council?
..............................................................................................................................................................
..............................................................................................................................................................

e) What is the approximate population of the area which the council serves?
..............................................................................................................................................................
..............................................................................................................................................................

f) What do most of the people of the area rely on as its main source of income and livelihood?
..............................................................................................................................................................
..............................................................................................................................................................

g) What are the role/ functions of the Council that is decision in regards to which issues are made by the Council?
..............................................................................................................................................................
..............................................................................................................................................................

2). Assessment of Environmental Problems

a) What kind of environmental problems have you had to deal with at council level over the past years?
..............................................................................................................................................................
..............................................................................................................................................................
..............................................................................................................................................................

b) Rank the following issues in order of most concern in the local community and also the level of priority given by the Council to the issues. (Rank by numbering 1-12)

<table>
<thead>
<tr>
<th>Concern/Priority #</th>
<th>Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution (solid and liquid waste management)</td>
<td>..........................</td>
</tr>
<tr>
<td>Development (construction near waterways)</td>
<td>..........................</td>
</tr>
<tr>
<td>Social issues (population, housing etc)</td>
<td>..........................</td>
</tr>
<tr>
<td>Sickness and diseases</td>
<td>..........................</td>
</tr>
<tr>
<td>Change in rainfall</td>
<td>..........................</td>
</tr>
<tr>
<td>Hurricane/ storms</td>
<td>..........................</td>
</tr>
<tr>
<td>Change in sea level/ water level in Rewa river</td>
<td>..........................</td>
</tr>
<tr>
<td>Flooding</td>
<td>..........................</td>
</tr>
<tr>
<td>Droughts</td>
<td>..........................</td>
</tr>
<tr>
<td>Erosion (shoreline or river bank)</td>
<td>..........................</td>
</tr>
<tr>
<td>Deforestation (including mangrove destruction)</td>
<td>..........................</td>
</tr>
<tr>
<td>Inundation (coastal land being covered with water at high tide)</td>
<td>..........................</td>
</tr>
<tr>
<td>Drinking water</td>
<td>..........................</td>
</tr>
<tr>
<td>Unsustainable resource use (declining seafood stock)</td>
<td>..........................</td>
</tr>
<tr>
<td>Declining in agricultural food production</td>
<td>..........................</td>
</tr>
<tr>
<td>Others (please specify)</td>
<td>..........................</td>
</tr>
</tbody>
</table>

c) What is your view on the term “climate change”? Identify at least three words you associate with this term.

……………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………

d) How has the lives of the people in the area been affected by these environmental problems?

……………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………

e) What do you think is the trend like for environmental changes in your locality over past years and what it would be like in next 50-100 years? (tick box)

Changes have and will be minimal
Changes have and will be more severe into future
No changes observed

3). Policy/Decision making to Environmental Problems

a) How have environmental problems surrounding the area been dealt with in previous years?

……………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………
b) Are there rules/ regulations/ policies for environmental problems such as pollution, flooding, erosion and others? If yes then please specify.

……………………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………………

c) How effective are present national as well as local environmental laws in the community?

Very effective, implementation is excellent
Ineffective
Only effective in urban and not rural community
Unsure


d) How often to officials from the council make visits within the local community to observe that rules are being adhered and to see the difficulties your people are facing?

Once a week
Once a month
Once a year
Never
Other (please specify)


e) Can you remember cases from the area where the council has helped the people to understand or provide possible solutions to environmental problems which they were facing? Discuss.

……………………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………………

f) From your experience of living in the area, how seriously do you think the people perceive the issue of climate change? How do their perceptions differ from urban to semi rural to rural communities?

………………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………………


g) What steps has the council taken to ensure that the people being affected by environmental problems understand the possible causes and effects of the problems they are facing?

………………………………………………………………………………………………………………………………………………
………………………………………………………………………………………………………………………………………………
h) How vital has external assistance (by NGOs or the government) been in trying to address environmental issues in the area as well as in empowering local communities to climate change?

……………………………………………………………………………………………………………………………………………

…………………………………………………………………………………………………………………………………………….

i) Do you think community level participation is vital in environmental decision making?
   Yes
   No

j) To what extent are the local communities involved in decision making? Provide examples of instances where the council allowed meetings with community members to hear their grievances and find possible solutions.

……………………………………………………………………………………………………………………………………………

…………………………………………………………………………………………………………………………………………….

k) Has there been any sort of environmental campaigns (keeping climate change in mind) organized by the Council for its residents? If yes than when and who were the target audience, what was the outcome etc.?

……………………………………………………………………………………………………………………………………………

…………………………………………………………………………………………………………………………………………….

l) Do you think enough is being done by the council to prepare its people for future climate change? If yes than how is it preparing people, if no than discuss what all can be done?

……………………………………………………………………………………………………………………………………………

…………………………………………………………………………………………………………………………………………….

m) What are some of the barriers to implementing adaptive measures for the people in the face of current and future climate change in the area?

……………………………………………………………………………………………………………………………………………

…………………………………………………………………………………………………………………………………………….

n) Please provide any other comments you think is relevant

……………………………………………………………………………………………………………………………………………

…………………………………………………………………………………………………………………………………………….