VULNERABILITY AND ADAPTATION ASSESSMENT REPORT

FOR LOW LYING ATOLLS - ONTONG JAVA

MAY 2011

PACIFIC ADAPTATION TO CLIMATE CHANGE PROJECT: SOLOMON ISLANDS

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Map of Solomon Islands indicating Ontong Java and the study site

[*Source: Google Maps*]

Summary

Climate change issues reach far beyond atmospheric and oceanic sciences, affecting every aspect of life on this planet. The issues are increasingly pivotal in determining future environmental and economic well-being. Variations of climate have profound effects on natural and managed systems; the economies of nations and the well being of people everywhere" - (UNFCCC *Conference Statement-2nd world climate conference, 1990).* In Solomon Islands lack of empirical data on the intimate evidences of climate change e and its implications on the islands' inhabitants coupled with lack of technical and analytical capability has created gaps in the comprehensive understanding of climate change and sea level rise. Hence people have been ignorant of the adverse effects of climate change until recently (Hiriasia, 2007).

This report presents the results of an exploratory assessment conducted in Ontong Java Atoll in May 2011, to identify the climatic conditions encountered by the Ontong Java communities: Pelau and Luaniua, and to determine appropriate adoptive measures for action pertaining to food security. The report provides a benchmark and a "snapshot" of the target population and their attitudes about their common climate change related problems, from which a baseline can be projected for informed analyses on whether or not the target population's attitudes and perceptions relative to climate change issues, especially food security, are improving over time. Possible vulnerability and adaptation measures vary from simple and self-attainable psychological and mental shifts and mitigation to essentially government-driven multi-sectoral interventions.

Key finding(s):

The assessment identified that generally there has been commendable improvement in food security, especially with the achievements of the on-going ACOM's Food and Water Security project and other initiatives. However, obstacles such as lack of land availability, lack of local capability and capacity, inadequate access to transportation services and communication technologies have continued to impede on envisaged opportunities and positive achievements.

The assessment also discovered that church organised groups have a lot of influence in the community and there is a need to do a wide range of consultation with them before different adaptation activities can be carried out on the island. The same can also be said of the existing council of chiefs that exert much authority and control over the people of the islands.

It was found that communication and transport sector plays a vital role in the acquisition of food from Honiara and bringing it to the atoll island communities.

The other sector which also plays a role in ensuring the capacity for acquiring food are the marine resources which provide the people with lucrative income. Government intervention banning some of these produces has impacted greatly on the livelihood of the locals.

The undertakers of this report acknowledges that various stakeholders, including relevant government ministries and leading NGOs have undertaken similar studies in the past on the same study site, but mostly on an adhoc or relativity basis. This V & A assessment is the first thorough study undertaken on the site. Hence, it takes into account previous findings and further builds on the emerging themes that have been identified as common trends, but makes a thorough assessment into the adaptation and vulnerability issues that impact on the livelihood and security of the inhabitants of the study site.

Summary of recommendations:

Based on indentified challenges, it is recommended that the following actions be implemented immediately or supported by the government policies aimed at addressing vulnerability and adaptation to climate change in the multi-sectors cited in this report:

- Establishment of a climate change adaptation committee for Ontong Java atolls
- Comprehensive study on the vulnerability of water and agricultural resources
- Supply of support facilities like water tanks to address salt water intrusion of traditional fresh water catchments and inundation of agricultural sites.
- Sustainable water management practices, initiatives and technologies for both farming and household usage

- Environmental impact assessment as a precondition for approval of projects in the various sectors.

- Build on the existing foundation set up by Anglican Church of Melanesia climate change network and work with Malaita NDMO climate change office to address climate change V & A issues.

- Advocacy and civic education awareness on climate change variability and its adverse effects

- Agricultural adaptation and improvement to identify new farming methods and crop species suitable for changing climatic conditions

- Improved information and communication technology (ICT) by working in collaboration with telecommunication providers to improve monitoring, surveillance and mitigation of natural disasters and hazards

- Run financial literacy courses in Ontong Java to improve small business entrepreneurial skills to achieve enhanced human capacity and self-attained climate change adaptation

- Commencing studies and planning for relocation to bigger islands. This must be done in consultation with the people of Ontong Java for a place of their choice to avoid fear of what the future may bring.

- Traditional practices of agro forestry, harvesting practices and food preservation practices must be maintained for sustainability.

- Encourage voluntary emigration from atolls through inter marriage with non-locals of bigger islands, education and formal employment.

- Identify and enhance other trade alternatives, such as marketing of dried fish and shells, so that people are not heavily reliant on beche-de-mer as the main source of income.

- Alternative shipping roots, such as through Isabel and nearby islands to boost inter-island trade on produces, especially food. The demand for kassava and kumara is high on the island but the produces are not grown locally

- Installation of relevant technology such as rainfall gauges to enhance local weather knowledge, mitigation and preparedness, and options to install desalination plants must also be considered

- Need for mainstreaming of climate change activities at the national, provincial and community levels

1. Introduction

Global warming due to increased greenhouse gas concentrations has become a new reality with detrimental effects. It has increased climate change variability, including the frequency and intensity of extreme weather patterns, sea level rise, coastal flooding, coastal erosion, inundation and salt water intrusion. These hazards have put parts of our communities at immediate vulnerability. As stated during the 2nd UNFCCC conference in 1990: "(c)limate change issues reach far beyond atmospheric and oceanic sciences, affecting every aspect of life on this planet. The issues are increasingly pivotal in determining future environmental and economic well-being. Climatic variations have profound effects on natural and managed systems; the economies of nations and the well being of people everywhere"[1].

Despite the universal awareness of the reality of global warming, sea level rise and climate change, the lack of specific and localised knowledge of the degree of incidence of climate change and its adverse implications to other sectors of societies such as food security in many parts of the world is also undeniable. In Solomon Islands, for instance, lack of empirical data on the intimate evidences of climate change and its implications on the islands' inhabitants coupled with lack of technical and analytical capability has created gaps in the comprehensive understanding of climate change and sea level rise. Hence people have been ignorant of the adverse effects of climate change until recently[2].

This vulnerability and adaptation assessment provides a synthesis of the current state of knowledge about the vulnerability to climate change of the people and communities of Ontong Java atolls. More importantly, it identifies the gaps and priority needs that are crucial to our understanding of Solomon Islands' vulnerability to climate and sea level change and the priority needs essential for effective adaptation.

[1] UNFCCC Conference Statement-2nd world climate conference, 1990

[2] Hariasi, D (2007). "Climate Change and Sea Level Rise in the Happy Isles: Document about the effects of enhanced green house in Solomon Islands, Solomon Islands Meteorological Services, Solomon Islands Government.

As much as this is a statement of what is known about the vulnerability of Solomon Islands to climate and sea-level change it is also a statement of what is not known and what needs to be known.

1.1 Sensitive Sectors and Exposure Units

While there is a wide diversity of social and biophysical environments within Solomon Islands, there are some particular systems throughout the country that are likely to be sensitive to climate change and sea-level rise. Those identified as being of greatest importance are: 1) Subsistence and Commercial Agriculture, 2) Human Health, 3) Coastal Environments and Systems, 4) Water Resources, 5) Marine Resources.

The above sectors are sensitive to the impacts of climate change and sea level rise and are regarded as having high exposure risks due to a number of dimensions which are mainly determined by the geographical and the socio-economic and political context of Solomon Islands. Some locations and islands, including Ontong Java, are located at areas that are not geographically protected hence their high vulnerability to the adverse effects of natural activities such as king tides and high swells. This level of exposure also impacts on the status of soil fertility and land use not only in the low-lying atolls but also in some of the coastal communities in the bigger islands. The pressure from a rapidly increasing population exacerbates the situation as speed of resources exploitation and land-use increases. In rural areas, especially remote islands such as Ontong Java, access to basic services such as health and medical services, water and sanitation, education, telecommunication, technology and transportation is difficult. Lack of access increases the degree of vulnerability and sensitivity.

Above all, in many occasions it is the (in) capacity of the government and partners to assist when required the most that intensifies the sensitivity and vulnerability of many of the aforementioned sectors. People are heavily dependent on the state and its partners to oversee their livelihood, especially during times of natural disasters. When the state is incapacitated to intervene, communities and populations are left exposed to the insecurities brought about by nature, including the impacts of climate change and sea level rise.

Table 1: Cyclone chronology, Solomon Islands

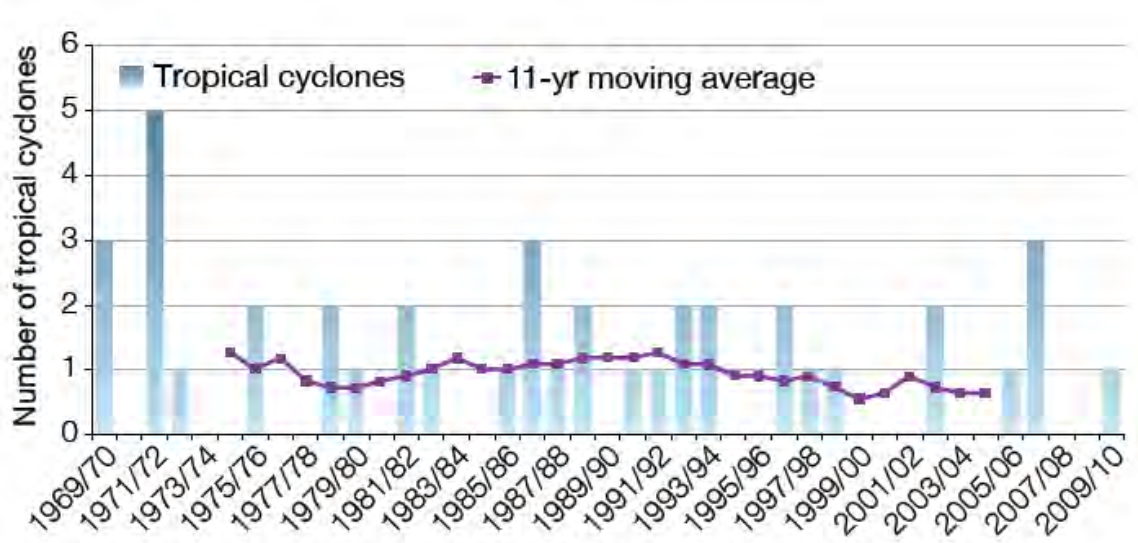
Year	Name of Cyclone	Duration	Mean Maximum wind (kts)	Minimum pressure Hectopascal (hPa)
1951	No name given	23-26 Feb	n/a	n/a
1951	"	24 Mar-01 Apr	"	"
1952	"	24-25 Jan	"	"
1952	"	22 Mar-08 Apr	"	"
1955	"	03-11 Apr	"	"
1968	"	18-24 Apr	"	"
1958	"	05-11 Jun	"	"
1959	"	07-14 Mar	"	"
1959	"	20-30 Dec	"	"
1961	"	07-13 Jan	"	"
1961	"	27 Jan-04 Feb	"	"
1961	"	02-08 Mar	"	"
1961	"	29 Nov-03 Dec	"	"
1963	"	21-26 Apr	"	"
1963	"	03-09 May	"	"
1963	"	08-14 May	"	"
1966	Angela	14-19 Nov	73	998
1967	Dinah	23 Jan-02 Feb	n/a	n/a
1967	Barbara	16-33 Feb	n/a	n/a
1967	Glenda	26 Mar-08 Apr	63	980
1967	Annie	10-16 Nov	63	998
1968	Giselle	03-09 Apr	35	980
1968	Becky	11-13 Dec	n/a	n/a
1969	Collen	27 Jan-05 Feb	n/a	n/a
1969	Esther	26 Apr-02 May	n/a	n/a
1970	Isa	13-18 Apr	34	998
1971	Ursula	02-16 Dec	100	940
1971	Althea	20-30 Dec	n/a	n/a
1972	Carlotta	05-21 Jan	71	940
1972	Wendy	30 Jan-02 Feb	n/a	n/a
1972	Emily	25 Mar-01 Apr	69	940
1972	Hannah	08-11 May	n/a	n/a
1972	Ida	30 May-03 Jun	52	952
1973	Marge	01-08 Mar	n/a	n/a
1976	Alan	30 Jan- 02 Feb	n/a	n/a
1976	Colin	26 Feb-04 Mar	n/a	n/a
1977	Norman	Date unknown		
1979	Kerry	13-18 Feb	70	945
1982	Bernie	01-07 Apr	43	970
1985	Hina	12-17 Mar	95	n/a
1986	Namu	15-22 May	63	983
1987	Blanch	22-23 May	45	990
1988	Anne	09-14 Jan	65	n/a
1989	Lili	06-12 Apr	75	995
1989	Meena	04-09 May	45	n/a
1991	Tia	14-21 Nov	72-93 (AWS)	987.9 (AWS)
1992	Betsy	06-08 Jan	45-55 (AWS)	n/a

[14]

1992	Esau	27 Feb-04 Mar	80	n/a
1992	Innis	28-30 Apr	35-55	n/a
1992	Kina	26-28 Dec	30-50	n/a
1992/1993	Nina	30 Dec-03 Jan	75-100	n/a
1993	Rodger	12-13 Mar	34-47	n/a
1993	Rewa	28-30 Dec	45-65	985
1994	Tomas	23-25 Mar	45-55	987
1994	Usha	24-26 Mar	40-50	987
1994	Vania	13-14 Nov	30-40	n/a
1996	Beti	22-28	n/a	n/a
1996	Fergus	23-30 Dec	80	960
1997	Drena	03-06 Jan	90	935
1997	Justin	15-19 Mar	80	950
1998	Susan	02-05 Jan	125	900
1998	Katrina	06-08 Jan	60	975
1998	Yali	18-20 Mar	45-50	990
1999	Dani	n/a		
1999	Ella	10-12 Feb	45	987
2001	Paula	25-27 Feb	90	935
2002/2003	Zoe	23 Dec-01 Jan	130	n/a
2005	Kerry	06-12 Jan	50	n/a
2010	Ului	14-17 Mar	65	n/a
2011	Vani	13- 15 Jan		
2011	Zelia	15-16 Jan		
2011	Yasi	30 Jan-01 Feb		

[Source: Solomon Island Meteorological Office, 2011].

Fig 1: Number of tropical cyclones passing within 440-km of Honiara. Eleven year moving average in purple



[Source: PACCSAP Program, accessed at www.cawcr.gov.au**]**

1.2 Climate and Sea-Level Scenarios for Solomon Islands

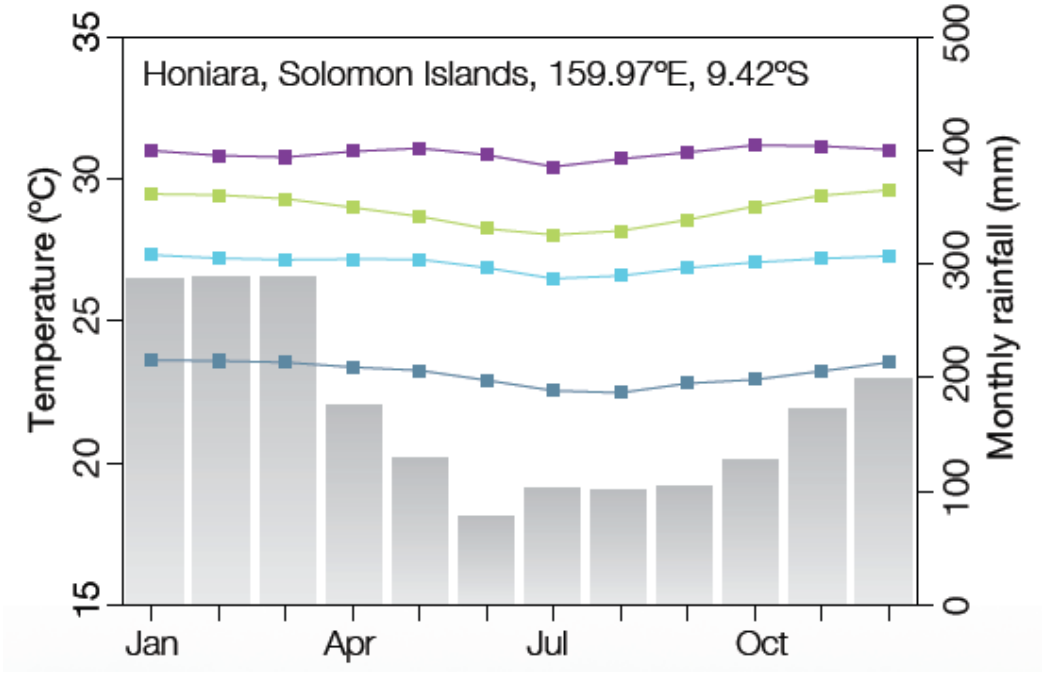
There is presently lack of detailed information or knowledge regionally regarding possible future changes in climate and sea level in Solomon Islands. Importantly, there is also a complete lack of any reliable information on how the El Nino/Southern Oscillation (ENSO) and cyclone events might change, as a result of climate change. Regionally, "(t)here is no firm idea on how…climate will change for individual countries or even the South pacific region. Although there is a lot of publicity about climate change on global scale, there is very little knowledge about possible weather and climate change on regional or national scales"[3]. Given this lack of information, the climate and sea-level scenarios presented here are based on the projections released by the Inter-governmental Panel on Climate Change (IPCC) in combination with the output from a number of general circulation models (GCMs). Only annual changes are presented here, although there are variations between months and seasons. In addition, historical analogues, based on the recent El Nino (1997/98) and cyclone Namu (1986), were used.

1.3 Temperature scenarios

Solomon Islands only have two seasons, a wet season from November to April and a dry season which usually falls between May to October. Throughout the year temperature changes revolve around these two seasons where it is usually hotter in the dry season and cooler in the wet season. In Honiara since 1951, the annual maximum and minimum temperatures have increased. Maximum temperatures have increased at a rate of 0.15°C per decade since 1951. These temperature increases are consistent with the global pattern of warming (PACCSAP Programme).

Fig 2: Seasonal temperature and rainfall in Honiara

[3] Climate change and sea level rise in the South Pacific Region, 1992



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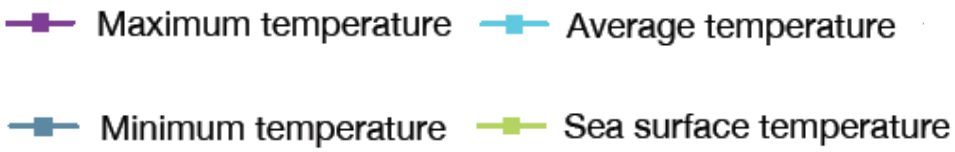
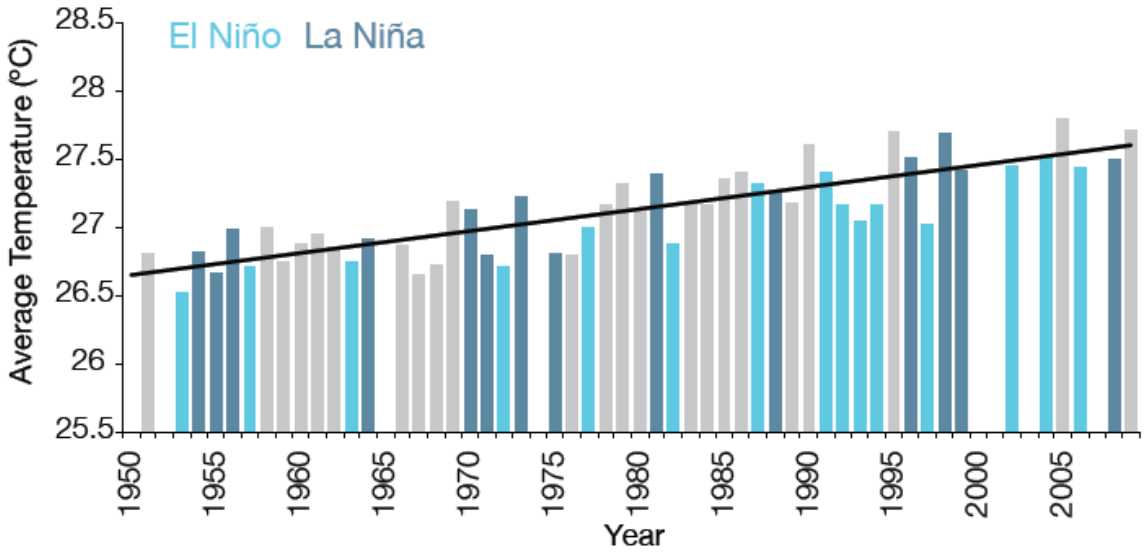


[Source: PACCSAP Programme]

Fig 3: Annual average temperatures for Honiara. Light blue bars indicate El Nino years, dark blue bars indicate La Nina years and the grey bars indicate neutral years.

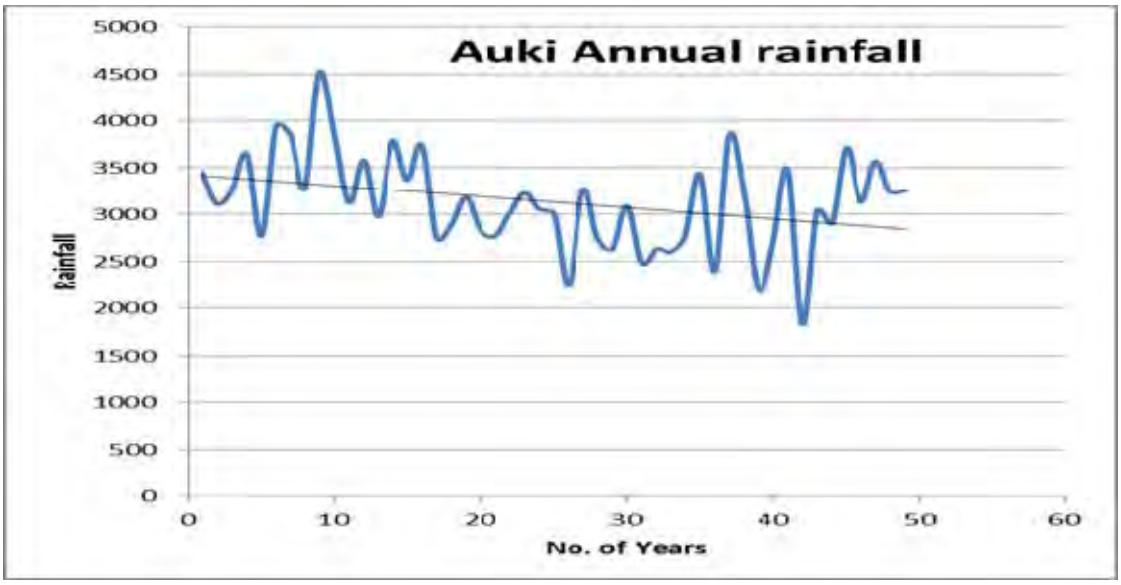


[Source: PACCSAP Programme]

1.4 Rainfall Distribution

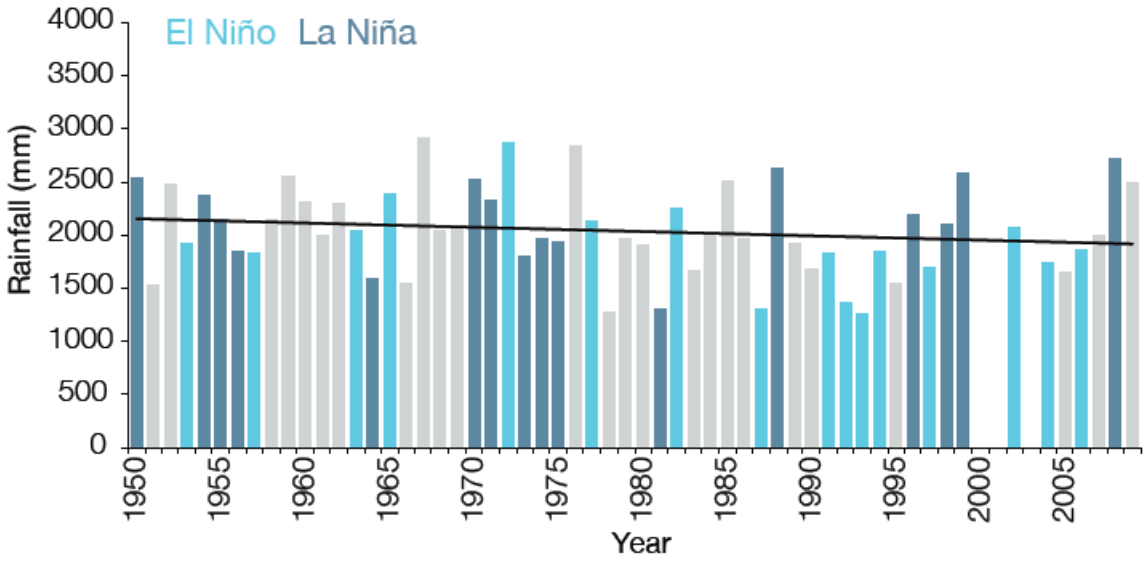
Lack of specific data on rainfall for Ontong Java Atolls has made it quite difficult to make analytical observations of rainfall distribution. However, by talking to the people on the atolls and analyzing data that is available for the whole of Solomon Islands (see Fig 3.), and especially nearby regions, particularly Auki in Malaita (see Fig 2) rainfall distribution varies throughout the year. The annual average rainfall is always high, with a lot of rain coming around the months of January, February, March, April, May, October, November and December. The months of March, June, July and August usually have a moderate average temperature. On average, the warmest month is January and the coolest month is August. March is the wettest month, while August is the driest month.

Fig 4: Annual rainfall trend of Auki, Malaita Province



[Source: Solomon Islands Meteorological Services]

Fig 5: Annual rainfall for Honiara. Light blue bars indicate El Niño years, dark blue bars indicate La Niña years and the grey bars indicate neutral years.



[Source: PACCASP Program, accessed at www.cawcr.gov.au]

1.5 Future Projections

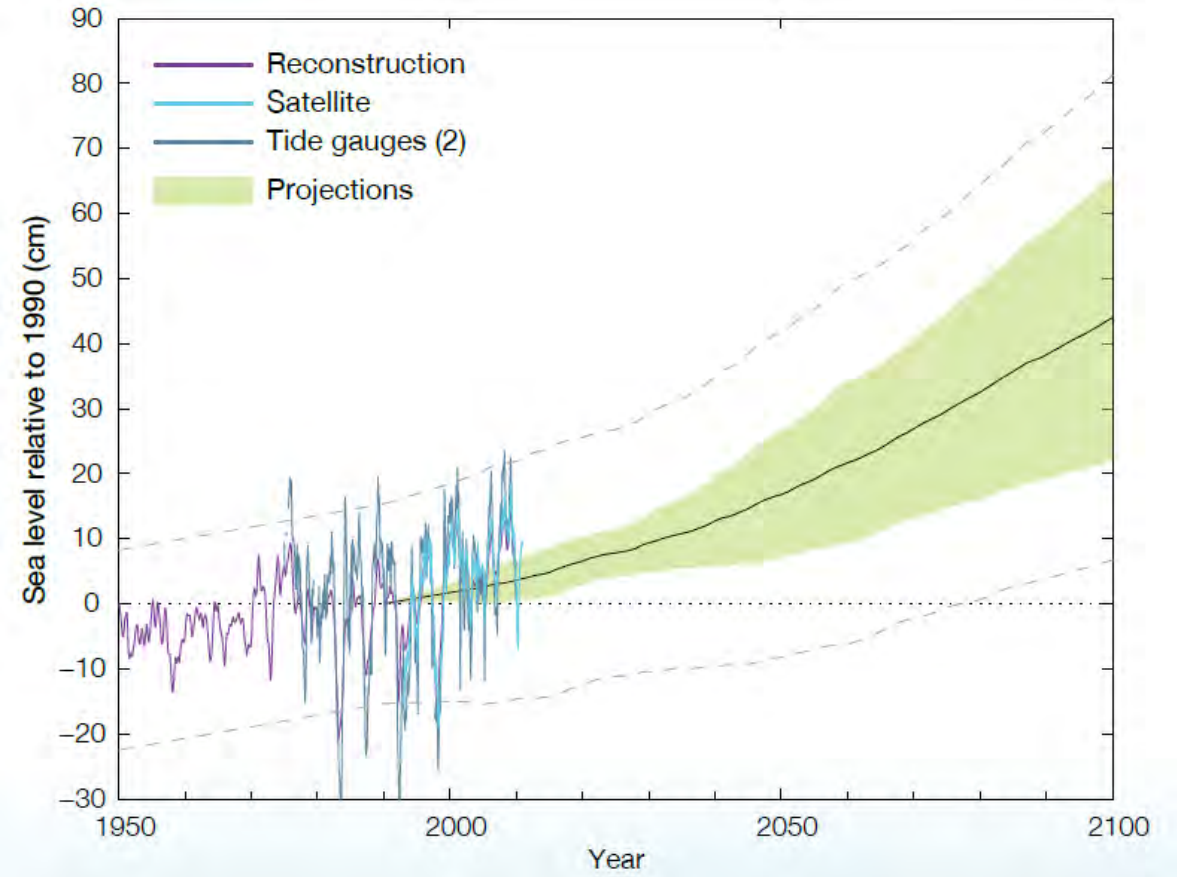
1.5.1 Sea level projections

Globally, sea level rise is increasing as ocean water warms and melting away the glaciers and ice sheets of, especially the poles. Satellite data have indicated the sea level has risen near Solomon Islands by about 8mm per year since 1993. This is larger than the global average of 2.8 – 3.6mm per year. This higher rate of rise may be partly related to natural fluctuations that take place year to year or decade to decade caused by phenomena such as the El Nino-Southern Oscillation (PACCSP, 2011).

On Ontong Java, the effect of this increasing sea level is becoming very obvious along the shorelines and exposed locations of the island. Older people who have been there for decades have also testified to this change and confirmed that shoreline erosion as a result of the rising sea level has intensified in the recent years. Many sites that people use to have as gathering sites along the coasts have now been washed away, even including some garden sites close to the shoreline. In their view if nothing can be done, many villages and settlements will also be threatened or washed away in the near future.

Fig 6: Observed and projected relative sea-level change in Solomon Islands. The observed sea-level records are indicated in dark blue (relative tide-gauge observations) and light blue (the satellite record since 1993). Reconstructed estimates of sea level near the Solomon Islands (since 1950) are shown in purple.

The projections for the A1B (medium) emissions scenario (representing 90% of the range of models) are shown by the shaded green region from 1990 to 2100. The dashed lines are an estimate of 90% of the range of natural year-to-year variability in sea level.



[Source: PACCSAP Program, www.cawcr.gov.au]

1.5.2 Temperature Projections

Recent projections for Solomon Islands have predicted that annual air temperature and sea surface temperature will continue to rise. The PACCSAP program has reported that by 2030 the projected increase in temperature will be in the range of 0.4 – 1.0 °C under a high emissions scenario. Consequently there will be hotter days and warn nights and a decline in cooler weather throughout the year. This projection is consistent with the current general experience in Solomon Islands, including in Ontong Java where people have experienced and have been complaining about new extremes in weather conditions, especially in terms of hotter weather patterns that negatively impacts on food and water security. Traditional methods of collecting water therefore are no longer reliable as wells tend to run dry quickly and the taste and quality of water declining.

Generally, temperatures are projected to increase over the years. In the table below, the years 2050 and 2100 were chosen for projecting the scenarios for a decade. These are based

on the IPCC best guess greenhouse gas (GHG) emissions scenario (IS92a), assuming a climate sensitivity of 2.5°C, and patterns of change from three GCMs (BMRC, CSIRO9M2, and ECHAM3TR). Some studies have indicated that there were only minor variations among the different GCM patterns, with a temperature increase of 0.7°C to 1.1°C by 2050 and 1.2°C to 2.0°C by 2100. Other studies projected an annual mean trend of 0.14 to 0.28 °C per decade. This designates an average change of 0.2 °C per decade, which is consistent with the temperature trend, projected by the IPCC studies. As shown in the following table, there is little variation across the longitudinal range of Solomon Islands, including the Ontong Java Atoll group.

Table 2: **Projected Temperature for area latitude 5 to 10 deg south and the given longitudes, east.**

Fig 7: Projected annual average air temperature changes for the Solomon Islands for three emissions scenarios and three time periods. Values represent 90% of the range of the models and changes are relative to the average of the period 1980-1999.

	2030 (°C)	2055 (°C)	2090 (°C)
Low emissions scenario	0.2–1.0	0.7–1.5	0.9–2.1
Medium emissions scenario	0.4–1.2	0.9–1.9	1.5–3.1
High emissions scenario	0.4–1.0	1.0–1.8	2.1–3.3

[Source: PACCSAP Programme]

1.5.3 Rainfall Projections

Inconsistency in projected rainfall levels makes it difficult to make reliable estimates and ddrought projections are also inconsistent across Solomon Islands. However, according to the PACCSAP Programme, it is projected that the aaverage annual and season rainfall is projected to increase over the course of the 21st century. In addition, Model projections show extreme rainfall days are likely to occur more often. Wet season increases are likely due to the expected intensification of the South Pacific Convergence Zone and the Western Pacific Monsoon.

1.6 Definitions and Issues

1.6.1 Vulnerability

The IPCC defines "vulnerability" as "the extent to which climate change may damage or harm a system", adding that vulnerability "depends not only on a system's sensitivity but also on its ability to adapt to new climatic conditions" (Watson et al, 1996). A "highly vulnerable system is one that is highly sensitive to modest changes in climate and one for which the ability to adapt is severely constrained"[4] . Vulnerability is the degree to which a system will respond to a given change in climate including beneficial and harmful effects. It is also the degree to which a system is susceptible to or unable to cope with, adverse effects of climate change including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity (IPCC Working Group II)[5].

Vulnerability can be classified as low, medium, high and critical, and is cross-tabulated with impact categories of people affected as a percentage of the total population on the one hand, and people probably at risk. The climatologically baseline selected is in accordance with two criteria:

a) As representational of the present day or recent average climate in the study region; and

[4] Watson, IPCC, 2000a

[5] As cited in Natcom,(unknown). "Vulnerability Assessment and Adaptation due to Climate Change: India's Initial Communication to the UNFCCC", Ministry of Environment and Forests, Government of India.

b) Data and information which are of sufficient duration to encompass a range of climate variations, including a number of significant weather anomalies (e.g. severe drought or cool season).

1.6.2 Adaptation

Adaptation involves a process of adjusting. In relation to climate change, it includes behavioural and economic adjustments to anticipated or actual changes in climate conditions. The IPCC defines adaptation as having "the potential to prevent the effect; change the use; change the location; research; and educate, inform and encourage behavioural change" and the "degree to which adjustments are possible in practices, processes, structures of systems to projected or actual changes of climate. Adaptation can be spontaneous, or planned, and can be carried out in response to or in anticipation of changes in conditions (IPCC, 1996). Adaptive capacity is therefore the ability of a system or people to adjust to given situations, including climate change, "to moderate potential damages, to take advantage of opportunities or to cope with the consequences"[6].

1.6.3 Food Security

The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". Commonly, the concept of food security is defined as including both physical and economic access to food that meets people's dietary needs as well as their food preferences. In many countries, health problems related to dietary excess are an ever increasing threat, In fact, malnutrition and food-borne diarrhoea are becoming double burden[7].

Food security is built on three pillars:

- Food availability: sufficient quantities of food available on a consistent basis.
- Food access: having sufficient resources to obtain appropriate foods for a nutritious diet.

[6] Natcom,(unknown). "Vulnerability Assessment and Adaptation due to Climate Change: India's Initial Communication to the UNFCCC", Ministry of Environment and Forests, Government of India.
[7] Cited from WHO's website, Accessed at http://www.who.int/trade/glossary/story028/en/

- Food use: appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation.

1.7 Climate Change Impacts

The three most important problems affecting the households are food shortage, lack of good drinking water and overcrowding. These problems are caused by the impacts of climate change. Such impacts include drought, intense cyclone and storm surges, coastal inundation and erosion, sea level rise, and surface and underground salt water intrusion. The distribution of climate change impact on the islands varies according to their geographical exposure. For instance, the Southern tip of Pelau experiences more coastal erosion and therefore salt water intrusion than other areas where there are reefs to protect the coastline. This level of exposure and incidence distribution also determines to a certain degree the frequency and intensity of climate change impacts on the island.

In addition, the climatic and environmental consequences of changing natural circumstances are not the only adverse impacts of climate change on the locals. The social implications of continuous environmental shifts on the social behaviour, mentality and psychology of the islands' inhabitants is also an important climate change implication. People are resilient, but are also unconsciously reactive to the need for them to continuously make adjustments relative to unpredictable shifts in weather patterns and forces of nature.

Coastal erosion on Pelau, one of the main islands in Ontong Java

2. Background

2.1 Geography of Ontong Java Atoll (Lord Howe Islands)

Ontong Java Atoll is the most northern islands of the Solomon Islands. The islands are located at latitudes 5 to 12 degrees and distributed between longitudes 143 to 168 degrees. The atoll covers an area of 1400 sq km with 12 sq km of land. The diameter is 50 km making it the largest atoll in the world. There are 122[8] small islands in the atoll, with the highest point of land merely 3 to 4 meters above sea level. Two islands are permanently inhabited. Several others are used by the villagers as temporary homes while they are on fishing trips. There are 23 passages through the atoll reef.

The people of Ontong Java are ethnically of Polynesian descent. The two islands which are permanently inhabited by the people are Luaniua and Pelau. These two islands were chosen by the Polynesians because of the fertile soil suitable for gardening providing them plenty of food, including fish and coconuts. These were the basis of their food security.

There are two land systems in Ontong Java. They are Lomousa and Pusaraghi. The Lomousa land system consists of deep freely drained beached sand from coral and mineral sand soils[9]. Sustainability and potentiality of this soil type is moderate in agricultural use in relation to food production without soil improvement. The common limiting factors are soil salinity, rockiness, and coarse textured soils. Only coconuts strive well and in abundance. The Pusaraghi Land system consists of poorly drained peat and alluvium which are found mostly at the back of the islands barely 15 metres from the shoreline. These depressions are suspected to be contaminated with salt due to infiltration of salt water which is currently causing harm to the swamp taro crop.

2.2 Luaniua Island

The Island is located in the south east of the atoll chain and contains the atoll's largest village. It is the most populated island with a total population of 2057[10]. Luaniua Island has 5 tribes and 13 chiefs. There are six trading stores and a main anchorage for ships. The boat

[8] A total of 122 islets in the Ontong Java atolls
[9] Hansel and Wall, 1976.
[10] Solomon Islands National Population Census Estimate for 2009.

trip from Honiara takes two days and one night. Faster ships like the patrol boat take only a night.

2.3 Pelau Island

This is the second most populated island in the group. It is located in the north east of the atoll. The total population on the island is 800[11]. The island has one chief supported by 8 working members. The important marine resources of Ontong Java are trochus shells and beche -der –mer. The *kakake* is their staple land food.

A sketch of Pelau island identifying vulnerable locations.

Household Survey

[11] Ibid

3. Assessment Objectives

This report presents the results of the findings of the Vulnerability and Adaptation Assessment which was conducted in Ontong Java Atoll in May 2011. The V&A assessment was conducted to identify and determine the popular perceptions of vulnerability and adaptation to climate change of the people of Ontong Java atoll islands in order to identify and assess to what climatic conditions the communities are vulnerable in order to devise appropriate adaptive interventions.

The assessment aims to gather objective information that would be useful to decision-makers, who could immediately address issues that are important utilizing resources for the benefit of the people. It provides a "snapshot" of the target population and their attitudes about their climate change related problems in particular the people's vulnerability and adaptation measures.

The vulnerability and adaptation assessment included several sectors of the socio-economy and livelihood of the people of Ontong Java. The sectors were based on several natural and human systems. They are: human settlements and health; water resources and freshwater ecosystems; energy, industry, commerce, and financial services; agriculture, food security, land degradation, forestry, and biodiversity; and coastal zone and marine ecosystems.

Information was required from all sectors hence the assessment contains data obtained from a household survey and a vulnerability and adaptation workshop (PRA). Both methodologies were designed to solicit information relevant to take on board popular perceptions of vulnerability and adaptation to climate change of the people of Ontong Java. It was of utmost importance that the assessment was conducted in a more participatory and direct approach.

It was essential to provide an opportunity to discuss key topics with our target population: Communicating with respondents and participants about the assessment topic allows for deeper insight into the climate change issues, problems, and can shed light on other related and relevant topics. By providing a benchmark, the assessment represents a "snapshot" of the target population and their attitudes about the common climate change related

problem to help establish a baseline from which we can compare whether or not target population attitudes and perceptions relative to the issues are improving over time.

Generally, the Vulnerability & Adaptation assessment objectives are as follows:

a) To collect relevant data and information of relevant sources, complied, compared and analysed.

b) To develop a baseline report on existing vulnerability status of the communities.

c) To develop a PACC V&A assessment strategy

4. Methodology

The study was undertaken using the IPCC Common Methodology (CM) approach. The methodology was first proposed in 1991 and specified three key scenario variables: global climate change including sea-level rise; socio-economic development; and response options. The CM approach has underpinned several subsequent vulnerability assessment procedures, including the study by Harvey et al. (1999a) and the wetland risk assessment procedure of van Dam et al. (1999).

The CM was appropriate for Solomon Islands as it is inclusive of all factors relevant to the issues of climate change and sea level rise, especially its adversities in respect of socio-economics and in food security in the area of study. The method incorporates expert judgment and data analysis of socioeconomic and physical characteristics of Ontong Java to assist in estimating a broad spectrum of impacts from sea level rise, including the value of lost land and wetlands.

In the design and preparation a list of analyses that should be done was prepared based on the scope of the study, with explicit instructions on how to perform the analyses. Information from the analyses were used as a basis to formulate strategic adaptation recommendations, to be used for further physical and economic modeling. The assessment involves the following steps: (1) delineate the case study area; (2) inventory study area characteristics; (3) identify the relevant socioeconomic development factors; (4) assess the physical changes; (5) formulate response strategies; (6) assess the Vulnerability Profile; (7)

identify future needs. Adaptation focuses around three generic options: retreat, accommodate or protect.

The methodology used was also guided by the IPCC technical guidelines (see Carter et al, 1994). It examined the present conditions and generated scenarios for possible future changes in climate and sea level in Solomon Islands for the years 2025, 2050 and 2100.The scenarios, based on these time horizons are then used to examine the possible effects of vulnerability to climate and sea-level changes on the various areas and sectors identified. Similarly, the recent Vulnerability & Adaptation Assessment include(s); literature reviews, Household survey (HHS), Participatory rural appraisal (PRA) and field observations.

Other survey tools used when collecting information for this report are; interview of elderly and middle age men and women, site visits and direct observations of the islands and the atoll geographic spread.

4.1 Household Survey (HHS)

4.1.1 Scope and Coverage

The survey gathered data from the household units. Data gathered were especially related

to the people's perceptions of vulnerability and adaptation to climate change in the atoll islands of Ontong Java. Related information such as demographic and economic characteristics of the population and housing characteristics were also included.

The survey involved the interview of a sample of 20percent of the total household (394), which is 62 households from the two communities. There were 56 households from Luaniua and 20 households from Pelau. A household is defined as a group of related or unrelated people living together in a housing unit and sharing meals. Focus groups selected were community leaders, men, women and youth.

Household Survey in Luaniua

4.1.2 HHS and Sampling Design

The Household Survey Questionnaire (HHSQ) was designed in such a way as to solicit information on the people's perceptions of vulnerability and adaptation to climate change in the context of the atoll islands. The open questionnaire was designed so that responses are not restrictive to common trends but to encourage respondents to provide information voluntarily, even if not required specifically under each question. The HHSQ was also guided by previous best practices relevant to V & A assessments, especially as recommended by IPCC.

Table 3: Original and final sample of the 2011 HHS

Community	Original Sample				Final Sample	
	Estimated population	Households	Sample households	Sampling fraction percent	Sampled households	Sampling fraction percent
Luaniua	2057	278	56	20	42	15
Pelau	800	116	20	20	18	15

[Source: HHS, 2011]

4.1.3 Recruitment, Training and Enumeration

Survey workers were recruited from the Ontong Java settlement in Honiara. They include competent enumerators in previous surveys who were trained by one of our facilitators. There were 5 enumerators recruited, 3 for Luaniua and 2 for Pelau. All candidates were tested for competency in English and Pidgin, but most importantly they were selected because they would use their own language in the interviews. Instruction to enumerators and a supervisor were carried out prior to the survey. A verbatim training guide was used in the training to ensure uniform understanding of the procedures, terms and concepts. Field – practice interviewing, a key part of the training process, was not carried out due to time limitation.

Though different readers may interpret answers to any specific question differently, we can draw some general conclusions. Foremost is the consistency of responses with the input

obtained from the two communities. Data was extracted from the questionnaire for analysis.

4.2 Participatory Rural Appraisal (PRA)

The use of Participatory Vulnerabilities & Adaptation Workshop or PRA Methodology in this climate change adaptation assessment ensures a common approach by communities of Luaniua and Pelau to work together in identifying the adverse effects of different climate change related disasters that have negatively impacted on their livelihood.

Community members of Luaniua participating in the workshops

The participatory data collection methodology can also help to empower villagers to take ownership of the problem of climate change in their community, and to work together to identify the causes of the problem and to determine ways to increase their adaptation activities through community action and planning.

Participatory workshops involve a number of participatory tools to help communities to participate in reliable data and evidence retrieval. Past experience has shown that if community members are taken through a Participatory Vulnerability & Adaptation Workshop at the beginning of the project, they will become active in using skills learnt and

information collected to prepare and plan for any future adaptation activities in their respective communities.

PRA at Pelau

5. Results and Findings: Current and Future Vulnerability

Generally, Solomon Islands has already experienced long-term changes in climate over the last 30‐100 years[12]. The annual mean surface temperature, for instance, has increased by between 0.5 and 0.80C per century through the period 1901 to 2005, with an increase of between 0.15 and 0.250C per decade since 1979. This is consistent with the entire tropical western Pacific region and the near-surface temperature observations from Fiji, showing higher than normal temperatures in the years 2003‐2006, along with a significant increase in the numbers of both hot days and hot nights[13]. Also, the analysis of temperature data at four synoptic stations on the Solomon Islands reveals an increase in the near-surface

[12] Trenberth, K.E., Jones, P.D., Ambenje, P., Bojariu, R., Easterling, D., Klein Tank, A., Parker, D., Rahimzadeh, F., Renwick, J.A., Rusticucci, M., Soden, B. & Zhai, P. (2007): Observations: Surface and Atmospheric Climate Change. Pp. 235‐336 in: Solomon, S., Qin, D., Manning,M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. & Miller, H.L. (eds.): Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, Cambridge University Press.

[13] Mataki, M., Koshy, K. & Lal, M. (2007): Baseline Climatology of Viti Levu, Fiji and Current Climatic Trends. Pacific Science 60: 49‐68.

temperature in recent years[14]. In relations to the Ontong Java atoll group, the V & A assessment undertaken identified critical observations in the sectors discussed below.

5.1 Agriculture, Food Security, Land Degradation, Forestry and Biodiversity

5.1.1 Agriculture

Agriculture development in the atoll islands of Ontong Java has been difficult. The HHS highlighted that it is affected by the following factors:

5.1.2 Land, Soil and Usage

Land

Ontong Java, also known as Lord Howe, are low-lying coral raised islands. There are 122 islets in the group and throughout the islets the ground level is merely 3 to 4 metres high above sea level. Coastal areas consist of narrow strips of coconut palms and shrubs. With its low altitude, it is highly vulnerable to seal-level rise and flooding. Flooding is also caused by stormy events and every year a few houses are either washed away due to flooding or relocated landwards to avoid damage from exposure to high tides.

It has been reported that in early 2006, stormy weather coinciding with high tides caused massive flooding and several houses were relocated to slightly higher lands[15]. Erosion has been an observable impact of changing tides and strong currents and has had a significant impact on islanders and in some cases there has been a shift of regimes, from "*the building of land*" before events such as tropical cyclones, particularly cyclone Annie in 1967, towards a negative sediment budget or net erosion after the cyclone event. Such incidences of erosion could impact negatively on land productivity and there are socio-economic factors that could enhance such impacts, this includes farming technology and practices and pressure on land from the demand fuelled by population pressure. However, it is also recognized that erosion is a natural attribute of the low-lying atoll islands and that it is also

[14] Rasmussen, K., May, W., Birk, T., Mataki, M., Merz, O., & Yee, D., (2009). 'Climate change on three Polynesian outliers in the Solomon Islands: Impacts, vulnerability and adaptation', *Geografisk Tidsskrift – Danish Journal of Geography 109(1):1-13*, 2009

[15] Ibid

exacerbated by non-climate stresses such as the cutting of palm trees and vegetation acting as protection against erosion[16].

Soil

The soil composition of the two land systems in Ontong Java, Lomousa and Pusaraghi, do not provide favourable conditions for productive agricultural activities, especially due to increased lose of top soil humus. This increases the risk of food insecurity, especially in terms of medium to large term agricultural farming including for commercial purposes. The low-lying nature of agricultural land- just barely 15 metres from shoreline poses high soil contamination risks due to salt water intrusion which is currently causing harm to the swamp taro crop, an important staple ingredient in the islanders' livelihood.

Land Use

The land is mainly used for coconuts. One village is located at Pelau and another on Luaniua and growing in the backyards at the villages are crops like banana, stem taro, kongkong taro, few cut nuts, slippery cabbage and pumpkin. Pigs can be seen tethered under the coconuts near the villages. The main and only crop is the swamp taro (*kakake*) which is the islands most important staple. This crop accounts for the family's daily food need.

A family of 6 to 7 members has an average of 150 square metres. The swamp taro in this area can last the family for at least 6 months. Some of the larger families might use up their swamp taro within a shorter time especially at times when they are not getting alternative food like rice and flour.

5.1.3 Food Crops

The range of suitable food crops available for planting is very limited because of the poor soil texture and lack of knowledge about or access to suitable crops. The situation has increased the vulnerability of the communities to food insecurity. With only one staple food crop- the swamp taro, the communities are highly vulnerable to food shortages and hunger.

[16] Ibid

Some food crops on Ontong Java

When there are food shortages, people often rely entirely on the cash economy as their source of food in exchange for rice and other imported food products. Beche-de-mer is the main commercialised produce, apart from copra. However, people have reported that when the beche-der-mer trawling is closed they cannot buy other food supplements like rice and flour. This means they depended entirely on the swamp taro. When this happens the taro runs out within 3 to 6 months. Coconuts also provide food and drinks but is not a staple food.

5.1.4 Salt Water Intrusion

It has been suspected recently that salt water intrusion has increased, contaminating the swamp taro growing creeks due to sea level rise and occasional sea surges during bad weather. A 2008 Ministerial report described after high swells were experienced that:

> *"The waves of the high swells have caused much damage to the agriculture of the atoll people. Severe in Luaniua, moderate in Pelau. High waves drives through the coast and into the planting fields that are located very close to the coast. The inner kakake fields were affected by salt water intrusion. Due to the high waters that came with the waves, salt water intrude in to the water table*

as a result that the kakake fields were flooded with saltwater. As a result of those kakake plants went brackish, wilt then die after. Kakake fields or gardens were flooded from waves and upwelling."[17]

Although swamp taro has improved since the high swells in 2008, there is continuing evidence that immature swamp taro tubers are found rotting at the base. In normal gardening areas the soil is characterised by freely drained sandy soils which usually have high pH levels meaning that they have high salt content.

Immature rotting of swamp taro tubers on Ontong Java

5.1.5 Pests and Diseases

Pests

There are pests that have existed on the islands for a long time. This includes rats, the red-nosed bird, and whitefly. Rats or '*keiore*' as they are called locally and the red-nosed bird known as '*dodoili*' in Isabel, attack taros. The degree of damage they impose however is

[17] Kauhiona, H. and Fugui, G. (2008). "Impact of High Swells and Climate Change on Luaniua and Pelau, Ontong Java Atolls, Malaita Province Outer Islands", Report, Climate Change Division, Ministry of Environment, Conservation and Meteorology, Solomon Islands Government

manageable. The whitefly, which infects pawpaw, banana, and other crops pose grave concerns. Steps have to be taken to eradicate it from the islands.

Diseases

Exposed to potential introduction of new diseases through introduction of new crop species and varieties Ontong Java is vulnerable to such pests and diseases that may be a threat to the existing crops and the local plant species. So far the HHS indicated that there is still no observable evidences of the existence of any diseases that might be a threat to the local plants. Neither any fungal disease has been noticed. Nevertheless, the Department of Agriculture should be on the alert to watch out for them. One reason why all taros are imported from Temotu Province is because it is the only province that is free from the destructive viral disease of taro called 'Alomae' and 'Bobone'.

5.1.6 Nutrient Deficiency

The obvious one (type) is the yellowing of the foliage which is the sign of lack of nitrogen. Some of the crops have been adversely affected by severe heat of the sun and the sand. It is believed that when the canopy of the tree structure is established it will provide the micro-niche environment for the crops. This will give the coolness and shading that the crops need. Such conditions could be improved if the ground can be covered with cover crops such as legume plants. Several species have been tried without any good signs. Puero, Centro, and Siratro were tried. Only Siratro has survived but not promising. The importance of raised beds underlain by commercial plastic is now inevitable.

Yellowing of taro leaves due to severe heat

5.1.7 Threat from introduced crops

There is a concern by some scientists that if any of the introduced crops would possibly become an invasive species, spread in such a way as to harm native species and the ecosystem. The species we have identified are those with localised characters. This means any of the plant parts do not have the capability to spread to another location unless they are moved and planted.

Their capability for self regeneration is only enhanced within its growing position. So the chances for any of the newly introduced crops to be a threat to the native ecosystem would be minimal. But steps will be taken to ensure that such incident does not occur. We also will have to double check on the crops agronomic potentials.

There was an incident from the past that an exotic disease entered and actually wiped out the traditional taro variety. Luaniua people related the loss to salt water flow into taro gardens from the cyclone that hit them in 1967.

Pelau people on the other hand tied the explanation to the newly introduced taro species called ‘dodo creek’ which was brought by Luaniua people in an attempt to revive taro on the

island. The Pelau people said when 'dodo creek' was planted there it out-competed the native species. They also said that although they eradicated the introduced species later their native species were gone for good.

Table 4: MATRIX of Issues, Problems, Coping and Solution– Ontong Java Communities

ISSUES	PROBLEMS	COPING	SOLUTION
Human Settlement Health	• Overcrowding, • Sickness, • Hunger, • Land shortage, • Domestic violence	• Migration, • Keep clean, hygiene • Balanced diet, hard work, • Forward planning • Married out, • Awareness programme and teaching	• Control underage marriages • Need more medicine, nurse, clinic • NDMO Supplies • Resettlement • Police post
Water Resources, Wetlands, Fresh Water Ecosystem	• Saltwater Intrusion (sea-level rise), • Lack of fresh water, Freshwater more brackish	• Shifting cultivation • Dig more wells. • Plant more coconut trees plant on higher ground	• Move to better gardening locations (good soils), • More water tanks, • More mulching
Energy Industries, Commerce and Financial Services	• Too expensive • Destroys ocean environs & resources • Lack of alternatives	• Use fire and shell coconut for lighting, use outrigger canoes for sailing	• Use Solar Power, Pressure lamps, manpower
Agriculture, Food Security, Land Degradation, Forestry Bio-Diversity	• Loss of soil • Lack of crops, trees due to indiscriminate cutting for firewood & demand from growing population	• Need more mulching. • Need to plant more mangroves and fruit trees	• Need more good soils, need to build seawall
Coastal Zone and Marine Ecosystem	• Coastal erosion	• Plant more trees along coast • Build-up coastal debris to create higher coastline • Build seawall • Plant mangrove	• Request outside expertise

[Source: PRA workshop]

5.2 Food Security

The HHS revealed that the food security status of Ontong Java is somewhat not stable. It depends very much on certain factors. When asked about their perceptions of food security the responses indicated an understanding that linked food security and other factors, including the following:

5.2.1 Food Garden

From the entire respondents 100 percent indicated that they have a garden. There are 80percent who revealed that they only have coconut and swamp taro in their gardens. The rest of 20 percent indicated they have other crops such as banana, true taro, pawpaw and pumpkin. The only surviving crop now is swamp taro which the people can draw their daily food from. A few other crops such as banana and pawpaw could be seen growing among the houses apart from the coconuts.

HHS also revealed that 85 percent of the respondents take cassava on a monthly basis. However there is no cassava crop grown on the islands. The supply of cassava is brought from Honiara by ship each time a ship comes to Ontong Java. Another 93 percent take rice, flour, biscuit and other food items on a weekly basis, also depending on the schedule of ships to the islands.

Salt water intrusion into the swamp creeks has affected the growth and yield of the swamp taro. This exacerbates the situation of food shortage because Ontong Java lacks alternative staple food crop. With one staple crop, swamp taro, only capable to provide food for 3 to 6 months the people could be without food for 6 to 9 months. If Ontong Java can be able to grow additional staple crops to fill in the 9 or 12 months period it would have achieved an improved food security situation. Although there is effort to grow food in their food gardens it is extremely challenging because it is very difficult to find planting materials for the people to plant in their food gardens.

The loss of swamp garden land combined with increasing population has really exacerbated land scarcity on the islands. One lady interviewed told us that it is very hard to find a new piece of land because the land was divided by their great grandfathers in the past and once

it is lost there is nowhere else to get new land. She also said even the ones whose lands (gardens) and islands are not badly affected they are finding it hard to manage them because the resources are few and there are too many people with needs. The situation is helpless if one needs an item from the shops where goods prices are really high.

5.2.2 Swamp Taro (*Kakake*)

About a decade ago in 2000, a new problem had arisen with *kakake* tubers. This time it was noticed that tubers were getting rot at their bases. Initially the issue occurred mostly in gardens that were located in the areas close to the coast on both islands, but later it also slowly affected the patches in the centre and the southern end of the island.

Plant growth is decreasing further, with plants now about 30 – 60 centimetres at the most and no big trees are standing in there. However, in the patches that are positioned in the centre of the islands with big trees standing, *kakake* plants are growing really healthy with heights of 1 – 5 feet high.

Based on information collected the people said the rotting of plants is due to sea level rise and salt water intrusion. They said that it is really affecting their food supply because *kakake* is the only food crop that they rely on for survival, since the loss of taro.

5.2.3 Income

Marine resources and specifically beche-de-mer is the main source of income and the people are relying on it for survival but with the ban on the harvesting of the product currently in place, life is very hard on the islanders. The ban has put the atoll communities vulnerable to food insecurity because 51.2 percent of the people's total income meets 63percent of food expenses. The beche -de -mer ban means they have little income and have limited access to food from the stores. This is compounded by the fact that their subsistence crops have limited productivity.

Table 5: Percentage distribution of total sampled household income by source

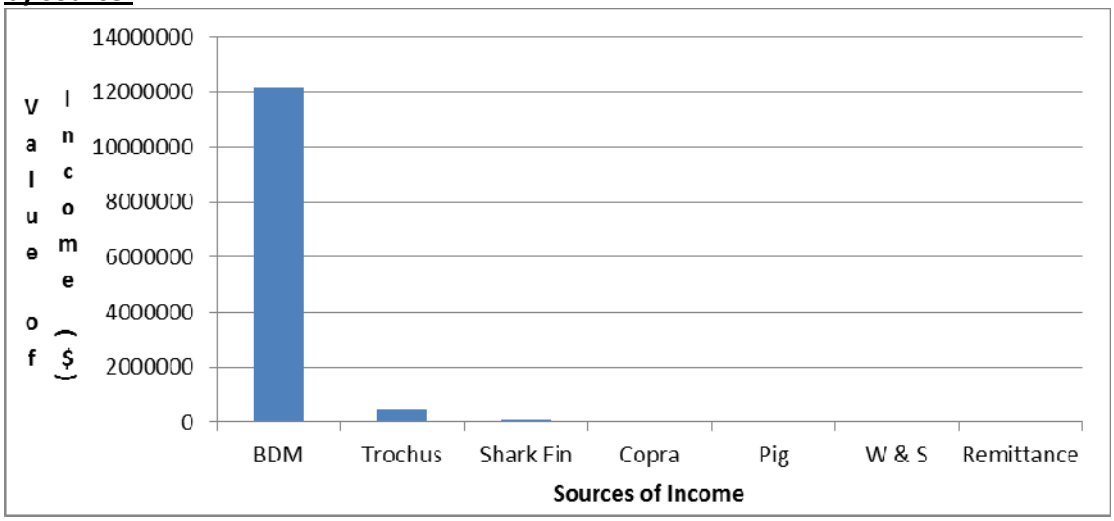
Source of Income	Value	Percent (%)	Number	Percent (%)
Beche – de – mer	12,160,000	95.4	60	100
Trochus	480,000	3.7	60	100
Shark Fin	60,000	0.47	60	100
Copra	13,333	0.1	4	7
Pig	16,000	0.13	2	3.3
Wages and Salary	12,000	0.09	1	1.3
Remittances	1000	0.008	1	1.3
Total	12,742,333	100	60	100

[Source: HHS 2011]

Although the people of Ontong Java earn a good income the people need to manage it in a sustainable way. People need to have literacy training in financial management. It is strongly suggested that financial management training is conducted for the people of Ontong Java.

Furthermore, awareness and education to understanding why the ban was put in place, the benefits of letting the resource regenerate and the concept of over-harvesting need to be conducted for the people.

Fig 8: Bar Chart showing the percentage distribution of total sampled household income by source.



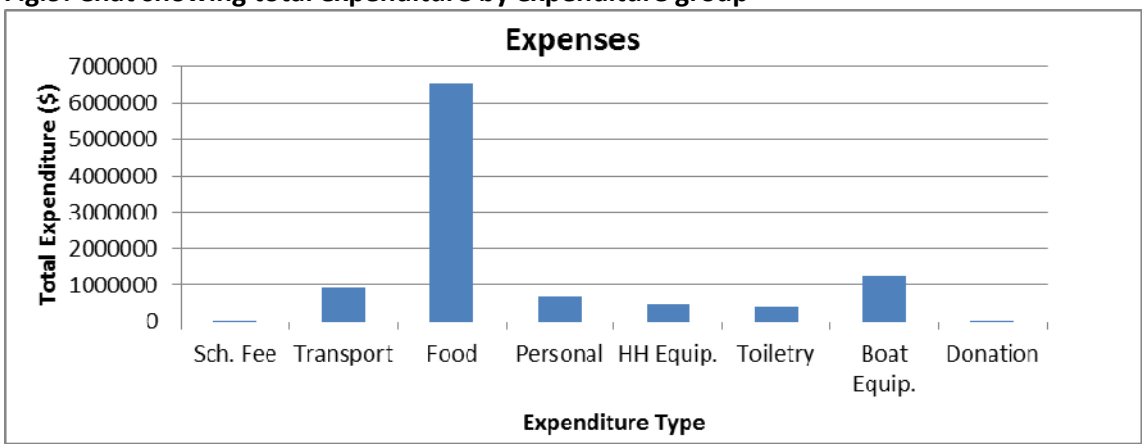
5.2.4 Household Expenditure

The HHS revealed that 51.2percent of the total income meets food expenses. The expense for food alone makes up 63percent of the total expenditure which is quite substantial as can be seen on the tables and the charts.

Table 6: Total expenditure by expenditure group

Expenditure Group	Amount (SBD$)	Percentage (percent)
School fees	68,000	0.7
Transport costs (i.e. fuel for outboard, and or payment for ride to town etc)	922,400	8.9
Food	6,518,160	63
Personal Expenses (cigarette, alcohol, clothes, betel nut, etc	706,310	6.8
Household equipment (pots, pans, buckets, radios, lamps, radios, etc)	480,000	4.7
Disposable household products (i.e. soap, washing powder)	390,000	3.8
Other equipment and assets (nets, boat parts, tools, engine parts etc)	1,248,000	12.1
Donations to church Ceremonies, weddings etc?	15,000	0.4
Total	1034870	100

Fig.9: Chat showing total expenditure by expenditure group



5.2.5 Transport and Telecommunications

Being so remote from the rest of the country transportation, especially shipping plays a vital role in the livelihood of Ontong Java people. Ontong Java does not produce enough crops to feed its population and so they rely heavily on ships to bring in food from the Honiara. The HHS revealed that people of Ontong Java eat a lot of rice, flour, biscuit and other imported food items. Much of cassava, sweet potatoes are imported from Honiara. This means shipping is very important transport mode to assist in the importation of food from Honiara. This assists in the improvement of food availability and therefore helps to improve food security. A reliable shipping or transportation service is therefore essential to ensure food security of the islanders. This includes the establishment of alternative trade routes to boost trade and interisland relationships. Without such a service the risks only intensify.

Telecommunication also plays a vital role in the vulnerability of the islanders, for it is to them a link to the wider world where information about weather patterns and forecasts can be delivered or disseminated. Climatic awareness, especially in relation to future weather forecasts increases the ability of the people to adapt and manage themselves in different situations, especially when they serve as early warning systems for natural disasters. Simple technology such as rain gauge and access to mobile service networks can help a lot in disaster mitigation and preparedness, especially when to comes to harsh climatic conditions and weather patterns. Hence, reliable telecommunication services therefore are essential for the enhanced security and adaptation of the people of Ontong Java.

5.3 Land Degradation

The survey revealed that soil fertility is a major issue in Ontong Java. This is because the land has been extensively used to make gardens. Gardening had been going on since the time the islands were inhabited. An elder on Luaniua recalled that the gardens are on the same areas since their fore fathers inhabited the islands many years ago adding that soil in the past was very dark and the water in the swamp was good to drink. Today the soil has lost its colour; water is brackish in most areas and the soil mostly sandy. The elder relates that the loss of soil fertility was due to loss of traditional knowledge by the younger generations.

Sandy soil at garden sites

The other causes of land degradation are due to the impact of cyclones which sometimes induces coastal flooding and beach erosion. From observation it is clear that coastal erosion had been affecting the Atoll for quite a long time and it is continuing. One area was used to be their cemetery and is still today, but it is evident from the gravestones that have been eroded away that it had been badly affected by coastal inundation. Here the impact of sea level rise compound with storm surges is evident.

Sea level rise may also result in salt-water intrusion, which would compromise the quality of groundwater in atolls and low-lying areas[18] while high intensity rainfall events cause turbidity and contamination and flooding can often damage infrastructure[19]. In Ontong Java atoll sea level rise has contributed to the degradation of land but also recent changes people noticed are that swamp soil is slowly losing its darker colour and the water in the area is changing both in colour and taste. In the early 1990s the communities began noticing changes to the tuber sizes and the plant growth. The *kakake* plants are not as high and green and the tubers are getting smaller in size. Today water in the area has turned brownish and brackish. The changes were first noticed in the main swamp or gardening area which is located in the centre of the island. But today that has spread all over to other gardens on the islands.

5.4 Forestry

The status of forest cover is very fragile. No longer there is a forest cover. The vegetation mainly consists of coconuts growing throughout the islands with sporadic patches of pandanus and shrub undergrowth mixed with ferns. Along the shoreline is isolated pine trees layered below with beach shrubs. The lack of forest cover makes the communities to be vulnerable to adverse heat of the sun and the sand. Also the forest can provide protection from strong winds and is the source of fuel wood but because Ontong Java forest depleted the people are vulnerable to impacts of strong winds.

[18] Hiriasia, D (2007). "Climate Change and Sea Level Rise in the Happy Isles: Document about the effects of enhanced green house in Solomon Islands, Solomon Islands Meteorological Services, Solomon Islands Government.

[19] Yee, D., Wale, S. and Ariki, M (1999). "National Statement on Vulnerability and Adaptation to Climate and Sea-Level Change in Solomon Islands", Ministry of Environment and Conservation, Solomon Islands Government.

Thin forest canopy

5.5 Biodiversity

Biodiversity refers to all living organisms that live on the land and marine ecosystem. These includes trees, plants, birds, animals, insects, shells and fisheries and other micro-organisms that live on land, in waters and in the sea. The vulnerability of biodiversity to climate change has been evident for some time. Many species of plants have become extinct. Tree density and floristic richness is decreasing. Rarely are new species of plants and animals showing up in the ecosystems. A rich biodiversity corresponds to the health and richness of the forest in both flora and fauna. Vulnerability of the people of Ontong Java is worsened because of the weak biodiversity where people derive their livelihoods.

5.6 Human Settlements and Health

5.6.1 Human Settlements

Finding from the assessment showed that there were many ways in which climate change could affect human settlements and health. Some of the impacts are direct, others are indirect. Human settlements in Ontong Java were affected by climate change in a variety of ways. The rural population concentrations were disrupted particularly along the coast due to sea-level rise and coastal inundation and erosion. Some settlements are known to have already relocated farther inland from their original sites in response to sea incursion over some decades. In Pelau Island quite a substantial distance has already been eroded away forcing villagers to move further inland.

5.6.2 Population

The total population of people who reside on Ontong Java is 2857 people (2009 Census Report). However, population displacement and migration particularly to, Honiara will arise as people leave the islands due to both drought incidences and accelerated sea level rise. Rises in sea-level will also threaten rural housing facilities in the communities. Extreme climate conditions such as high wind, heavy rainfall, and heat can result in wide-ranging

scenarios such as tropical storms, coastal flooding, droughts and sea-level rise. The population is quite vulnerable to these extreme weather conditions.

5.6.3 Relocation

According to HHS, it revealed that 100percent of the respondents favour the opportunity to be relocated if the Government offers alternative locations where they can migrate to. It was revealed that motives for favouring relocation are based on fear and uncertainty. The people still need to be made aware of what are climate change and its impacts. They need to know and understand its effects and the vulnerabilities and what adaptive measures are available. To date there has not been any plans to alter the natural settings to the shoreline, creeks and wave breaks nor has there been any hint for human resettlement. It would be very difficult to alter any natural settings. However, the people have opted to undertake any plans by the National and the Provincial governments for relocation.

Relocation is therefore an important need for the people of the islands, but it has to be a gradual process that has to begin sooner than later. It is a very difficult process that involves not only the need for new infrastructure but also new social beginning.

5.6.4 Pest and Diseases

Pests and diseases are implicated in climate change. Significant climatic conditions such as temperature, precipitation, sunshine and wind can affect and accelerate their dispersion and their increase. Food crops are affected by their presence creating social and economic problems because of low crop yields and food shortages, as well as human population problems such as malnutrition. Of particular importance is the incidence of whitefly which affects banana, pawpaw, and fruit trees. Measures must be taken to eradicate this pest.

5.6.5 Mosquitoes

A number of indirect impacts of climate change on human health were identified. A shift could occur in the location of some vector-borne diseases, such as malaria mosquitoes in response to shifts in the patterns of rainfall and temperature; mosquitoes currently thrive in locations where water logging and poor drainage most especially in the swamp taro creeks and in dense coconut groves. At certain times of the year when mosquito breeding is

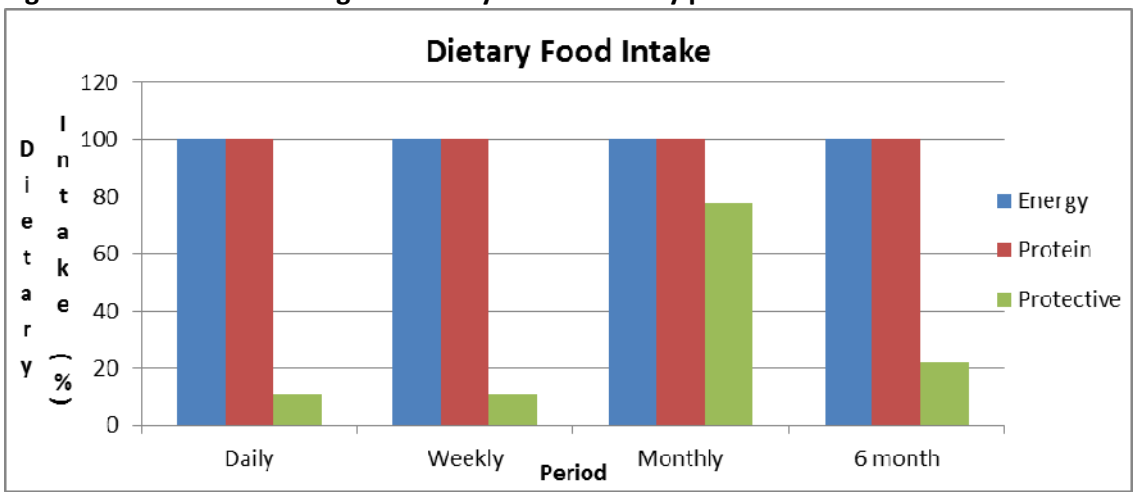
favoured by temperature and high rainfall people move to other small islands where mosquito is not so disturbing.

5.6.6 Health

Direct impacts include health problems induced by increasing incidences of salt water intrusion which affects the wells. When there is drought period people resort to well for drinking water. The incidence of diarrhoea is exacerbated by the contamination of wells.

As far as the diet of the people is concerned, much of the food intake is energy foods and protein foods. Protective foods are almost absent. According to the HHS there are incidences of high blood pressure, diabetes, diarrhoea, TB, and yaws. Protective foods are not grown in the islands because of poor soil conditions. This is attributed by land degradation caused by salt water intrusion in the garden areas as a result of sea level rise. The survey show that daily intake of protective food is only 11.1 percent which is very small.

Fig 10: Bar Chart- Percentage of dietary food intake by period



5.7 Water Resources and Freshwater Ecosystems

5.7.1 Water Resources

Changes in weather and climate have been known to profoundly influence water resources, a factor that increases the vulnerability of the people to certain hazards. Generally, for the people of Ontong Java, water resources involve wells and water tanks as well as creeks needed for life's necessities, ranging from domestic needs involving drinking, washing and cleaning, to agricultural needs involving watering of crops and swamp taro growing.

Water for drinking comes from two sources, generally: atmospheric water in the form of rain collected in water tanks. According to the HHS the Pelau community have access to sufficient water. However the Luaniua community is not so fortunate.

There are 13 wells and 68 water tanks on Luaniua and 17 wells and 55 water tanks on Pelau. The average size of the tanks is 800 gallons.[20] Well water has been contaminated with salt water making it brackish and unfit for drinking. However, when there is dry spells well water is used for washing. Tank water is used for cooking and drinking. The population stands at 2057 for Luaniua and 605 for Pelau.

Luaniua Water Need- Water need for Luaniua community is 69938 gallons. Currently 68 water tanks provide 54400 gallons, a short fall of 15538 gallons. This is equivalent to 20 tanks of 800 gallons each. It can be seen from the above crude calculation that Luaniua still needs another 20 storage tanks. Pelau on the other hand has adequate storage tanks.

The low-lying nature of coastline of the atoll islands makes the Atoll vulnerable to climate change. It is prone to sea-water intrusion into coastal fresh water resources. There is a high frequency of coastal erosion and flooding both are climate change-induced forms of land degradation.

[20] Fugui (2008). “Ontong Java High Swells assessment report”, MECM.

5.7.2 Drought

The survey revealed that occasional total absence of rain for a very long time is detrimental to the local gardening. It leads to a distortion of seasonal patterns which drastically affects agricultural crop yield

The impact of changes in water resources will be overwhelming. It is obvious that rainfall variability, climate, soil, and diseases have a direct impact on water resources. Climate change has brought about changes in rainfall patterns, variability in rainfall, changes in water level, and frequency of storms and drought.

Table 7: Shows hazards increasing frequency and increasing impact on the household

Hazards	**Frequency (increasing)**	**Impact (increasing)**
Drought	√	√
Flooding	√	√
Saltwater intrusion into food gardens	√	√
Saltwater intrusion into wells	√	√
Sea Level Rise	√	√
Beach Erosion	√	√
Coral Bleaching	√	√
Extreme Storms of Cyclone	√	√
Hotter Climate	√	√
Changes in weather (i.e. rainy season, dry periods, wind patterns etc leading to changes in planting season etc.)	√	√

[Source: HHS 2011]

Table 8: Household livelihood being impacted by hazards

Livelihood	Tick all that have been impacted	Identify Hazards that have caused the impact	Three most impacted
Water supply	√	Saltwater intrusion into wells	1
Food gardens	√	Drought, heat, saltwater intrusion	2
Bush areas	√	Coastal erosion and inundation	
Fishing grounds	√	Coral bleaching	
Transportation	√	Lack of reliable shipping	
Communication	√	No telecommunication	

Loss of property	√	Cyclone, erosion, saltwater intrusion	
Loss of village cemetery	√	Coastal erosion	3

[Source: HHS 2011]

5.7.3 Fresh Water Ecosystem

Lack of freshwater will worsen the already poor sanitary and health conditions in the two communities as well as uncontrolled disposal of wastewater. Human waste is disposed of at sea. Sea level rise which results in the flooding of low-lying coastal areas, inundation of coastal areas, beach erosion, and biodiversity loss; salt water intrusion into coastal fresh water resources; decline in species (flora and fauna), especially in the fragile vegetation, greater frequency and intensity of thunderstorms and floods that threaten coastal ecosystems, arising from heavy rainfall-related overland flow and flooding, frequency of storm, drought, flooding, etc.

5.8 Energy, Industry, Commerce and Financial Services

5.8.1 Energy

The survey shows 100percent of the respondents use solar power for lighting while 83percent use firewood for cooking and 17 percent use Speed-E-Gas for cooking. The fragile forest vegetation of Luaniua and Pelau will not allow more vegetation to be destroyed in search for wood for firewood. Much had been cut down for used to provide heat to dry the lucrative marine product, beche-der-mer and for cooking. In the face of coastal erosion more trees close to the shoreline will be lost.

5.8.2 Industry

There is no big industry of any sort other than few small primary industries. There is harvesting of beche-der-mer, trochus, shark fin, and copra. The people also harvest shells for drying. These products form the basis for income generation.

5.8.3 Commerce

There are businesses involving trading, especially in consumer goods and retailing. Commerce however is very much influenced by clientalism whereby groups are formed by business people, especially around family ties as the means of trade relations. Often people would sell produces to business owners who in turn would offer goods in kind in exchange. A major problem in this system is that businesses often over-charge their prices making the people to exchange their produces at values that are much higher than the appropriate price for goods in shops. While the commerce sector in the islands offer potential networks that can be utilised, it also served as an exploitation avenue whereby ordinary people, especially women and children are exploited by business-owners.

8.4 Financial Services

There are no financial services such as banking or any credit scheme services. People keep their own money and when goods and services are available they use their savings to pay for the goods. The commerce and trade system described earlier also serve as the financial system on the island.

5.9 Coastal Zone, Marine Ecosystems, Cyclones and Storms

5.9.1 Coastal Zone

The HHS revealed that over the last 40 years there has been a change in the sea level rise and it has been a threat to the coastal areas of the atoll islands of Ontong Java. In particular, beach erosion, and coastal flooding. This sea level rise is a threat especially to the community settlement as coastal inundation and erosion continues. The impact of sea level rise has put the communities vulnerable and will continue in the future.

5.9.2 Marine Ecosystems

The two communities continue harvesting marine resources: beche-der-mer, shark's fin, trochus, shells. Hence, the marine ecosystem is central to their sense of security and livelihood. With an increasing population, the pressure on resources, especially within the marine ecosystem and their depletion will also increase overtime.

5.9.3 Cyclones and Storms

The Solomon Islands is located in the 'ring of fire' an imaginary path susceptible to natural disasters, including tropical cyclones and storms and has a long-term average of 1.4 tropical cyclones per year over the cyclone seasons 1969/70‑2004/05[21]. However, over the last approximately 50 years, Ontong Java, has rarely experienced tropical cyclones because of its location close to the equator, except for cyclone Annie in 1967. This is according to scientific reports. However, the people have reported that they have in the past experienced cyclones. It has also been reported that people on Ontong Java recurrently experience impacts from storms, some following in the trail of cyclones elsewhere in the region[22]. For instance, a storm in early 2006 coinciding with high tides, caused extensive flooding on the two permanently inhabited islands, Luaniua and Pelau. This incident led the government of the Solomon Islands to initiate a number of shipments with disaster relief. The damage of crops due to cyclone depends on the intensity of the cyclone and mainly affects above-ground crops. Previously its has been reported (see Rasmussen et al 2009) in the three main isolated island groups in Solomon Islands (namely, Tikopia, Rennell and Bellona and Ontong Java) that given the relatively great importance of imported foods and the considerable exchange of goods with the capital, Honiara, the crop losses caused by cyclones do not seriously threaten food security. However, Ontong Java can be regarded as highly vulnerable to cyclones. due to the high exposure and sensitivity to impacts from flooding, dependence on few crops (mainly coconuts and taro) and wind-sensitive house constructions.

6 Findings: Current and Suggested Adaptation Strategies

6.1 Agriculture

Agriculture activities and production of foods could be improved by investing in agriculture management and technology. Because of the poor soil systems of the atoll islands featuring mainly sandy soils it is essential that appropriate farming systems are designed and suitable

[21] Rasmussen, K., May, W., Birk, T., Mataki, M., Merz, O., & Yee, D., (2009). 'Climate change on three Polynesian outliers in the Solomon Islands: Impacts, vulnerability and adaptation', *Geografisk Tidsskrift – Danish Journal of Geography 109(1):1-13*, 2009

[22] Ibid

crop species identified. Strategies aimed at removing the constraints posed by climate change to increasing agriculture productivity are:

ACOM's Current Adaptation Efforts

Currently the Anglican Church of Melanesia is doing a Food and Water Security Project in Ontong Java. In its program it is mandated to implement a number of activities, however, many of the activities have not been done because of insufficient funds. The project goal, expected outcome, outputs and list of activities are attached as Annex 1.

6.1.1 Legume Plants

The use of cover crops in such sandy soil conditions as that of the atoll islands is essential not only to protect the soil from adverse heat and torrential rain. They help to smother weeds and protect the soil from solar heat which makes the ground dry through heating and evaporation killing useful soil organisms. Leguminous cover crop such as vine legumes is important because they also help to increase the level of nitrogen in the soil through biological fixation. This ensures the nutrient enrichment of the soil for succeeding cropping seasons.

The use of the tree legume, Lucaena (Lusina), will be very useful because it is the only legume plant that has shown positive sign growing in the alkaline sandy soils.[23] It will be necessary to supply Lusina seeds and have them shared among the farmers. . Lusina can provide quite good source of the three major nutrients nitrogen, phosphorous and potash by composition of 4.3percent, 2percent and 2.5percent.[24] This tree is important because it is able to provide nitrogen direct to the companion crops. Two 20kg rice bag full will be sufficient. A bag of Lusina seeds will cost about $400.00 for a 20kg.

6.1.2 Appropriate Technologies

Identification of appropriate technologies to use in the atoll will help us to implement activities that would provide tangible benefits. For such a situation as in Ontong Java Atoll where soil is already and will continue to be affected by salt water intrusion there are

[23] ACOM Climate Change Food Security Project Ontong Java Report, 2011.
[24] David Shaw Wah, Can Handbok,2007.

adaptation options which could be tried. For example construction of raised beds, trellises, container planters, fence planters, water tanks, tools and equipment, and any others that may be useful. However, such technologies will require non local materials.

6.1.3 Mixed Farming Practices (Agro forestry)

It is suggested that mixed farming practice is encouraged. The reason is that land is scarce so it would be beneficial to incorporate many crop species in one garden area. Besides it would be a useful approach for such a harsh condition as that of the atolls. However, this requires careful planning and design taking on board tree crops, root crops and vegetable crops.

Currently similar work is being done by the Anglican Church of Melanesia in Ontong Java through her Climate Change Food Security Project. They call the mixed farming system 'Atoll Permaculture'. They have identified salt tolerant crops for the system. Tree crops component is part of the tree structure of the Atoll Permaculture. There are seven tree crop species, five root crop species (five main varieties of taro), and eight vegetable crop species.

The system allows for various levels of shading generated by the canopy and the production of biomass. This process enables the system to sustain the soil, the diverse plant community, wild life, and the system itself. It becomes self-sustaining, self-regenerating and self-mulching.[25]

This is an efficient multiple-cropping system because it maximizes the use of the land. It would give the people the opportunity to grow many species and varieties of crops thus increasing the amount of food available which people will have a wider choice of what they want to eat.

This may have some effect on how the people do their gardening. However, the possible changes that may come would due to the different approach of gardening and the different crops that are being introduced. This will not at all affect the traditional method of farming the staple swamp taro. Actually the new systems are introduced in areas that are not usually used.

[25] J.M. Bonie, Improved Temotu Traditional Agriculture, 1993.

One other suggestion is to utilize the coconut groves. Shade tolerant crops need to be identified to grow under the coconut trees.

6.1.4 Mulching

Mulching is essential once the plants are planted. If the soil is not covered, weeds will grow back quickly. One way of preventing this from happening is by using deep mulch onto the soil. Mulch keeps the soil temperature constant; it adds organic matter and nutrients to the soil over time and conserves soil moisture.

The type of soil found in Luaniua is most vulnerable to both sun and rain extremes. When there is a long period of sun the soil water evaporates quickly and dries up the soil giving unfavourable stresses to plants. But when it rains the water sinks very quickly washing away all plant foods sitting in the surface of the soil. The answer to this is to put heavy litter on the ground so that it holds the moisture in dry periods but also holds plants foods from being leached when it rains.

Table 9: Food crop types on Ontong Java

Tree crops	Root crops	Vegetable crops
• Breadfruit (Artocarpus altilis) • Polynesian Chestnut (Inocarpus fagiferus) • Funny Face (Spodius cyathera) • Malayan Apple (Eugenia malacsensis) • Local Avocado (Burkela obovata) • Cutnut (Barringtonia procera) • Alite Nut (Terminalia catapa)	• Swamp taro (Cyrtosperma chamissonis) • Kongkong taro (Xanthosoma esculenta) • Stem taro (Alocasia esculenta) • Selfish taro (Colocasia esculentum) • Topia • Pacific Yam (Dioscoria numularia)	• Bananas -3 varieties (musa sp.) • Pawpaw (carica papaya) • Pumpkin (Cucurbita pepo) • Egg plant (Solanum melongena)

Other vegetables crops are possible but they need raised beds and or trellises.

For the Atoll Permaculture there are tree food plants selected to be planted throughout the farm which will later become the main source for the production of the needed biomass. They produce heavy litter so that it will cover the ground and protect it from the two adverse extremes. When the litter decays plant foods will be released and made available to the crops. All plant debris will not be burned.

6.1.5 Salt Tolerant Crops

Salt tolerant crops needs to be identified for Ontong Java. The ACOM Climate Change Food Security Project has identified some as follows:

6.1.6 Pest, Disease Control and Quarantine

Pest and Disease Control

There is concern over the whitefly insect in Pelau Island. The insect pest attacks pawpaw leaves and some local trees. It may be necessary to introduce biological control.

Quarantine

There is fear that the introduction of new crops to the Atoll Islands may bring in new pests and diseases. Introduced crops could possibly become an invasive species, spread in such a way as to harm native species and the ecosystem. On the other hand there might be insect pests as well as diseases that could harm the existing crops. Therefore quarantine as a guard to protect plant infection is important.

In addition, Quarantine authorities must take preventive measures to ensure the African Giant Snail does not make its way to the islands. If it does, given the high vulnerability of the islands vegetation, it will be very easy for the pest to destroy the islands root crops within a short period of time.

6.1.7 Information

Information as a tool to enhance knowledge and skill is important and therefore they must be made available. Information about climate change and its impacts on agriculture need to be disseminated. This includes information and past and present findings of studies done by government authorities, NGOs and even individual researchers. There is also a great need for the documentation of soil tolerant crops and other agricultural produces that are likely to be susceptible to the islands' soil texture and climate.

6.1.8 Capacity Building (Training)

Capacity building of gardeners for agriculture development is important. Although Ontong Java people are renowned for their care for their swamp taros it would be essential that they will need a lot of training in order to equip them with new methods and skills for new farming systems and associate crops as suggested adaptation options.

6.2 Food Security

Individuals and communities need to adopt behaviours to conserving the environment. Increased self-reliance, planting appropriate tree species, using agro forestry and organic farming, and maintaining adequate food supplies will lessen the vulnerability to food security. Government initiatives such as improving transportation offering transportation subsidies is an important contribution because it will to bring food from Honiara.

Food such as cassava, kumara and a whole range of consumer goods are purchased in Honiara and shipped to Ontong Java. High priority to soil improvement and water harvesting should be considered as adaptive measure.

6.2.1 Food Production

Priority should be given to producing food to feed the population of Ontong Java. Several approaches could be taken:

Agriculture Improvement

Steps that are being taken by the Anglican Church of Melanesia (ACOM) are good and they could be ideal lessons to learn from. An option for Ontong Java would be to join force with ACOM and build on the work that has already been done rather than replicating the approach which would incur costs that would have to be used in other areas besides the same information would be repetitious for the same people. This process would require an establishment of understanding and the execution of a Memorandum of Understanding between the Pacific Adaptation to Climate Change/ Ministry of Agriculture and Livestock and the Anglican Church of Melanesia.

Improvement of agriculture must include the practice of mixed multiple cropping and the adoption of agro forestry (Atoll Permaculture) which will be appropriate for the fragile soil conditions; identification of salt tolerant crops and the use of disease-resistant, quick-maturing crop and plant species (cassava sticks, fruits and nuts); the use of best practices such as erection of raised beds throughout the farm as a safeguard against subsoil saline presence, proper preservation of seeds and plant seedlings to ensure healthy germination in the succeeding farming season; the use of organic manure, as preferable to chemical fertilizers; and pest and disease control and quarantine.

Satellite Farm Commune

Currently much food is imported from Honiara. They include rice, cassava, and kumara as well as other vegetables and small livestock. These food items can be farmed in another location and shipped to Ontong Java after harvest. It is strongly suggested that the Government assists to either purchase or lease a piece of good agricultural land and allow the people of Ontong Java to do farming to grow the food and ship it to the Atoll communities. This would facilitate the settlement of part of the Atoll population actually on the farm. The ideal area would be on the Guadalcanal plains where alienated lands are available.

Traditional Food Preservation Methods

Encourage food processing and preservation using traditional methods. This area must be supported in order to provide improved facilities capable for higher output of production. For example, the drying of fish and shell which are common delicacies in times of food

shortage. In addition, current food preservation methods should be improved with stakeholder support through the use of simple technology such as solar power to ensure hygiene in preparation processes as well as in preservation and the length of time they can be stored.

6.2.2 Income

Marine resources and specifically beche-de-mer is the main source of income and the people are relying on it for survival but with the ban being placed on the harvesting of the product life is very hard on the islanders. The ban has put the atoll communities vulnerable to food insecurity because 51.2percent of the people's total income meets 63percent of food expenses. The Beche -de -mer ban means they have little income and have limited access to food from the store. This is compounded by the fact that their subsistence crops have limited productivity.

It is therefore suggested that the people of Ontong Java get food subsidies for the period of the Government ban on the beche-der-mer to help them relief from food scarcity. The government should also provide alternative sources of income such as creating niche markets in Honiara for dried fish, and provide facilities to enhance sustainable economic production, such as provision of cool storage rooms, clam farming and so forth.

6.2.3 Shipping

Being so remote from the rest of the country shipping plays a vital role to bring in food from the Honiara port. Ontong Java does not produce enough crops to feed its population. The HHS revealed that people of Ontong Java eat a lot of rice, flour, biscuit and other imported food items. Much of cassava, sweet potatoes are imported from Honiara. This means shipping is very important transport mode to assist in the importation of food from Honiara. This assists in the improvement of food availability and therefore helps to improve food security.

Thus, it is suggested that the Government initiative on transport subsidies be strengthened.

6.3 Land Degradation

Land degradation has been exacerbated by coastal flooding and erosion due to storm surges and king tides. Furthermore sea level rise has also played a role in salt water intrusion which has caused wells to be contaminated with salt as well as swamp taro creeks and garden areas.

6.3.1 Land Management

The following are recommended actions for managing land degradation are the avoidance of mono- cropping in preference for mixed cropping; the construction of raised bed technologies to help prevent salt susceptible crops; the establishment of wood-lots at the community level; the wood-lots are composed of fast-growing plant species that yield domestic fuel wood for community members and the minimization or abolition of bush burning.

6.4 Forestry

Rather than depending on unsustainable wood supply from the forests, it is suggested that reforestation is encouraged to provide coastal protection and fuel wood. It is also worth considering planting fruit trees that can help provide alternative food sources during times of natural disasters and hunger.

6.4.1 Woodlots

Establishment of woodlots along the coasts will provide protection from coastal flooding and erosion. It is suggested that forest trees suitable for coastal regions be identified and encouraged to be planted. Trees like *hekau,* as it is locally known on the island, and Barringtonia marinus are good species to use.

Other species Lusina *(Leucaena leucocephala)* could be established for fuel wood and its litter for mulching.

6.5 Biodiversity

Encouragement of small woodlots will in turn promote build-up of biodiversity. In addition, options to boost or enhance the fragile biodiversity on the island should also be explored. This includes replanting of mangroves along the coastlines to protect the shoreline from erosion as well as to provide habitats to micro organisms.

6.6 Human Settlements, Health Care and Education

The household survey has shown that individual and technological strategies exist that can mitigate the negative effects of climate change. Adaptive measures can be taken at the community level and at the personal level although it would be more effective at the community level.

6.6.1 Planning for Relocation

The survey showed that 100percent of those who have responded favour any opportunity to be relocated if the Government offers alternative locations where they can migrate to. To date there has not been any plans to alter the natural settings to the shoreline and wave breaks or any suggestions for sea walls to provide protection against king tides or coastal erosion nor has there been any hint for human resettlement. It was even stated in the country's Initial National Communications that "Resettling options may become necessary for some areas but because of their high social, environmental and economical cost would only be considered as last resort options".[26]

However, the latest unfolding of events of inundation and flooding in some of the atolls and small islands could qualify resettlement as their suitable adaptation option following an incident of severe inundation and flooding that carpeted the whole of Ontong Java atolls in 2006. It was reported that crops were damaged water wells were contaminated with salt and properties were either lost or damaged.

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[26] Mike Ariki. (Eds). *Initial National Communication*. (Honiara: PICCAP. 1997).

Some of their elders were even mentioning the possibility of resettling their people on the bigger islands and considering resettlement as their best option. This affirmed that the people have opted to undertake any plans by the National and the Provincial governments for relocation. Observing the trend and intensity of some of these climate extremes, it can only be wise to quickly undertake such anticipatory adaptation option where necessary before it is too late considering the slow processes that will be involved such as preparing institutional capacity, development expertise and building knowledge through research and monitoring involved in such anticipatory approaches as resettlement.

It is suggested that consultations with concerned local communities, Provincial governments, Dioceses, National Government, NGO's, possible land donor communities, government agencies and other stakeholders must begin initial planning and consultations. It is however important that there has to be linkages between the current adaptation activities and planning for relocation. Hence, there is a need to properly explore adaptation options in light of the need for relocation. Relocation is a long process that will be difficult, hence the need to approach the issue amicably.

6.6.2 Health Centre

The survey revealed that health facilities in Ontong Java are insufficient. Adaptation options include preventative measures such as careful application of insecticides for mosquitoes, developing efficient and safe water systems, data gathering and archiving of diseases associated with climate change and their seasonal variations. It is suggested that the centre is improved by providing a building and stocked with appropriate medication and staffing.

6.6.3 Education

Education can serve as a viable option to achieving sustainable vulnerability and adaptation measures. Evidently, the lack of education and awareness especially in regards to the adverse impacts of climate change and sea level rise have impacted greatly on the possible achievements of current initiatives. While many solutions and adaptation measures are self-attainable, the lack of awareness has served as an obstacle to sustainable management of scarce resources including financial-wise. Education can also enhance voluntary emigration which would help to lessen the pressure that growing populations can exert on limited

resources, including land and food supplies. Continuous education and literacy is important to ensure that vulnerability is managed and adaptation strengthened.

One unconventional but considerable option would be to provide long-term training opportunities for the islanders so that they are encouraged to voluntary emigrate and settle wherever they are employed.

6.7 Water Resources and Ecosystems

A number of strategies were identified for each of the sector areas. For individuals, households, and communities, the following were suggested:

- supply adequate water tanks to the needs of the two communities
- use of better water storage system such as non-rust water tanks
- improved rain catchment strategies;
- creation of community water resources for humans, animals and crops

6.7.1 Water Tanks

The age old well water source have all been contaminated with salt water due to salt water intrusion. Several reports such as The Ontong Java High Swells Assessment Report(2008), The Solomon Islands NAPA Report (2008), ACOM Food Security Report (2010), The Vulnerability and Adaptation Household Survey (2011), and other report of earlier periods, have all implicated the adverse effects of the impacts of climate change

It is suggested that 40 water tanks be supplied to meet their current water needs. Supply should proportional to the population of the two communities which is 2057 (276 households) for Luaniua and 605 (116 households) for Pelau. This would mean 30 water tanks for Luaniua and 10 for Pelau.

The catchment for the water tanks will require 80 bags of cement, 200 pieces of 12 feet long roofing iron, I carton of roofing nails, 1 carton of 3inch nails, 1 carton of 4 inch nails, 160

pieces of 4inx4inx 8ft timber posts, 120 pieces of 4inx2inx12ft rafters, 120 pieces of 3inx2inx12ft purling.

6.7.2 Coastal Zone and Marine Ecosystems

Future adaptation methods should include the following:

Replant coastline

It is important that stabilizing shore line through tree planting trees along the coastline. Mangroves grow well in the swamps of the island but not along the coastline. Hence, planting of salt-water tolerant mangroves on the shoreline to protect the shores from erosion and flooding could also be considered. It may also be worthy to consider constructions of sea walls using simple technology, such as building of stonewalls.

Proper Management of Marine Resources

Regulate production and harvesting of marine resources to ensure sustainable use of the product. Proper management of marine resources can be achieved through proper training and awareness. Hence, education providers such as Solomon Islands College of Higher Education (SICHE) and the University of the South Pacific should be encouraged to provide training to the people on sound resources management. The government, both at the national and the provincial level together with the islands' Member of Parliament should also collaborate to enhance the capacity of the islanders so that they are better able to manage their scarce resources in a sustainable and efficient manner.

6.8 Energy, Industry, Commerce, and Financial Services

In the short and long terms, effective adaptation strategies are critical to meeting the challenges of climate change at the community level. Relevant measures will include the following:

6.8.1 Solar Energy

It is suggested that the use of solar energy must continue especially to provide lighting and other electrical needs. Besides the use of solar energy it will be more viable to also establish wood lots to provide firewood for cooking.

6.8.2 Business

Business must continue to be encouraged but it is suggested that cooperative form of business development could be an adaptation option to be considered which will enhance cooperative financial services and address financial literacy so that community members can manage the good income from their marine resources. It is understood that Solomon Islands has experienced challenges to the corporate society model in the past, however with the small population size and the great need to active business activities, the corporation model offers great opportunities for the islands to explore. In addition, other financial services and activities such as credit unions, with the assistance and support of Solomon Islands Credit Union, and women's fund should also be considered and encouraged.

6.9 Obstacles and Options to Adaptation

Obstacles to adaptation include the following:

6.9.1 Traditional Land Tenure System

The existence of traditional land tenure and land management systems that do not favour food security may create an obstacle to adaptation. This is partly due to the fact that most elders are very reluctant to give up coconut growing sites for other initiatives that would enhance the island' level of food security. This then require community awareness on the impacts of climate change and its suggested adaptation strategies. Land scarcity leading to adoption of unproductive and unsustainable farming practices are also matters of great concern.

6.9.2 Lack of Information

Lack of information (awareness) and knowledge (education) on the phenomenon of climate change is a major obstacle to the successful implementation of adaptation strategies.

6.9.3 Policy

Public policies that target adaptation at relevant stakeholder levels still need to be put in place. Policies do exist but only at the sectoral level. There needs to be mainstreaming of climate change policies through the Climate Change Division within the Ministry of Environment, Conservation and Meteorology and the establishment of a Climate Change Country Team to coordinate all activities currently ongoing that aim at improving the food security, adaptation and vulnerability of sensitive and exposed sectors, including locations such as Ontong Java. Clear strategies must be put in place to clearly map out challenges, solutions and current progress of activities that address the adverse effects of climate change and sea level rise. The Climate Change Division must be proactive to take the leading role in driving identified solutions, adaptation options and projects forward by formulating and implementing relevant policy directions and work programs that would enhance current adaptation capabilities of sites that are already identified and solutions determined.

7 Coping Capacity

7.1 Water Security

The people of Ontong Java are quite resilient. Over the years they have been able to cope with harsh weather patterns and unstable climatic conditions due to changes in global weather trends, including climate change and sea level rise. However, their level of resilience will not last forever given the worsening of global climatic conditions. For instance, over the years people have depended heavily on underground water for consumption and household use, including gardening. Today, with increasing sea levels these same water sources which have been used from one generation to another have become saline to the extent that they are no longer consumable. People now depend on rain water collected through water tanks and other means as well as natural coconut water. Even so, as mentioned earlier, not all families have access to water tanks and as population

pressure increases even coconuts are becoming a much less reliable source of drinking water. Hence, as time passes, the people's ability to catch and store water for consumption and agricultural purposes has lessened drastically.

7.2 Food Security

Food supply and availability is also one of the major determinants of the peoples coping capacity and ability. Rich agricultural soil is scare therefore people have depended on traditional farming, preparation and storage methods to survive. However, traditional farming methods are now being seriously challenged due to salt water intrusion, and so are their food preparation and storage methods due to a range of factors, including increasing dependence on imported food and social change which leads to a general erosion of traditional norms and practices.

With the people's increasing dependency on imported goods, Honiara is the only source of food supply. However, as highlighted earlier, shipping services are not always reliable and many times people resort to whatever means they can to be able to survive. Often these short-term means of survival results in people consuming food but those that does not contain important healthy dietary requirements, such as protein.

This threat and vulnerability in food security is worsened by the fact that traditional farming methods which the people have depended and survived on for many years are now being seriously challenged due to increasing sea levels which results directly in salt water intrusion. In addition, many garden sites that have been used for centuries are now abandoned as the sea erodes the coastal regions and infiltrates low-lying locations. People are now moving to other sites to make gardens and most of these new locations are sandy soils which are not suitable to food plants such as swamp taro. Hence, there are very limited crop varieties that can adapt well to change in soil conditions. The shift in agriculture practices due to changing climatic conditions have really impacted greatly on the coping ability of the people on the island.

Table 10: Some identified adaptation options summary matrix

Adaptation Options	Effectiveness	Costs	Technically feasible	Social and cultural feasibility	Speed of implementation
Introduce new farming systems, suitable slat resistant crops and build on existing ACOM FSP	Medium	High	High	Medium	Low
Traditional Food Preservation Practices	Medium	Medium	High	High	Medium
Supply of Water Tanks for rural communities	Medium	Medium	High	High	Medium
Climate Change Awareness	Low	High	High	High	Medium
Environment and resource management training for communities	Medium	Low	High	Medium	High
Financial Literacy Training	Medium	Low	Medium	High	High
Improve communications	Low	High	High	Medium	Low
Improve Shipping Services	Low	High	High	Low	Low
Relocation Plan	Low	High	High	Low	Low

8. Conclusion and Recommendation

This assessment and study on the vulnerability and adaptation to climate change of the people of Ontong Java reveals information from which some conclusions can be drawn:

The impacts of Climate Change on Agriculture, Food Security, Land Degradation, Forestry, and Biodiversity are far ranging. Salt water intrusion in the garden land coupled with coastal inundation and erosion has highlighted big concerns for the people's livelihood particularly on the food security and fuel wood. Land degradation will need to be corrected. Food security improvement depends very much on how agriculture, land degradation, forestry and biodiversity are improved. New sustainable and permanent farming systems need to be designed and developed to enhance the production of food and other livelihood needs in order to meet the demands of food security. The survey highlighted other areas of the people's conception about what food security means to them. They include transport and communication, marine resources from which they derived a lucrative income. Shipping brings a lot of food from Honiara such as cassava, rice, flour and other non food items. They are able to do this because they get good income from marine products.

Human Settlements will be affected by impacts of climate change especially due to sea level rise and coastal erosion. Already Pelau community has experienced such a situation by

moving further inland from king tides and storm surges. A temporary village on an island was almost eroded away. The people had expressed concern and in the household survey 100percent of the respondents showed that they favour relocation if the Government offered alternative sites for people to move to. With regard to health the people are vulnerable because of the contamination of water wells by salt water caused by sea level rise. One other concern is the people's diet. The survey showed that food intake is lacking in protective foods. This means that strong effect must be make to grow vegetable crops to provide this dietary need.

Water resources are a vital need. Being atoll islands Luaniua and Pelau do not have rivers nor do they have streams and springs. Wells are contaminated with salt water. There needs to improve water catchment for the need of the people, livestock and crops.

The present or future governments, Non-government Organisations and all other stakeholders should demonstrate that they are concerned about climate change phenomenon and its possible impacts on man and the ecosystem by taking affirmative actions to address it. Alternatives should be created which would serve as adaptation strategies for the citizens of Ontong Java and all others that are immediately affected by the impacts of climate change. It is imperative that the government institutes policies that will address all aspects of climate change, and effectively plan for and understand the short, medium and long-term response measures required to address all aspects cited in this report. What is urgently needed at present is the will to pursue a proactive approach to climate change and its impact on Ontong Java or those who are vulnerable to the effects of climate change.

Some priority needs that has to be addressed include financial literacy programmes, climate awareness, education and training, capacity building for agriculture, sustainable environmental stewardship, resource management training and planning, and a phased out implementation of relocation options, plans and strategies.

7.1 Lessons Learnt during the Assessment

- The church organised group has a lot of influence in the community and there is a need to do a wider range of consultation with them before different adaptation activities can be carried out on the island.

- It was found that communication and transport sector plays a vital role in the acquisition of food from Honiara and bringing it to the atoll island communities.

- The other sector which also plays a role in ensuring the capacity for acquiring food is the marine resources which provide the people a lucrative income.

- There is a strong chiefly system on the island so future consultations has to be in line with the current structure

- Adaptation activities, such as the ACOM and other implementing agencies are ongoing. However, there has to be close collaboration between the agencies to avoid duplication and misunderstandings.

7.2 Recommendations: The Way Forward

It is recommended that the following actions could be implemented immediately or supported by the government policies aimed at addressing vulnerability and adaptation to climate change in the multi-sectors cited in this report. It must be recognised that these generic recommendations are cross- or multi-sectoral in nature therefore their successful implementation requires close collaboration and partnership by all stakeholders.

7.2.1 Short term

- Set up community-based climate change adaptation committee for Ontong Java atolls, recognising the partnership and role of church-based and community-based organisations such as mothers union, companions, chiefs and other community leaders

- Study or look and learn visit to other Pacific island countries to learn about issues like type of crops suitable for atolls environment and water management systems and practices.

- Supply of water tanks to the communities to address water shortage issue, coordinated in manner like 1 family per 350 gallon tank.

- Environmental impact assessment as a precondition for approval of projects in the identified vulnerable sectors.

- Build on the existing foundation set up by Anglican Church of Melanesia climate change network and work with Malaita NDMO climate change office.

- Instalment of meteorological instruments to boost climatic awareness, mitigation and preparedness

7.2.2 Medium term

The medium term recommendations would need to be addressed more as strong priorities because they reflect directly on the people's need as seen in their vulnerability and adaptation perceptions. They are:

- Advocacy and education on climate change variability and their impacts on the people, livelihood, and the environment.

- Employment of new farming methods, and identification and trial of new crop varieties. Being a low atoll islands Ontong Java soils is very infertile, thus efforts must be made to introduce new farming systems to help out with the atoll's agriculture.

- Improved communication to enhance good flow of information especially between Honiara and the Atolls. Possibilities of involving currently available advanced communication technologies should be explored.

- Send regular multi sectoral assessment, awareness and service offering teams to the islands to raise awareness amongst communities of the importance of sustainable

harvesting of resources, health, climate change and give clear information on how they can address these issues themselves.

- Run financial literacy courses in Ontong Java to enable communities to better manage money coming from resources like Beche-de-mer and implement projects which ensure sustainable livelihoods and opportunities. If people are going to be able to cope with the impacts of climate change, then their vulnerability in terms of financial management will need to be addressed.

- Arrange with telecommunication companies like Solomon Telekom and Bemobile company to expand their services in the two main islands, and will monitor and trace for early warnings and information dissemination during natural hazards such as tsunamis, cyclones, storm surges, sea water intrusions, king tides etc.

7.2.3 Long term

- Specialised training of identified Ontong Java individuals about climate change vulnerability and adaptation issues. Studies and trainings should be incorporated with Climate Change Division within the Ministry of Environment, Conservation and Meteorology and should be encouraged by training institutions such SICHE through its School of Natural Resources Programme and Rural Training Centres, an NGO's such as Custom Garden.

- Traditional practices, including agro forestry harvesting practices and food preservation practices must be maintained for sustainability.

- Encourage voluntary migration through practical means such as inter marriage with the people who live on bigger islands and the provision of scholarships for potential people, especially educated youths of the islands

- Impose strict quarantine measures to restrict introduction of new crop varieties. Introduced crop varieties should only be brought to the islands after properly clearly by relevant government authorities.

- Commencing studies and planning for relocation to Main Island. This must be done in consultation with the people of Ontong Java for a place of their choice to avoid fear of what the future may bring.

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APPENDIX

Annex 1: ACOM Food Security Project Activities

Project Goal: Improve food security and reduce vulnerability of the people Ontong Java to food shortages by 2015.	**Outcome**: The people of Ontong Java both in Luaniua and Pelau achieve food security and basic humanitarian nutritional standards by 2015.	**Output 1**: The House of Chiefs, and other Community leaders, and the people of Ontong Java improve capacity to manage food security issues within their own resources.
Activities: 1.1 Training for Community leaders to improve capacity to assess and plan responses to emerging food security challenges. 1.2 Conduct a Participatory Rural Appraisal (PRA) in target communities to assist community leaders to work together, collect baseline information and establish a Community Based Disaster Risk Reduction Committee. 1.3 Community self-reliance planning meetings to improve community capacity to plan and manage food security issues within own resources. 1.4 Two training of trainer workshops in food security self-reliance skills. Training workshop topics will include food preservation, accessing local foods and appropriate cooking. 1.5 Monitoring and support to communities to facilitate implementation of self-reliance skills *1.6 S*upport to NDMO to respond to requests for food security assistance. Support to focus on assisting NDMO to conduct humanitarian food security assessments		
Output 2: Target communities improve subsistence agricultural production so that basic food needs		

of each family can be met through family agriculture.

Activities:

2.1 Two improved subsistence agriculture seminars at each target community. Seminars to cover topics including: composting, crop diversification, basic pest management.

2.2 Four training of agricultural trainer programs: Two in Luaniua and two in Pelau. Training will be in cooperation with Kastom Gaden Association (local NGO) and the Department of Agriculture. Training will build a pool of skilled community agricultural trainers that will be a resource to each community. Development of training program may require research into appropriate farming system, planting materials and composting techniques.

2.3 Four pilot plots established on Luaniua and four on Pelau to demonstrate and to improve subsistence agricultural production so that basic food needs of each family can be met through family agriculture.

2.4 Monitoring and technical support to communities to facilitate improvement in agriculture.

Output 3:

Target communities improve access to income by 10percent in each family to reduce vulnerability to food insecurity.

Activities:

3.1 Improved financial planning seminars at each target community. Seminars to cover topics including: goal setting, family financial planning, cost-benefit analysis, marketing and saving.

3.2 Research and report on the viability of small-scale income generation options for

communities.

3.3 *Two* training of income generation skills trainer programs. Training will build pool of skilled community trainers that will be a resource to each community.

3.4 Distribute, based on demonstrated performance and commitment, essential non-local materials for appropriate small income generation activities.

3.5 Monitoring to facilitate dissemination of income generation skills training and support financial planning.

Output 4:

Project effectively managed throughout the project cycle, with an effective monitoring and evaluation system established to feed lessons learned back to participating communities.

Activities:

4.1 Ensuring appropriate staffing of project for optimal project implementation and monitoring.

4.2 Active and ongoing involvement of Government authorities and NGO partners in designing, implementing and monitoring of project progress

4.3 Project Coordinator provides regular quarterly narrative and financial reports that incorporate lessons learned.

4.4 Project Monitoring and Audit throughout project life and End of Project Evaluation, completed within 30 days of project closure.

Tables and figures

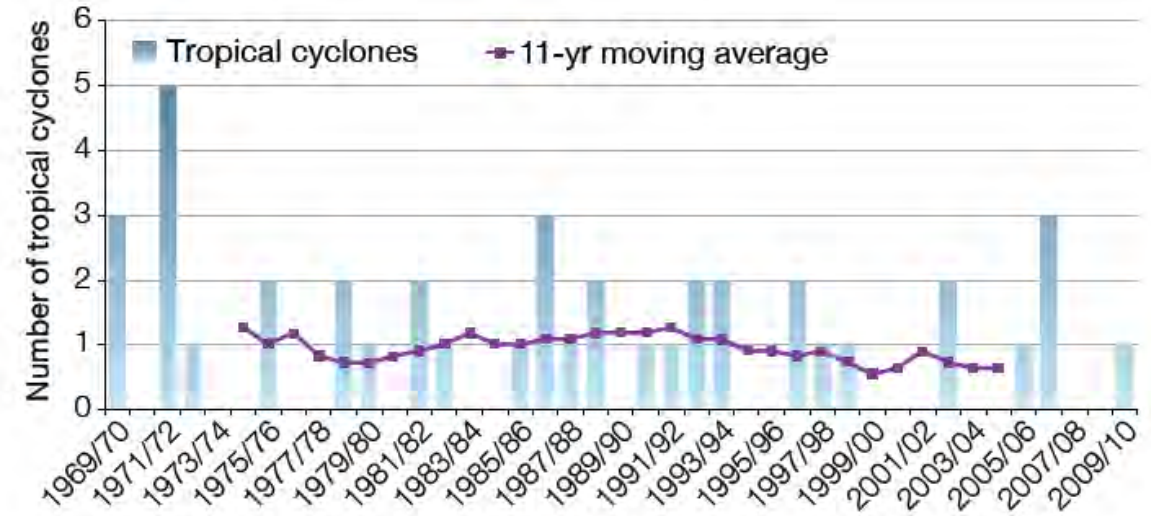
Table 1: Cyclone chronology, Solomon Islands

Year	Name of Cyclone	Duration	Mean Maximum wind (kts)	Minimum pressure Hectopascal (hPa)
1951	No name given	23-26 Feb	n/a	n/a
1951	"	24 Mar-01 Apr	"	"
1952	"	24-25 Jan	"	"
1952	"	22 Mar-08 Apr	"	"
1955	"	03-11 Apr	"	"
1968	"	18-24 Apr	"	"
1958	"	05-11 Jun	"	"
1959	"	07-14 Mar	"	"
1959	"	20-30 Dec	"	"
1961	"	07-13 Jan	"	"
1961	"	27 Jan-04 Feb	"	"
1961	"	02-08 Mar	"	"
1961	"	29 Nov-03 Dec	"	"
1963	"	21-26 Apr	"	"
1963	"	03-09 May	"	"
1963	"	08-14 May	"	"
1966	Angela	14-19 Nov	73	998
1967	Dinah	23 Jan-02 Feb	n/a	n/a
1967	Barbara	16-33 Feb	n/a	n/a
1967	Glenda	26 Mar-08 Apr	63	980
1967	Annie	10-16 Nov	63	998
1968	Giselle	03-09 Apr	35	980
1968	Becky	11-13 Dec	n/a	n/a
1969	Collen	27 Jan-05 Feb	n/a	n/a
1969	Esther	26 Apr-02 May	n/a	n/a
1970	Isa	13-18 Apr	34	998
1971	Ursula	02-16 Dec	100	940
1971	Althea	20-30 Dec	n/a	n/a
1972	Carlotta	05-21 Jan	71	940
1972	Wendy	30 Jan-02 Feb	n/a	n/a
1972	Emily	25 Mar-01 Apr	69	940
1972	Hannah	08-11 May	n/a	n/a
1972	Ida	30 May-03 Jun	52	952
1973	Marge	01-08 Mar	n/a	n/a
1976	Alan	30 Jan- 02 Feb	n/a	n/a
1976	Colin	26 Feb-04 Mar	n/a	n/a
1977	Norman	Date unknown		
1979	Kerry	13-18 Feb	70	945
1982	Bernie	01-07 Apr	43	970
1985	Hina	12-17 Mar	95	n/a
1986	Namu	15-22 May	63	983
1987	Blanch	22-23 May	45	990

1988	Anne	09-14 Jan	65	n/a
1989	Lili	06-12 Apr	75	995
1989	Meena	04-09 May	45	n/a
1991	Tia	14-21 Nov	72-93 (AWS)	987.9 (AWS)
1992	Betsy	06-08 Jan	45-55 (AWS)	n/a
1992	Esau	27 Feb-04 Mar	80	n/a
1992	Innis	28-30 Apr	35-55	n/a
1992	Kina	26-28 Dec	30-50	n/a
1992/1993	Nina	30 Dec-03 Jan	75-100	n/a
1993	Rodger	12-13 Mar	34-47	n/a
1993	Rewa	28-30 Dec	45-65	985
1994	Tomas	23-25 Mar	45-55	987
1994	Usha	24-26 Mar	40-50	987
1994	Vania	13-14 Nov	30-40	n/a
1996	Beti	22-28	n/a	n/a
1996	Fergus	23-30 Dec	80	960
1997	Drena	03-06 Jan	90	935
1997	Justin	15-19 Mar	80	950
1998	Susan	02-05 Jan	125	900
1998	Katrina	06-08 Jan	60	975
1998	Yali	18-20 Mar	45-50	990
1999	Dani	n/a		
1999	Ella	10-12 Feb	45	987
2001	Paula	25-27 Feb	90	935
2002/2003	Zoe	23 Dec-01 Jan	130	n/a
2005	Kerry	06-12 Jan	50	n/a
2010	Ului	14-17 Mar	65	n/a
2011	Vani	13- 15 Jan		
2011	Zelia	15-16 Jan		
2011	Yasi	30 Jan-01 Feb		

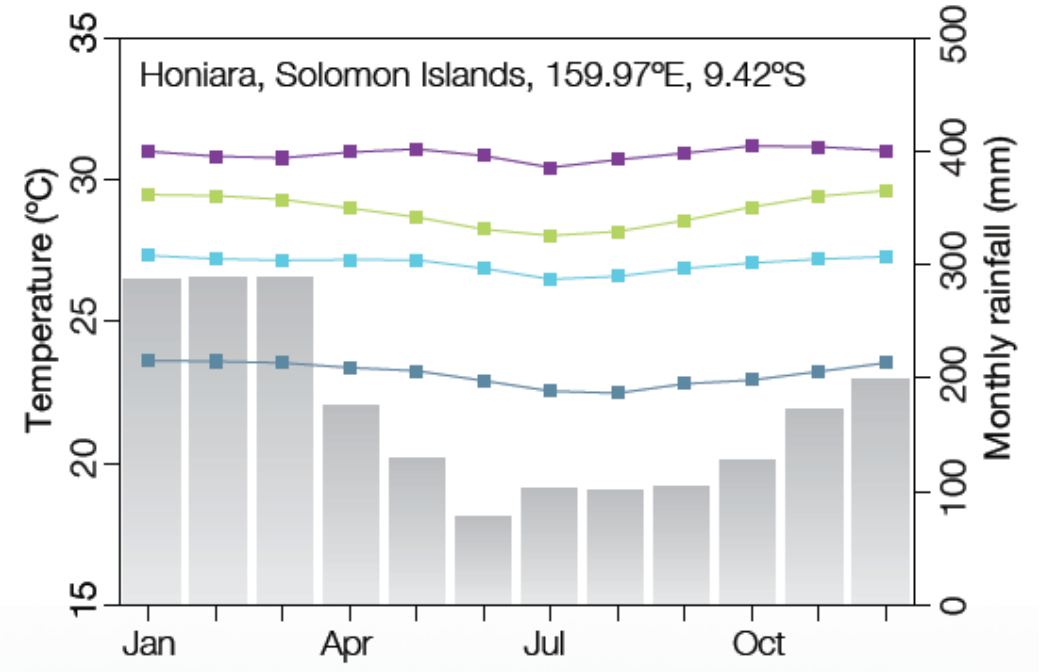
[Source: Solomon Island Meteorological Office, 2011].

Fig 1: Number of tropical cyclones passing within 440-km of Honiara. Eleven year moving average in purple



[Source: PACCSAP Program, accessed at www.cawcr.gov.au]

Fig 2: Seasonal temperature and rainfall in Honiar



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[Source: PACCSAP Programme]

Fig 3: Annual average temperatures for Honiara. Light blue bars indicate El Nino years, dark blue bars indicate La Nina years and the grey bars indicate neutral years.

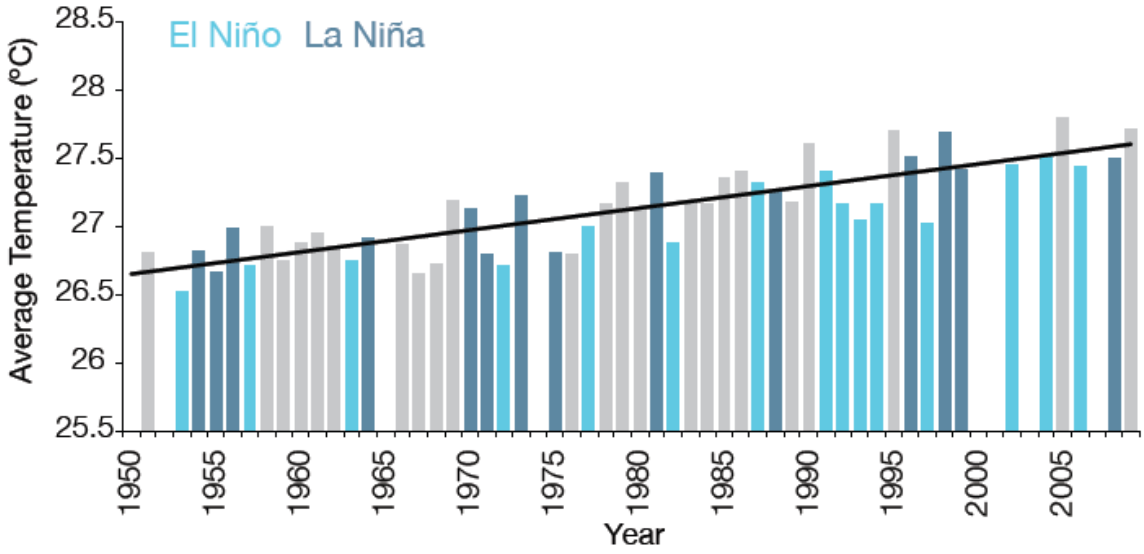
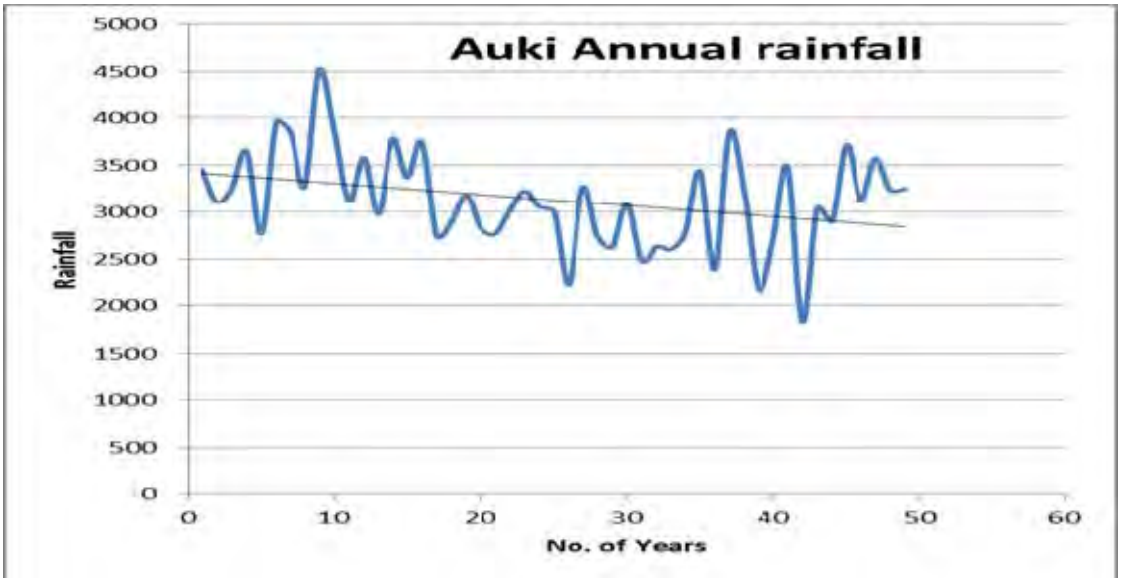
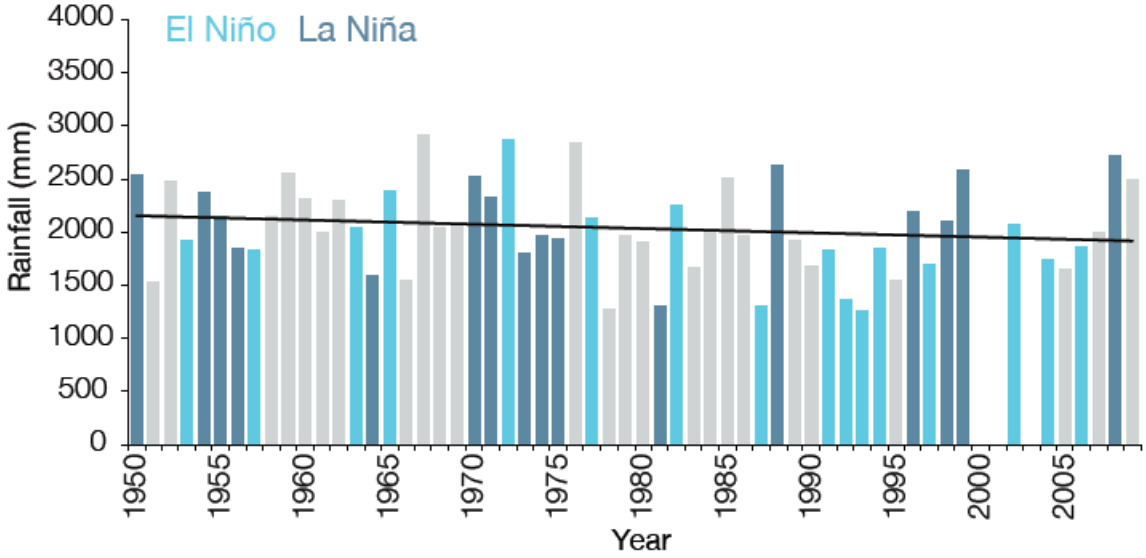


Fig 4: Annual rainfall trend of Auki, Malaita Province



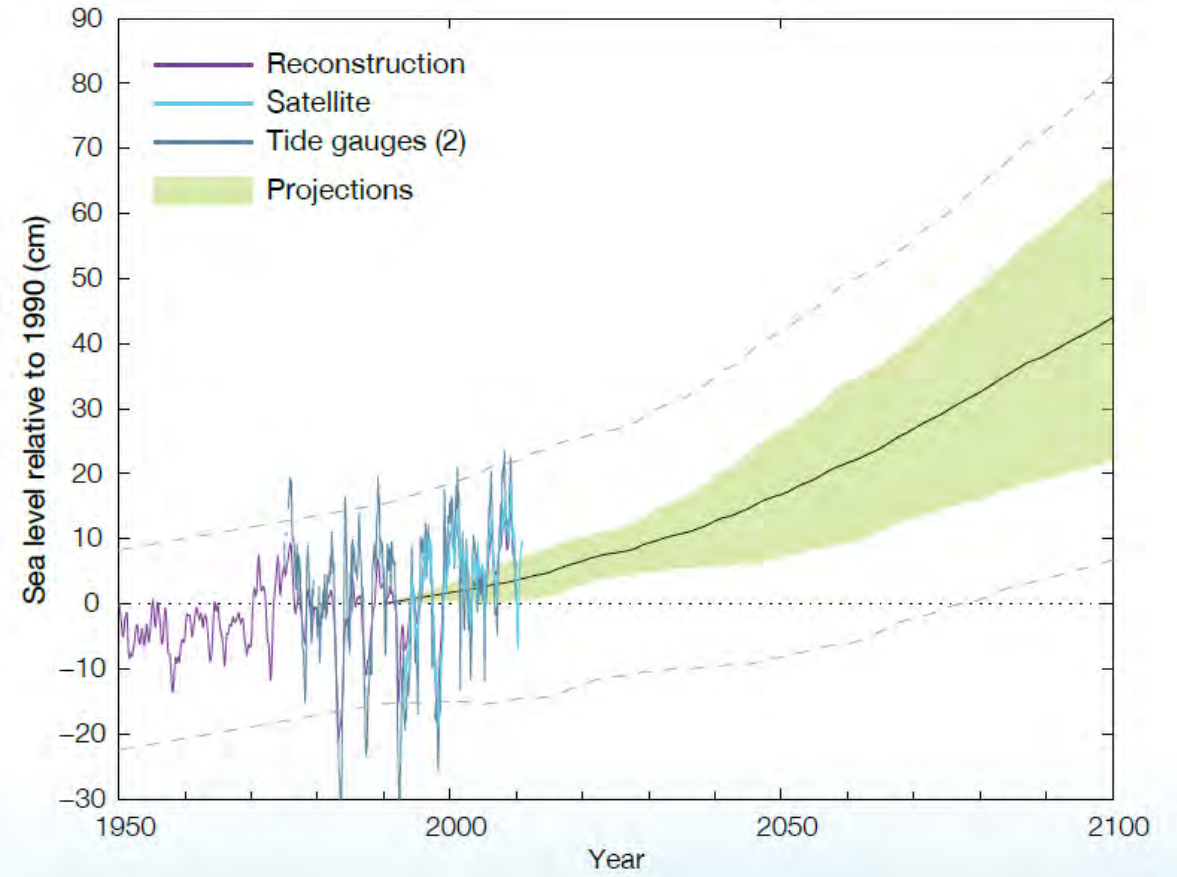
[Source: Solomon Islands Meteorological Services]

Fig 5: Annual rainfall for Honiara. Light blue bars indicate El Niño years, dark blue bars indicate La Niña years and the grey bars indicate neutral years.



[Source: PACCASP Program, accessed at www.cawcr.gov.au]

Fig 6: Observed and projected relative sea-level change in Solomon Islands. The observed sea-level records are indicated in dark blue (relative tide-gauge observations) and light blue (the satellite record since 1993). Reconstructed estimates of sea level near the Solomon Islands (since 1950) are shown in purple. The projections for the A1B (medium) emissions scenario (representing 90% of the range of models) are shown by the shaded green region from 1990 to 2100. The dashed lines are an estimate of 90% of the range of natural year-to-year variability in sea level.



[Source: **PACCSAP Program,** www.cawcr.gov.au**]**

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Fig 7: Projected annual average air temperature changes for the Solomon Islands for three emissions scenarios and three time periods. Values represent 90% of the range of the models and changes are relative to the average of the period 1980-1999.

	2030 (°C)	2055 (°C)	2090 (°C)
Low emissions scenario	0.2–1.0	0.7–1.5	0.9–2.1
Medium emissions scenario	0.4–1.2	0.9–1.9	1.5–3.1
High emissions scenario	0.4–1.0	1.0–1.8	2.1–3.3

Coastal erosion on Pelau

A sketch of Pelau island identifying vulnerable locations.

Household Survey in Luaniua

Table 3: Original and final sample of the 2011 HHS

Community	Original Sample				Final Sample	
	Estimated population	Households	Sample households	Sampling fraction percent	Sampled households	Sampling fraction percent
Luaniua	2057	278	56	20	42	15

Pelau	800	116	20	20	18	15

[Source: HHS, 2011]

Community members of Luaniua participating in the workshops

PRA at Pelau

Some food crops on Ontong Java

Immature rotting of swamp taro tubers on Ontong Java

Yellowing of taro leaves due to severe heat

Table 4: MATRIX of Issues, Problems, Coping and Solution– Ontong Java Communities

ISSUES	PROBLEMS	COPING	SOLUTION
Human Settlement Health	• Overcrowding, • Sickness, • Hunger, • Land shortage, • Domestic violence	• Migration, • Keep clean, hygiene • Balanced diet, hard work, • Forward planning • Married out, • Awareness programme and teaching	• Control underage marriages • Need more medicine, nurse, clinic • NDMO Supplies • Resettlement • Police post
Water Resources, Wetlands, Fresh Water Ecosystem	• Saltwater Intrusion (sea-level rise), • Lack of fresh water, Freshwater more brackish	• Shifting cultivation • Dig more wells. • Plant more coconut trees plant on higher ground	• Move to better gardening locations (good soils), • More water tanks, • More mulching
Energy Industries, Commerce and Financial Services	• Too expensive • Destroys ocean environs & resources • Lack of alternatives	• Use fire and shell coconut for lighting, use outrigger canoes for sailing	• Use Solar Power, Pressure lamps, manpower
Agriculture, Food Security, Land Degradation, Forestry Bio-Diversity	• Loss of soil • Lack of crops, trees due to indiscriminate cutting for firewood & demand from growing population	• Need more mulching. • Need to plant more mangroves and fruit trees	• Need more good soils, need to build seawall

Coastal Zone and Marine Ecosystem	• Coastal erosion	• Plant more trees along coast • Build-up coastal debris to create higher coastline • Build seawall • Plant mangrove	• Request outside expertise

[Source: PRA workshop]

Table 5: Percentage distribution of total sampled household income by source

Source of Income	Value	Percent (%)	Number	Percent (%)
Beche – de – mer	12,160,000	95.4	60	100
Trochus	480,000	3.7	60	100
Shark Fin	60,000	0.47	60	100
Copra	13,333	0.1	4	7
Pig	16,000	0.13	2	3.3
Wages and Salary	12,000	0.09	1	1.3
Remittances	1000	0.008	1	1.3
Total	12,742,333	100	60	100

[Source: HHS 2011]

Fig 8: Bar Chart showing the percentage distribution of total sampled household income by source.

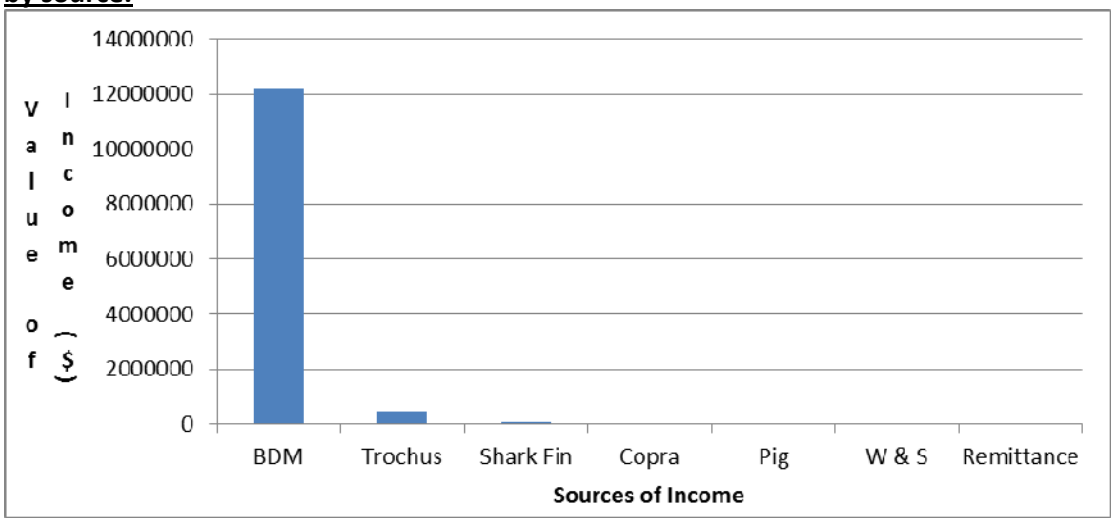

Table 6: Total expenditure by expenditure group

Expenditure Group	Amount (SBD$)	Percentage (percent)

School fees	68,000	0.7
Transport costs (i.e. fuel for outboard, and or payment for ride to town etc)	922,400	8.9
Food	6,518,160	63
Personal Expenses (cigarette, alcohol, clothes, betel nut, etc	706,310	6.8
Household equipment (pots, pans, buckets, radios, lamps, radios, etc)	480,000	4.7
Disposable household products (i.e. soap, washing powder)	390,000	3.8
Other equipment and assets (nets, boat parts, tools, engine parts etc)	1,248,000	12.1
Donations to church Ceremonies, weddings etc?	15,000	0.4
Total	1034870	100

Fig.9: Chat showing total expenditure by expenditure group

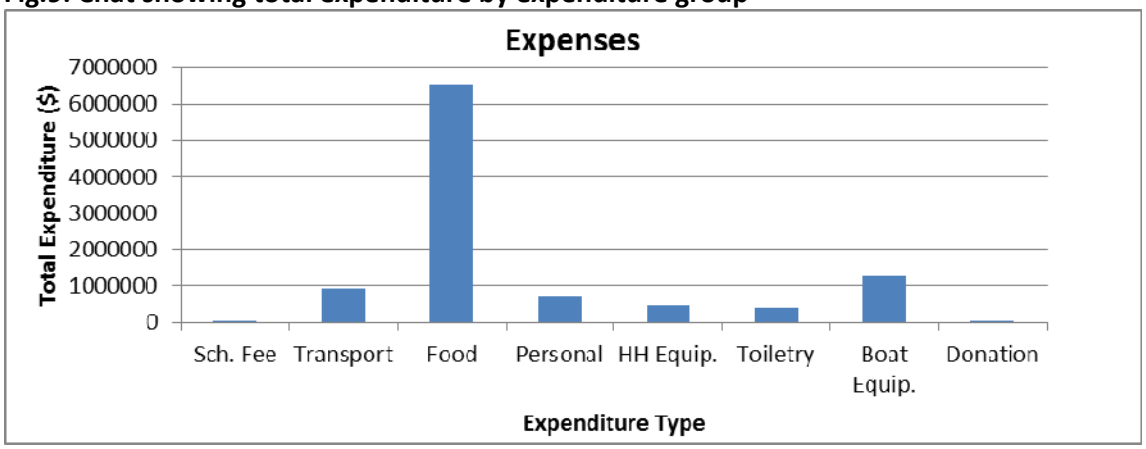

Fig 10: Bar Chart- Percentage of dietary food intake by period

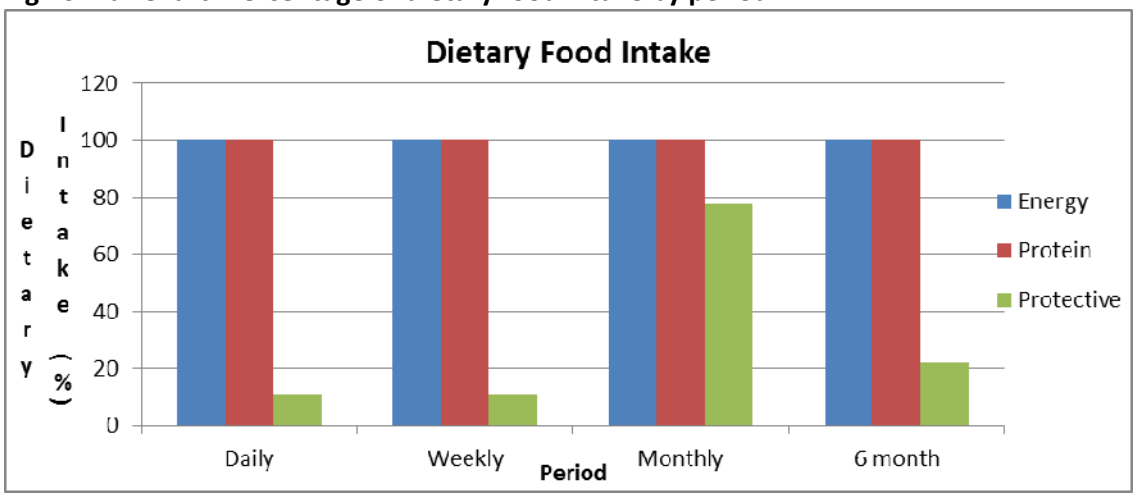

Table 7: Shows hazards increasing frequency and increasing impact on the household

Hazards	Frequency (increasing)	Impact (increasing)

Drought	√	√
Flooding	√	√
Saltwater intrusion into food gardens	√	√
Saltwater intrusion into wells	√	√
Sea Level Rise	√	√
Beach Erosion	√	√
Coral Bleaching	√	√
Extreme Storms of Cyclone	√	√
Hotter Climate	√	√
Changes in weather (i.e. rainy season, dry periods, wind patterns etc leading to changes in planting season etc.)	√	√

[Source: HHS 2011]

Table 9: Household livelihood being impacted by hazards

Livelihood	Tick all that have been impacted	Identify Hazards that have caused the impact	Three most impacted
Water supply	√	Saltwater intrusion into wells	1
Food gardens	√	Drought, heat, saltwater intrusion	2
Bush areas	√	Coastal erosion and inundation	
Fishing grounds	√	Coral bleaching	
Transportation	√	Lack of reliable shipping	
Communication	√	No telecommunication	
Loss of property	√	Cyclone, erosion, saltwater intrusion	
Loss of village cemetery	√	Coastal erosion	3

[Source: HHS 2011]

Table 10: Food crop types on Ontong Java

Tree crops	Root crops	Vegetable crops
• Breadfruit (Artocarpus altilis) • Polynesian Chestnut (Inocarpus fagiferus) • Funny Face (Spodius	• Swamp taro (Cyrtosperma chamissonis) • Kongkong taro (Xanthosoma esculenta)	• Bananas -3 varieties (musa sp.) • Pawpaw (carica papaya) • Pumpkin (Cucurbita

cyathera) • Malayan Apple (Eugenia malacsensis) • Local Avocado (Burkela obovata) • Cutnut (Barringtonia procera) • Alite Nut (Terminalia catapa)	• Stem taro (Alocasia esculenta) • Selfish taro (Colocasia esculentum) • Topia • Pacific Yam (Dioscoria numularia)	pepo) • Egg plant (Solanum melongena)

Table 11: Identified adaptation options summary matrix for PACC V & A assessment

Adaptation Options	Effectiveness	Costs	Technically feasible	Social and cultural feasibility	Speed of implementation
Introduce new farming, suitable crops and build on existing ACOM FSP	Medium	High	High	Medium	Low
Traditional Food Preservation Practices	Medium	Medium	High	High	Medium
Supply of Water Tanks for rural communities	Medium	Medium	High	High	Medium
Climate Change Awareness	Low	High	High	High	Medium
Environment and resource management training for communities	Medium	Low	High	Medium	High
Financial Literacy Training	Medium	Low	Medium	High	High
Improve communications	Low	High	High	Medium	Low
Improve Shipping Services	Low	High	High	Low	Low
Relocation Plan	Low	High	High	Low	Low

Map of Solomon Islands indicating, Ontong Java, the study site

[*Source: Google Maps*]

Abbreviations and Acronyms

ACOM	Anglican Church of Melanesia (Food and water security project)
EDA	Eastern Development Agency
PRA	Participatory Rural Appraisal
PACC	Pacific Adaption to Climate Change
IPACC	Inter-governmental Panel on Climate Change
MAL	Ministry of Agriculture and Livestock
MECDM	Ministry of Environment, Climate Change and Disaster Meteorology
MFMR	Ministry of Fisheries and Marine Resources
NDMO	National Disaster Management Office
SPREP	South Pacific Regional Environment Progamme
SIG	Solomon Islands Government
UNFCCC	United Nations Framework Convention on Climate Change