

AN ASSESSMENT OF THE IMPACT OF CLIMATE CHANGE ON AGRICULTURE AND FOOD SECURITY

A CASE STUDY IN VANUATU



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EXECUTIVE SUMMARY



Vanuatu is highly vulnerable to all natural hazards including tropical cyclone, storm surge, coastal flood, river flood, drought, earthquake, landslide, tsunami and volcanic eruption. Impacts from these events will be inequitably spread throughout the islands, with localized areas on low-lying islands and areas experiencing subsidence due to tectonic and volcanic processes being the most severely affected.

The impacts of climate change and increased carbon dioxide concentrations on plant growth, productivity and the nutrient value of crops commonly grown in Vanuatu is not well understood. However, general knowledge of possible impacts suggests changes may be detrimental to agricultural production and hence national food security.

Both commercial and subsistence agriculture in Vanuatu are based on rain-fed agricultural production systems. Changes in rainfall, and in particular the projected scenario of overall rainfall decline, a greater proportion of rainfall falling in association with high intensity storm events during the wet season, increased evaporation and more pronounced dry seasons, could have severe impacts on agricultural production. Intense rainfall during planting seasons could damage seedlings, reduce growth and provide conditions that promote plant pests and diseases. More pronounced dry seasons, warmer temperatures and greater evaporation could cause plant stress reducing productivity and harvests.

The alternate scenario of increased rainfall could have equally severe impacts, with water-logged soils decreasing agricultural production, while increased humidity and rainfall could provide ideal conditions for the proliferation of a number of plant pathogens.

Some agricultural crops are already showing signs of stress under current climatic conditions. Water scarce areas and small islands that depend entirely on rainwater and under groundwater sources are also experiencing severe water shortages. Coastal erosion and inundation are reported from coastal communities and fish poisoning has been an emerging problem in recent years. These problems will be aggravated by any further changes to current climatic conditions. And while

some progress has been made in recent years to understand and appropriately address climate change issues, there is currently limited data to enable Vanuatu to plan effective responses to climate change impacts.

Although Vanuatu has benefited from participation in a number of regional and national climate change projects in the past ten years or so, these have had limited long term impacts due to the lack of government funding to maintain staff positions and continue awareness raising at all levels. Government agencies focus on immediate and practical priority issues and have difficulty maintaining levels of service necessary to effectively address long term issues such as climate change. Hence, while recognizing the long term importance of reducing GHG emissions and preparing for climate change, it has been difficult for the government to take the longer term economic decisions necessary to effectively deal with the issue. This situation is unlikely to change soon and as a consequence, Vanuatu will continue to look at its development partners and UN organizations for assistance to adapt to climate change.

SUMMARY OF RECOMMENDATIONS

- ~ The government should pay more attention to controlling population growth rate as an important part of any strategy to reduce the impact of climate change on the social and economic wellbeing of the country and its people.
- ~ The government should strategically address a limited number of clearly identified priority issues and actions based on the greatest needs and risks from climate change.
- ~ The government should continue to support the work of the National Advisory Committee on Climate Change (NACCC) as an effective means of advocacy for the UNFCCC and other climate change related agreements.
- ~ Human resource development initiatives need to be continued and expanded if Vanuatu is to be able to deal with the growing and complex issues associated with climate change.
- ~ Improving service delivery to rural areas should be made an explicitly higher priority for donor-funded developments in future.
- ~ Efforts should continue to improve the awareness and understanding of rural communities and farmers about the impact of climate change on their livelihood.

- ~ In the absence of site specific data and information, the findings and lessons learned from studies already completed in Vanuatu should be used to guide future efforts to plan for climate change.
- ~ Efforts should continue to increase the number of smallholders, promote the use of traditional food crops and provide support to make food gardens more sustainable.
- ~ The Ministry of Agriculture should improve and expand its plant breeding programme by decentralization and by broadening the genetic base of traditional crops as well as by providing basic training for rural farmers.
- ~ Government should provide support to NGOs and Civil Society Organizations (CSOs) to strengthen their accountability and general project management skills and knowledge especially in locations where government service is limited or absent. Care should however be taken to make sure that this support is not done in a way or scale that will overwhelm them.

INTRODUCTION

At the 6th Meeting of Ministers of Agriculture from the South West Pacific region held in the Cook Islands from 1–3 June 2005, the Ministers, in reaffirming their commitment to enhancing food security in the region, noted the increasing need for prudent policies based on more in-depth analyses of the prevailing macroeconomic conditions and taking into account non-economic concerns. The meeting recommended that studies be carried out to assess the impact of climate variability on agriculture and food security in the region and the capacities of countries to implement international and regional agreements relating to agriculture. This recommendation was again reinforced during the 7th Meeting of Ministers (Majuro, Marshall Islands 29–31 May 2007) which amongst other things, urged FAO to pursue a study to assess the impact of climate change on agriculture and food security in the Pacific Islands region.

This study was undertaken in accordance with the above recommendations of the 6th and 7th Meetings of the Ministers of Agriculture from the Pacific Islands. A desk review of existing climate change related reports and publications on Vanuatu was undertaken from 8 to 20 October 2007 and an in-country consultation carried out from 22 October to 8 November 2007.

PHYSICAL AND NATURAL ENVIRONMENT OF VANUATU

LOCATION

The Republic of Vanuatu is an archipelago comprised of some 80 islands scattered over a distance of 1 300 kilometers from North to South in the Western Pacific Ocean. The islands lie west of Fiji and north of New Caledonia between latitudes 12° and 23° South and longitude 166° to 173° East. The Vanuatu islands have a combined land area of 12 190 square kilometers and a maritime exclusive economic zone (EEZ) of 680 000 square kilometers. The two largest islands of Espiritu Santo and Malekula comprise nearly 50 percent of the total land mass while the two main urban centers, Port Vila and Luganville support 16 percent and 6 percent of the population respectively.

POPULATION

The population of Vanuatu is estimated at 209 920 people, with an annual population growth rate of 2.6 percent distributed amongst 36 415 households. This represents an increase of 6 897 households from 1999 when the national population was 186 678 (Agricultural Census, 2006). About 80 percent of the country's population live in rural villages ranging from one family to several hundred people on the seven islands of Efate, Espiritu Santo, Tanna, Malekula, Pentecost, Ambae and Ambrym.

The ni-Vanuatu people, a Melanesian race, dominate the population which includes French, British, Australian, New Zealand, Vietnamese, Chinese and other Pacific Island races.

Inter-island and intra-island travel and communication is difficult and expensive. The large volcanic islands with rugged terrain and tropical forests mean that villages tend to be scattered and separated over large distances. The number of telecommunication facilities is often very limited on islands with national radio reception lacking in many areas.

The limited road networks are confined to the larger islands, mainly around the major population centers situated on the coasts. There are regular shipping services to the central islands, but the outer islands are serviced irregularly. Air Vanuatu, the locally-owned company which operates domestic and international flights, provide daily passenger and cargo flights between Efate, Tanna, Malekula and Santo, but many of the smaller islands are served only 2 or 3 times per week. Many of the smaller islands

do not even have airstrips. In terms of infrastructure, Vanuatu has 29 airports, (5 paved and 24 unpaved) and approximately 1 894 km of roadways (111 km paved and 1 783 km unpaved), and two main ports and terminals, Port Vila and Santo (NACCC, 2007).

GEOLOGY

Vanuatu's islands are young in geological terms, small and highly disturbed as a result of natural cyclones, seismic and volcanic activity. Tectonic uplift is well documented in many areas of the country, while a few islands demonstrate subsidence. Active volcanism also impact on a number of islands. Because of the extent of tectonic activity affecting Vanuatu, it is difficult to attribute apparent changes in sea level to the effects of climate change. However, for much of the country, it is assumed that tectonic uplift of islands will proceed at a greater rate than sea-level rise. Nevertheless, there are concerns that sea-level rise might have locally severe impacts in the Torres Group, Aneityum, East Ambae, Shepherds Islands and the two towns of Port Vila and Luganville (GoV, July 1999).

The islands of Vanuatu are located along the Rim of Fire, the circum-Pacific volcanic belt which hosts most of the larger porphyry copper-gold deposits in the world. In the Southwest Pacific, the Rim of Fire extends from Papua New Guinea via the Solomon Islands, Vanuatu, Fiji and Tonga to New Zealand. This major plate boundary separates the Pacific Plate from the Australia-India Plate, and is physiographically marked by subduction-related oceanic trenches, partly emergent volcanic arcs, and back arc and intra-arc basins. The complex and multiphase history of the arc volcanism indicates that the two plates have been interacting from the early Tertiary (probably Late Eocene) to recent¹.

CLIMATE

Two distinct seasons influence the Vanuatu archipelago; a hot and wet season from November to April, known as the cyclone season, and a cold and dry season from May to October. Rainfall often peak during the earlier season as a result of heavy rainfall associated with cyclones or depressions in that period annually.

1 Vanuatu Mineral Exploration Initiative: Information Sheet.

There is limited historic climatic data for Vanuatu with records back to 1949 for Efate and 1973 for Luganville, the country's two urban centers. Average temperatures range between 21°C and 27°C and average humidity ranges between 75 percent and 80 percent. Average rainfall declines from over 4 000 mm in the north to less than 1 500 mm in the south (Mourgues, 2005). Trends suggest a gradual increase in temperature that is more marked in the south and a gradual decline in rainfall overall. There has also been a significant increase in the frequency of tropical cyclones in the country as a whole over the record period, although this trend could be influenced by improved recording of such events since the introduction of satellite tracking technology.

Vanuatu is prone to a broad range of natural disasters. Cyclones often occur during the warmer months from November to April, although cyclones have recently shown signs of development outside this season (Cyclone Rita, May 1991 and Cyclone Gina, June 2002). Vanuatu is also vulnerable to long dry spells and prolonged wet conditions associated with the El Niño (warm phase) and La Niña (cool phase) of the El Niño Southern Oscillation (ENSO) phenomenon. The country is highly vulnerable to other extreme climate events including storm surges, coastal and river flooding, landslides and hailstorms.

Earthquakes frequently occur in Vanuatu and they often originate at considerable depth and are therefore not too destructive (large magnitude but low density). Nevertheless, some earthquakes have caused extensive damages in the past. Some fault movements have also produced changes in shoreline elevations of up to 2 meters as islands have tilted. Destructive tidal waves (tsunami) occur occasionally as the result of earthquakes.

In a report to the International Decade for Natural Disaster Reduction for the Pacific Island Countries, Vanuatu was classified as highly vulnerable to all natural hazards: tropical cyclone, storm surge, coastal flooding, river flooding, drought, earthquake, landslide, tsunami and volcanic eruption (UNFPA, 1996).

On the basis of climate scenario modeling² and historical records available, it has been predicted that climate change over the next century will lead to warmer and

2 Climatic scenarios for Vanuatu have been modeled on the SCENGEN scenario generator with two Global Circulation Models: HADCM2 and CSIRO9M2. For more information, refer to the Vanuatu National Communication to the Conference of the Parties of the UNFCCC, July 1999.

drier conditions in much of Vanuatu with the size of the change increasing away from the equator (NACCC, 2007). However, the possibility of increased rainfall should not be dismissed. These effects will be accentuated by more frequent and severe cyclone events. Heavy rainfall is a normal component of cyclonic storms so a greater proportion of rain will be associated with the passage of storms. Indications are that there will be more frequent El Niño type conditions which are usually associated with prolonged dry seasons.

BIOLOGICAL DIVERSITY

Although Vanuatu's biodiversity has been widely reported as less rich than its neighboring countries, New Caledonia and Solomon Islands, recent studies have suggested that Vanuatu's biodiversity was in fact richer than was previously estimated (Environment Unit, 1999). Vanuatu is in fact an important faunal crossroad in the Pacific. The three main streams by which it is believed wildlife colonized the SW Pacific (Papuan, Australian and Polynesian), meet here.

Of all the islands in Vanuatu, Espiritu Santo has the greatest species richness with 49 native species of land and freshwater birds found here. This represents 75 percent of Vanuatu's native land and freshwater birds and 85 percent of land and freshwater birds that breed in Vanuatu. Seven of the eleven species of bats found in Vanuatu are also present in the Santo region (Nari *et al.*, 1996).

Vanuatu's 200 nautical miles exclusive economic zone is extensive and encompasses mangrove, sea grass, lagoon, coral and pelagic habitats. Mangroves, sea grass and other coastal ecosystems provide protective buffers that shelter land and human settlements from the full impact of storm events but are under pressure from subsistence and commercial land use.

ECONOMY

Vanuatu was accorded UN Least Developed Country (LDC) status in 1995 and is still in this group despite the fact that its per capita GDP now exceeds the LDC threshold. This situation has occurred due to the adjustment based on the 'vulnerability index' which takes into account the vulnerability of Vanuatu's economy to natural disasters (Mourgues, 2005). Adult literacy was estimated at only 33.5 percent, with life expectancy

at birth of 66 years. The Human Poverty Index (HPI) ranked Vanuatu number 13 of 15 Pacific Countries and 140 on the UNDP Global Human Development Index (HDI). Vanuatu was also ranked the most vulnerable state of 110 small developing countries by a 1998 Commonwealth Secretariat report. The most devastating recent natural disasters were cyclone Prema in April 1993 which affected 20 000 people and caused damages estimated at US\$60 million and the Penama Earthquake and Tsunami of November 1999 which killed 10 and affected 23 000 people.

The country's economic performance has been characterized by generally low rates of economic growth, although there has been an upturn in the last three years. This has been compounded by rapid population growth leading to a decline in per capita income by 18 percent between 1994 and 2003 (GoV, 2006).

The economic and social situation in Vanuatu reflects a narrow income base, with almost 65 percent of GDP being generated by the service sector; just under 25 percent from agriculture; and 10 percent from manufacturing. Tourism is the main foreign exchange earner but is still largely centered on Port Vila while the majority of the rural population is engaged in agricultural production for subsistence with limited cash cropping.

The economy of Vanuatu is primarily agricultural based with beef, copra and fish being the primary exports. Commercial logging also occurs as well as a small industrial sector that is found in Port Vila.

The subsistence economy and the cash economy operate side by side in Vanuatu. Over 70 percent of the population live on their traditional lands, growing food crops and harvesting forest and marine resources for personal consumption, exchange and gifting. All the necessities of life are available locally. Rural villagers' participation in the cash economy is a minor component of their economic activity. They do however earn cash income from marketing copra, cocoa, other cash crops, shells and handicrafts, or by granting logging company access to their timber. Cash income is primarily directed to school fees, transport to school and purchases of household items and other needs.

The cash economy is centered on two urban areas: Port Vila and Luganville. It is dominated by services and a limited range of agricultural commodities. The service sector includes government services, an off-shore finance center, and tourism. Although the agricultural sector contributes less to GDP than services, it is the principal economic activity and source of income for the majority of people and makes the largest

contribution to domestic exports. The industrial sector is small. Its contribution to GDP rose steadily from 8 percent in 1983 to over 13 percent in early 1995 but has since stabilized. Vanuatu is heavily reliant on imported manufactured goods and fuels.

The narrow economic base and the small local market makes Vanuatu's cash economy particularly vulnerable to external influences such as world commodity downturns or fluctuations in tourism. The value of imports exceeds export earnings and this situation is unlikely to change in the near future. Further development of the cash economy is constrained by distance from international markets; limited natural resource base; high cost of infrastructure and energy; limited and unstructured internal market; and damage to crops and infrastructure by cyclones, earthquakes and volcanic eruptions.

In an effort to address several structural problems within the economy, Vanuatu began implementing a Comprehensive Reform Programme (CRP) in July 1998. The CRP is based on three categories of reforms: public sector reform, economic reform, and reforms aimed at promoting equity and social development. An integral part of the CPR was the identification of five priority objectives with accompanying strategies. The priorities are: (i) improving the lives of the people in rural areas; (ii) supporting private sector growth; (iii) restoring good governance; (iv) improving participation by civil society; and (v) closing the gap between the rich and the poor and disadvantaged groups (UN, March 2002). These priorities were adopted as the goal for the United Nations Development Assistance Framework³ (UNDAF) for Vanuatu for the period 2003–2007.

SOCIAL AND CULTURAL SETTING

The ancestors of indigenous ni-Vanuatu arrived in a series of migrations from the northwest several thousand years ago. They settled throughout the archipelago practicing subsistence agriculture, hunting and gathering. Due to the difficult terrain and open seas between islands, there was limited contact and trade between

3 The UNDAF serves as the common frame of reference for UN cooperation in Vanuatu. It is a strategic document that gives effect to UN reform in Vanuatu, as an instrument to promote cooperation and enhanced coordination between UN agencies and with the government of Vanuatu.

settlements and as a result, complex cultures and languages were developed. In 1989, more than 110 languages were used by a population of about 177 400 people making Vanuatu the country with the highest number of languages per capita. Bislama, a pidgin language based on the English and French languages is the common lingua-franca of ni-Vanuatu from different language groups although English and French are both used by government, business and education today.

From 1906 to 1980, Vanuatu (previously known as New Hebrides) was governed as a Condominium of both Britain and France. This arrangement led to costly and at times confusing duplication of government and administrative services. It also led to competition between the two European nations as they sought to strengthen their individual interests and spheres of influence. The legacies of the Condominium include expensive duplication of services in both English and French language mediums, and a social and political division between Francophone and Anglophones.

Political independence for Vanuatu was obtained in 1980 and despite an initial period of political stability there have been a number of changes of government between elections over the past decade. Government changes between elections reflect shifts in party coalition loyalties often based on family, regional and ethnic ties.

The social and cultural setting in the capital area of Port Vila on the island of Efate is heavily influenced by both British and French cultures. To a lesser extent, the larger island of Espiritu Santo maintains many vestiges of European colonial life. The outer islands retain strong aspects of traditional life or *kastom* mixed with the influences of the missionaries. In the northern islands, women's roles are stronger and more dominant because of the traditional matrilineal culture. The opposite is true in the southern islands where males dominate society.

There is growing concern over the number of people facing a poverty of opportunity faced by those living in rural areas and the vulnerable groups living in or near the urban centers of Vanuatu. Political instability as well as weaknesses in governance institutions and the application of good governance principles has hampered sustainable economic development and the implementation of sound resource management policies, regulations and decisions. In many instances, the urban elite have been the major beneficiaries of many economic progress made to date.

There is a pressing need to address the disparities in the delivery of and access to quality basic social services and income earning employment opportunities between

men and women and between urban and rural areas. There are specific issues relating to the increased migration from rural to urban areas, with the unemployed poor and squatter settlements of urban areas also facing problems of inadequate housing, poor infrastructure and lack of access to water and sanitation services.

Vanuatu's Melanesian society does not have hereditary leadership with the result that the position a person attains is more closely linked to how successful they are in accumulating wealth and prestige. While this system is considered egalitarian, it does not necessarily engender an egalitarian society. It is also clear that while some women have achieved success in both the private and public sectors, there remain many cultural and social constraints to gender equality in the family, employment and decision making (UN, 2002).

The legal system recognizes and enforces private rights where those rights are granted under title or agreement. However, difficulties arise when the ownership of the property or right is either communal or uncertain. In these cases, it can be difficult to obtain and enforce rights and use.

THE AGRICULTURE SECTOR IN VANUATU

The economy of Vanuatu is comprised of a large smallholder subsistence agriculture sector and a small monetized sector. Small-scale agriculture provides for over 65 percent of the population while fishing, off-shore financial services and tourism also contribute to government revenues. In 2003, the national gross domestic product (GDP) was estimated at US\$580 million with per capita GDP at US\$2 900. As a proportion of GDP, agriculture accounted for 14.9 percent, industry 8.5 percent and the service sector 76.6 percent. Real GDP per capita is still lower than in the early 1980s due largely to the lack of long-term growth in the agriculture and fisheries sectors. Since 2003, the agriculture sector has grown at an annual rate of 3.3 percent compared to the 2.8 percent growth for the economy and average population growth rate of 2.6 percent (NACCC, 2005).

Immediately following independence in 1980, smallholders were encouraged to satisfy the demands of the export market with commodities such as copra, cocoa, coffee and meat and the promotion of these commodities was the focus of agricultural policies at that time. Market prices for all these commodities have

since declined and understandably, farmers are now reluctant to reinvest in these commodities. Under these circumstances, government was left with two important challenges to either (i) continue efforts to increase agricultural production or (ii) increase food import. Government decided to tackle the first challenge and has approached this by increasing efforts to improve productivity of household food gardens 68 percent of which were for subsistence only and the rest for sale and subsistence needs. According to the Agriculture Census (1999), 68 percent of the households grow coconut, 50 percent grow kava, 39 percent raise cattle, 24 percent grow cocoa and 2 percent grow coffee. 61 percent of the households regularly go fishing. It can be seen from these statistics that the small farmers of Vanuatu play a very important role in food production and food security in the country.

The specific situation pertaining to the various sectors of the agriculture industry is summarized in the following sections.

CROPS

The majority of the rural population of Vanuatu is engaged in agricultural production for subsistence with limited cash cropping. The main agricultural products are copra, kava (*Piper methysticum*), cocoa, coffee, taro, yams, fruits and vegetables. Low productivity and small holdings are identified as the key constraints towards expansion and commercialization of crop production in Vanuatu. There is little incentive to enhance productivity through the use of modern methods and technology and to compound the problem changes in world prices are also affecting this sector.

While large commercial farms and plantations are making a significant contribution to the cash economy of Vanuatu, approximately 80 percent of the population reside in rural areas and depend on small agricultural plots for their livelihood. Productivity of these plots are however quite low and the challenge for the sector therefore is to increase productivity by introducing sustainable and affordable management practices for traditional crops. Increasing the number of small plots (i.e. getting more rural dwellers involved) is a strategy favored by the Ministry of Agriculture as opposed to increasing the sizes of existing farmlands. This is because most small farmers are isolated and separated from each other

by long distances of poorly maintained access roads that make transportation of products and equipment extremely difficult and expensive for them. Small plots that are able to provide for their subsistence needs and allow for a small surplus for the local markets on the other hand are well within the capacity of small farmers to manage on a sustainable basis.

The increasing incidence of extreme events and climate change could add further stress to this sector. There is little additional information on the effect these changes will have on the cash crops such as yams, taro and sweet potatoes that are important to the sustenance of the ni-Vanuatu people. Mechanisms to enhance food storage to meet shortfalls during times of disasters are also lacking.

LIVESTOCK

Vanuatu's environment is ideally suited to raising beef cattle. The production of beef, pork, poultry, sheep and goat for local consumption forms an essential part of the rural economy. There is however still scope for improving the production, processing and marketing in this sector in order to increase its contribution to the overall economy of the country. The 1999 Agriculture Census placed the number of cattle in Vanuatu at 150 000 animals.

Increased demand for land and the enhanced degradation due to climate extremes and other hazards have added to the challenges in livestock production. In the 1990s, most of the beef was supplied by the small farmers. This has changed in recent years with the commercialized operations now providing the bulk of the beef consumed locally (Timothy, *pers. com.*). Most of the cattle are grazed under coconut plantations.

Climate change is likely to have far greater effects on the small farmers compared to the larger commercial operations. Small farmers often rely on streams for their water supply and do not have the means to set up adequate water storage facilities. Hence, when the streams dry up, as they are doing more and more nowadays, the farmers would find it hard to cope.

Incidence of diseases is also reported to be on the increase especially intestinal problems which are believed to be associated with pasture feed. The Veterinary Service provided by the Department of Agriculture is limited to Efate and Espiritu Santo leaving farms on the outer islands to fend for themselves.

FORESTRY

Some 36 percent of Vanuatu's total land area is forested, 27 percent of which is merchantable forests (Department of Forests, 1999). Rugged terrain prevents access to the rest of the forested areas.

Vanuatu possesses excellent soil and climate that are conducive to timber production. In 1996, the forestry sector earned around 13.2 percent of the total export revenue for Vanuatu. Landowners received about US\$0.36 million in log royalties and US\$0.27 million in sandalwood royalties during the same period. In recent years, there has been an increased interest in sandalwood harvesting and plantation. This high valued species has potential to make a significant contribution to the forestry sector and the national economy as a whole but if not managed properly, could result in large scale clearing of other valuable forested areas.

The importance of Vanuatu's forests can not be judged on economic benefits alone. Apart from providing job opportunities, income, and badly needed infrastructure, the development of the forest resources also stimulates activities within the whole economy. The balancing of the need for environmental protection and the development of the forestry sector must therefore be an important goal for the government of Vanuatu.

Vanuatu's vision for the management of the forestry sector is an arrangement whereby the government will work cooperatively with the landowners and the forest industry to achieve the sustainable management of the forest resources and thereby encourage revenue generation for the landowners, the wider community and the national economy while at the same time conserving Vanuatu's forest biodiversity.

The concept of sustainable forest management in Vanuatu must be tempered by the fact that there is no government-owned forest land, and that it is an inalienable right of landowners under the Constitution to manage their land as they see fit. However, given the decreasing forested area and the threat of further damage through extreme climatic events, a sustainable forest industry for Vanuatu can only be achieved through a collaborative effort by the government, the landowners and the industry.

FISHERIES

The fisheries sector contributes approximately 1 percent to the overall GDP and makes up 5.5 percent of the primary production sector (Statistics Office, 2000). The fisheries sector has good potential for exploitation but is not being properly exploited

at present. The reef fisheries are over-fished in some areas, notably in the coastal areas of Efate but are generally under-exploited near the outer islands. The coastal fisheries which contributes significantly to the rural income, nutrition and self-reliance, is particularly vulnerable to the impacts of climate change due to enhanced coastal erosion, sedimentation and over-exploitation. In addition, there is a perceived threat to marine resources given the demand from the growing coastal population.

As for most islands, the sea, oceans and coastal areas play an important part in the lives of the people in Vanuatu, as a source of food, transport and livelihood. Most coastal people rely on fishing as an important source of protein and income but these are likely to be affected through the destruction of marine ecosystems such as mangroves and reefs. There is also some concern about the possible increase in ciguatera poisoning due to increased temperatures of the ocean, marine pollution from land-based activities and sedimentation. It is also reported that after Cyclone Ivy which caused considerable damage to coral reefs around Efate, there have been several outbreaks of the Crown of Thorns which is contributing to the destruction of corals and reefs (Jimmy, *pers. com.*).

The Fisheries Division in an attempt to have a better understanding of what is happening to the coastal areas of the country has established a number of coral monitoring sites around Port Vila to monitor the health of the corals and reefs and to determine the impacts of bleaching and ground water run-off on coastal ecosystems. A number of similar sites are expected to be established around the other islands in the future.

At present, Vanuatu has a fishing fleet of about 150 to 160 boats whose catches are landed in Fiji for onward shipment to canneries around the region. This arrangement is unsatisfactory to government whose share of the sales is far less than could have been. It is not surprising therefore that plans for the establishment of a landing facility for tuna in Vanuatu is already in an advanced stage and it is expected that this facility will be operational in 2008 (*ibid*).

SIGNIFICANCE OF GLOBAL CLIMATE CHANGE TO THE PACIFIC ISLAND COUNTRIES

Climate change is likely to have substantial and widespread impacts on Pacific island countries including Vanuatu. Among the most substantial damages would

be losses of coastal infrastructure and coastal lands resulting from inundation, storm surges, or shoreline erosion. Climate change could also cause more intense cyclones and droughts, the failure of subsistence crops and coastal fisheries, and the spread of malaria and dengue fever.

The South Pacific has experienced the highest numbers of cyclones in a season during El Niño events. For example, in 1992/93, there were 16 cyclone events and in 1997/98, there were 17 events. The average (mean) for the South Pacific is between 9 and 10 cyclones per season (Vanuatu, undated).

During October 2007, rainfall was extremely high in areas under the active South Pacific Convergence Zone (SPCZ) with over 200 percent or more of normal in parts of Vanuatu, Fiji, central French Polynesia, and also well above normal in parts of New Caledonia, Niue and parts of Samoa. Heavy rainfall and flooding occurred in parts of Vanuatu at the end of the month with Aneityum recording a record high of 443.8 mm during the month. In contrast, rainfall was 50 percent or less of normal over much of Kiribati and parts of the Cook Islands (NIWA *et al.*, 2007).

Mean air temperatures for October were 1.5°C or more above normal in parts of Tonga and the Southern Cook Islands, and 1.0°C or more above normal in New Caledonia and parts of Fiji (the warmest October on record in Nadi, with records at several other sites). Temperatures were also above normal in Vanuatu and Samoa (*ibid.*).

Changes in climatic conditions would affect most Pacific islanders, but have its greatest impact on the poorest and most vulnerable segments of the population – those most likely to live in squatter settlements exposed to storm surges and disease and those most dependent on subsistence fisheries and crops destroyed by cyclones and droughts.

A World Bank study in 1999/2000 concluded that climate change is likely to affect coastal areas of the Pacific in three major ways: through a rise in sea level, leading to erosion and inundation; through more intense cyclones and storm surges; and through higher sea surface temperatures, leading to a decline in coral reefs.

Climate change is most likely to affect agricultural production through changes in rainfall. Agricultural crops could also be affected by rising temperatures, climate variability – such as more intense cyclones and El Niño/La Niña conditions – and

sea-level rise. If wetter conditions prevail in the future, water-sensitive crops such as coconut, breadfruit and cassava would likely benefit. A decline in rainfall by contrast, would hurt most crops, especially the traditional crops such as yam and taro.

Tuna fisheries in Central and Western Pacific is also likely to be affected by climate change in two major ways: by rising ocean temperatures to levels currently experienced during medium-intensity El Niño and by increasing year-to-year climate variability (Timmermann *et al*, 1999). The impact on tuna – the most valued deepwater fishing species in the region – is predicted to include the following:

- ~ Decline in primary productivity. Primary productivity in the central and eastern Pacific could decline due to the increased stratification between warmer surface waters and colder, deeper water (and resulting reduction in upwelling). Primary production in the western Pacific could conversely increase.
- ~ Decline in tuna abundance. The decline in upwelling could lead to a decline in the big eye and adult yellowfin population (the species targeted by the longline fleet). By contrast, the abundance of purse-seine-caught skipjack and juvenile yellowfin tuna is not expected to be affected.
- ~ Increased pressure on longline fishing. Given the continued high demand for sashimi in Japan, it is likely that longline fishing pressure on yellowfin tuna will increase to compensate for the decline in adult bigeye tuna, leading to unsustainable exploitation.
- ~ Spatial redistribution of tuna resources. The warming of surface waters and the decline in primary productivity in the central and eastern Pacific could result in spatial redistribution of tuna resources to higher latitudes (such as Japan) and towards the western equatorial Pacific.
- ~ Higher impact on domestic fleets. While distant water fishing fleets can adapt to stock fluctuations, domestic fleets would be vulnerable to fluctuations of tuna fisheries in their exclusive economic zones. Countries in the Central Pacific would likely be more adversely affected than those in the western Pacific (World Bank, 2000).

Climate change could also increase the incidence of ciguatera poisoning in some areas of the Pacific like Kiribati that already has one of the highest rates of ciguatera poisoning in the Pacific. It is predicted that the rise in temperatures will increase the incidence of ciguatera poisoning in that country from 35 per thousand people to about 160–430 per thousand in 2050 (Lewis and Ruff, 1993).

More intense cyclones and droughts are likely to increase nutrition-related deficiencies as experienced in Fiji during the 1997/98 drought when US\$18 million in food and water rations had to be distributed (UNCAD 1998). Loss of agriculture and fisheries could result in malnutrition and deterioration in standards of living. And the loss of infrastructure could lead to increased crowding conditions, exacerbating problems of urban management. These diffuse effects could well prove to be among the most important impacts of climate change on the livelihood of peoples in the Pacific in future years.

CLIMATE CHANGE SCENARIO IN VANUATU

Climate change is likely to impact on all sectors that are pertinent to the sustainable development of Vanuatu (NACCC, 2007). Vanuatu is highly vulnerable to the effects of natural disasters including climate change. A total of 124 Tropical Cyclones (TC) had affected Vanuatu since 1939. Forty-five of these were categorized as having hurricane force winds (>64 knots), twenty-six were of storm force winds (48–63 knots) and twenty-five were of gale force winds (34–47 knots). The remaining 28 were not categorized. TC Prema (1993), Paula (2001) and Ivy (2004) all caused considerable damage to property and the environment in Vanuatu.

Vanuatu is also prone to tsunamis and two in particular (1999 and 2002) caused loss of life and property. On November 1999, a magnitude Mw7.3 undersea earthquake occurred 140 km to the northwest of Port Vila. A tsunami was generated which caused destruction on Pentecost Island where maximum tsunami heights reached 6 metres. The tsunami claimed 3 lives, although many were saved when some residents recognized an impending tsunami as the sea receded and managed to warn people to seek higher ground. On January 2002, an earthquake of magnitude Mw7.5 occurred 100 km west of Port Vila. Several people were injured and there was widespread damage on the island of Efate (AusAID, 2006).

Sea level trend to date is estimated at + 3.1 mm/year but the magnitude of the trend continues to vary widely from month to month as the data set grows. Accounting for the precise leveling results and inverted barometric pressure effect, the trend is estimated at + 2.2 mm/year⁴ (Ibid). The scenarios for temperature and rainfall

4 Data from SEAFRAME which started measurement of sea level trend in Vanuatu since 1993.

as predicted by the SCENGEN generator for Vanuatu are presented in Tables 1 and 2 and for sea-level rise in Table 3. These results are compared with analogue predictions based on observation of past trends presented in figures 1 to 5.

TABLE 1: TEMPERATURE SCENARIO

SCENARIO	YEAR 2050	YEAR 2100
CSIRO9M2		
IS92a(mid)	0.9°C	1.5°C
IS92e(high)	1.5°C	3.0°C
HADCM2		
IS92a(mid)	1.4°C	2.4°C
IS92e(high)	2.2°C	4.5°C

TABLE 2: PRECIPITATION SCENARIO

SCENARIO	YEAR 2050	YEAR 2100
CSIRO92		
IS92a(mid)	7.4%	13.5%
IS92e(high)	12.1%	25.2%
HADCM2		
IS92a(mid)	-6.6%	-11.8%
IS92e(high)	-10.6%	-22.0%

TABLE 3: SEA-LEVEL RISE SCENARIO

SCENARIO	YEAR 2050	YEAR 2100
IS92a(mid)	19.8 cm	48.9 cm
IS92e(high)	39.7 cm	94.1 cm

FIG. 1: HISTORICAL CLIMATE TRENDS
ANNUAL MEAN TEMPERATURE - NAMBATU (EFATE)

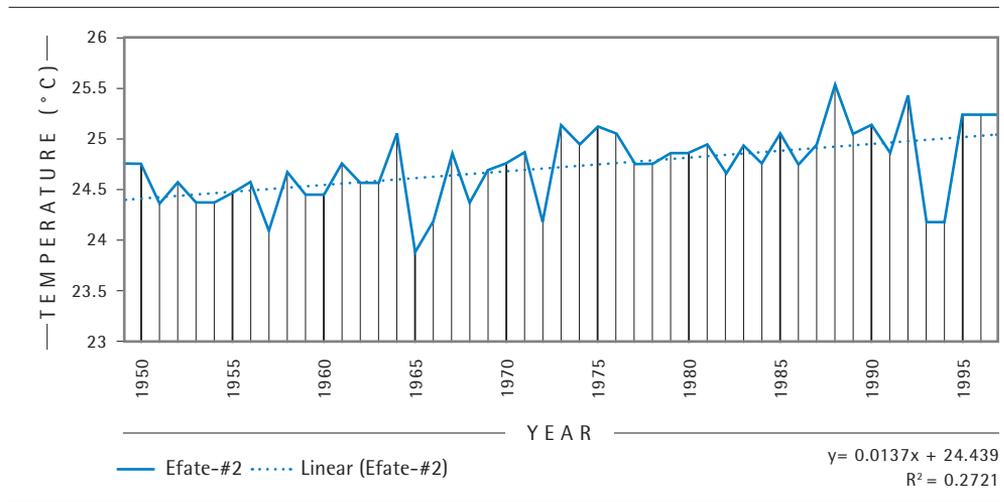


FIG. 2: HISTORICAL CLIMATE TRENDS
ANNUAL MEAN TEMPERATURE - PEKOA (SANTO)

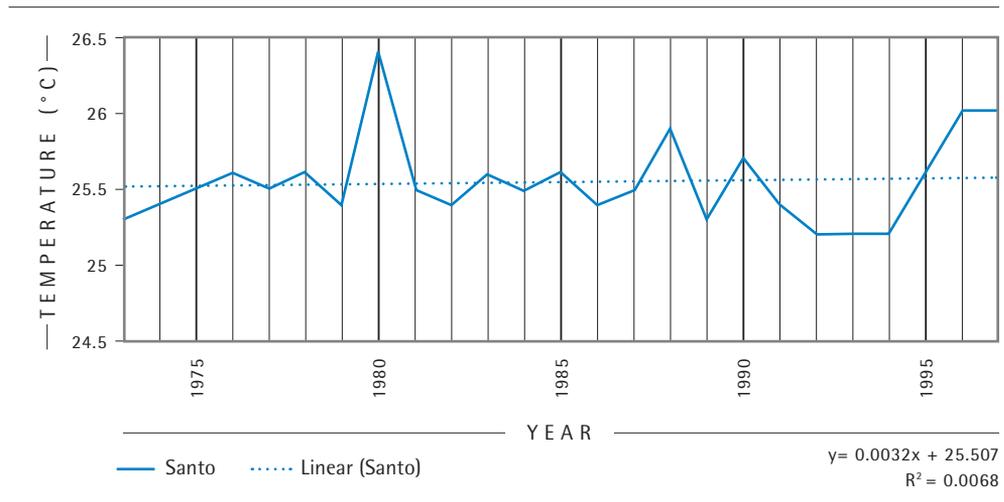


FIG. 3: HISTORICAL CLIMATE TRENDS
AVERAGE ANNUAL RAINFALL - NAMBATU (EFATE)

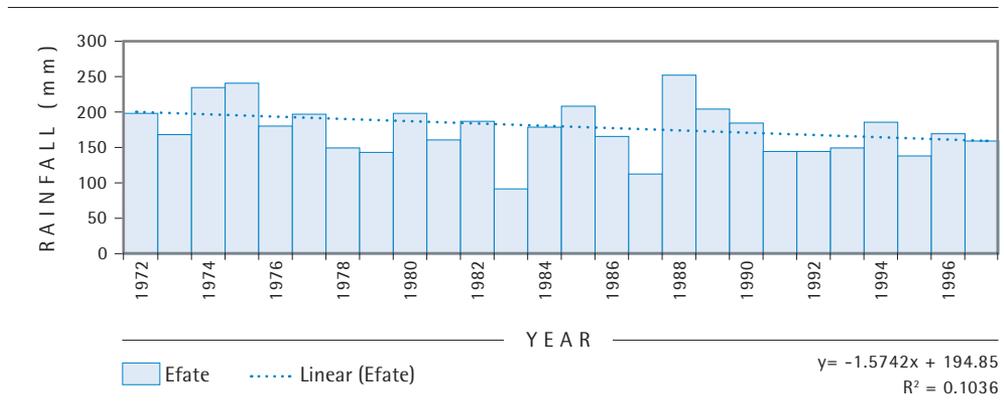


FIG. 4: HISTORICAL CLIMATE TRENDS
AVERAGE ANNUAL RAINFALL - PEKOA (SANTO)

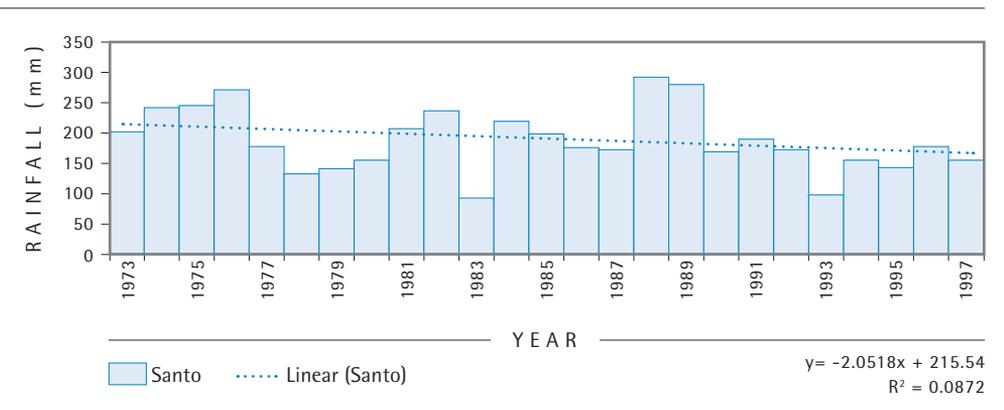
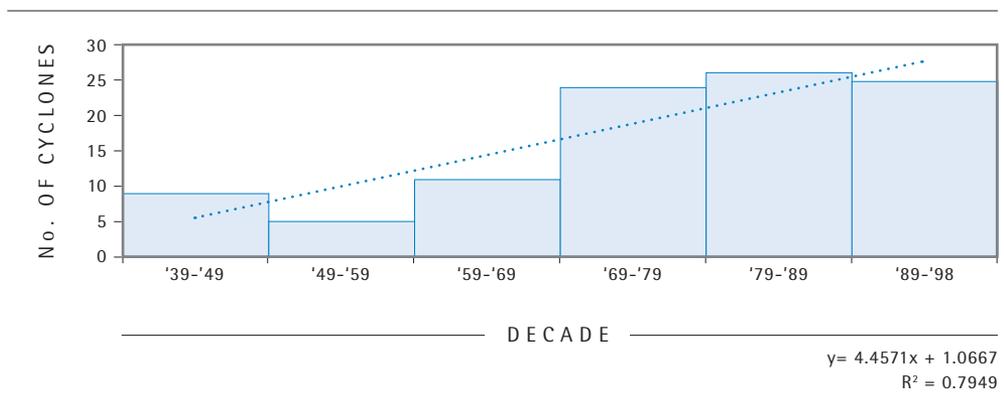


FIG. 5: HISTORICAL CLIMATE TRENDS
FREQUENCY OF CYCLONES AFFECTING VANUATU



THE LIKELY IMPACTS OF CLIMATE CHANGE AND CLIMATE VARIABILITY ON AGRICULTURE AND FOOD SECURITY IN VANUATU

According to FAO (2007a) the croplands, pastures and forests that occupy 60 percent of the Earth's surface are progressively being exposed to threats from increased climatic variability and, in the longer run, to climate change. Abnormal changes in air temperature and rainfall and resulting increases in frequency and intensity of drought and flood events have long term implications for the viability of these ecosystems.

Although there is limited historic data on which to base a more reliable assessment of the likely impacts of climate change on the agriculture sector and on food security in Vanuatu, a review of a number of reports and publications suggest that the following impacts are likely to be realized for the various components of the agriculture sector and for food security in Vanuatu. A clearer assessment of the likely impacts of climate change and climate variability on small islands of Vanuatu is presented in Table 6.

CROPS

Although the impacts of climate change on agricultural crops in Vanuatu are not well understood, general knowledge and anecdotal observations suggest that changes may be detrimental to agricultural production and hence national food security.

Climate related incidences are already affecting crop production. Increased temperatures, more frequent and prolonged dry conditions, increased variability of rainfall, salt water intrusion, droughts, soil erosion and cyclones have been experienced in the past few years. Pest activities have also increased with yams being the crop most affected. With projected temperature increases to 28.8 degrees and 29.7 degrees in 2050 and 2080 respectively, heat tolerance thresholds of crops are likely to be reached and this will most likely induce heat stress, wilting and crop failure. Subsistence crop production may fall as a result and in turn threaten food security on the island.

Both commercial and subsistence agriculture in Vanuatu are based on rain-fed agricultural production systems. Changes in rainfall, high intensity storm events,

increased evaporation and more pronounced dry seasons, could have severe impacts on agriculture crop production. Intense rainfall during planting seasons could damage seedlings, reduce growth and provide conditions that promote plant pests and diseases. More pronounced dry seasons, warmer temperature and greater evaporation on the other hand could induce plant stress reducing productivity and harvest and subsequently, affect food security.

The alternate scenario of increased rainfall could have equally severe impacts with water-logged soils decreasing agricultural production, while increased humidity and rainfall could provide ideal conditions for the proliferation of a number of plant pathogens. These conditions could lead to declining agricultural production and this would adversely affect both the country's economy and food security.

The farmers interviewed during the undertaking of this study commented on some plants flowering earlier than usual while others are fruiting much later than normal during the past 3–4 years. Another farmer referred to the south east trade winds that was still blowing at end October when traditionally this would have ended in August/September each year. Whilst these farmers agree that climate change may have something to do with these changes, it was difficult for them to determine the extent such changes were influenced by climatic conditions and variations. As these changes have only been observed in the past three to four years, the farmers suspect that the changes may be part of a cyclic event that could return to normal sometimes soon (Gordon, *pers. com.*).

The findings from the study carried out by the CBDAMPIC project involving the communities of Lateu, Luli and Panita as well as the Vulnerability Assessment of islands in the Torres, Tafea and Shepherd Groups highlighted the impacts of climate change on water supply, agricultural activities and health of these communities (see Table 6). Salt spray, water shortages due to prolonged dry spells, flooding and contamination of ground wells, and erosion of the foreshores are having a serious impact on the safety and health of these communities and these problems are likely to get worse as temperature and sea level rises. The seriousness of these problems has already caused a number of communities to abandon their villages to resettle elsewhere. This scenario is likely to happen again in other low-lying areas of Vanuatu as the government and rural communities have limited capacity to deal with these kinds of situations.

LIVESTOCK

It is predicted that increased carbon dioxide concentrations in the atmosphere and warmer temperatures will be conducive to rapid growth of green matter rather than crops and this might affect seasonal food security (NACCC, 2007). Rapid growth could reduce the nutritional value of pastures which could in turn result in fewer animals supported per unit area of pasture land and this could have a detrimental effect on beef production, both for export and for local consumption.

The Ministry of Agriculture has reported an increased incidence of intestinal problems in cattle often associated with pasture. Similar problems (worm and infections) have been encountered by the piggery farmers.

The Ministry offers a limited veterinary service to farmers on Efate and Espiritu Santo only and is ill-equipped to offer much assistance during any major outbreak of animal diseases whether climate change-related or otherwise. Hot temperatures could result in the relocation of stocks to cooler climates (an adaptation measure) and this could entail significant costs to the farmers especially given the poor state of most of Vanuatu's roads. Local farmers with knowledge of which breeds or varieties can best adapt to changing conditions can provide invaluable input to any effort aimed at mitigating the negative impacts of climate change to the livestock industry.

Small scale livestock farmers will be mostly affected by increased temperatures and drought as these could cause soil compaction and dry up the streams on which the farmers depend for their primary source of water. Overstocking and overgrazing could result from dried conditions and this would in turn result in loss of animal weight and further degradation of pasture lands.

WATER MANAGEMENT

Water is vital to agriculture development and production in Vanuatu. Population growth, particularly in urban areas, is already placing pressure on water resource and supply services. Climate change is likely to increase the demand for water and yet reduce the quality and affect water sources. This will have implications for water source management and water use especially for industries and agriculture which are heavy water users.

Vanuatu has limited surface water and villagers on many islands and residents of both urban areas (Port Vila and Luganville) are dependent on ground water.

Increased temperatures are likely to increase the demand for portable water, however increased heat, greater run-off from high intensity rainfall events, decreased rainfall and an associated increase in evaporation could reduce the rate of ground water recharge and decrease surface water flows. Water shortages that are already apparent in dry seasons would become more pronounced and may require more sophisticated water distribution networks to maintain human populations and agriculture production in severely affected areas.

Any increase in sea level could cause salt-water intrusion into the shallow ground water lens in coastal areas, particularly if ground water recharge was reduced or water over-extracted. Increased rainfall often associated with cyclones could also cause flash floods, soil erosion and further pollution of freshwater and marine environments. Increasing population will place additional pressure on the already stressed water supply systems and any further pressure resulting from climate change and climate variability would be extremely hard for the government and people of Vanuatu to cope with.

SOIL AND LAND MANAGEMENT

Increased rainfall could result in water-logged soils unsuitable for agriculture and other uses. It could lead to soil erosion and loss of soil nutrients important for plant growth.

Climate change could influence to the way land is managed in Vanuatu. Changes in rainfall could see the introduction of less water-demanding species and varieties or the introduction of new land management regimes that are better tailored to cope with the changing weather or rainfall patterns. Monoculture plantations may no longer be suited to the changing conditions in certain parts of the country and changes in rainfall and temperature could result in the proliferation of new or dormant pest and diseases that could cause considerable damage to agriculture crops and hence food security for the people of Vanuatu.

Agriculture crops like wild yams that used to act as soil cover against run-off is reported to be sprouting during the wet season as opposed to the past when they usually sprout before the wet season. This means that this crop has lost its soil protective function as a result of shifts in weather patterns (Brian, *pers. com.*). The promotion of multi-cropping system which are likely to increase the

resilience of agricultural crops to climatic events and prevent the spread of pests and diseases that is often associated with increased temperatures and high rainfall may be an appropriate approach to managing soil and land in response to future changes and shifts in weather patterns.

FORESTRY

The loss of forests, whether from agriculture land clearing or from climate related activities can have devastating effects for the people and economy of Vanuatu. While almost 70 percent of the country's land area remains under forest, less than 30 percent is of merchantable value. Non-forested lands are used primarily for agriculture, gardening and settlement. The rapid increase in population growth, coupled with the effects of cyclones and agriculture on the remaining land would inevitably result in the rapid decrease in total forested areas.

Most island forest species have small ranges, which in turn leaves them particularly vulnerable to land use changes because these changes can easily affect the species' entire range. (Fonseca *et al*, 2006). Clearing of forest leaves areas open for invasion by alien species that then dominate secondary forests.

Vanuatu Forestry staff reported changes in the flowering and fruiting patterns of certain forestry crops and there appears to be an increase in the incidence of pest and diseases in species such as sandalwood, white wood (caterpillar attack) and mahogany (shoot porous). Invasive species are said to be more wide spread and seed collection from major species has been particularly low compared to past years (Viji, *pers. com.*). Salt spray in certain islands of Vanuatu is causing forest dieback and the slash and burn method used for agriculture land clearing is a common threat to forest areas.

Very little is known about the likely impact of climate change on forest wildlife in Vanuatu. Birds and bats play an important role in propagating forest species and are often excellent indicators of the health of forested areas.

Reforestation plans may need to be reviewed in light of changing climatic conditions. Increased temperatures in the northern islands may require research into the use of species that are resilient to the hot weather conditions in that part of the country. Increased rainfall in the other areas of the country would likewise deserve the choice of species that can do well under the wet conditions.

FISHERIES

Vanuatu, like other Pacific island countries depend heavily on subsistence fisheries for their food security. Seafood comprises a very high percentage of the animal protein consumed by Pacific Islanders, much higher than the world average of 17 percent. If the subsistence fisheries ceased to exist, Vanuatu may have to spend US\$7–\$15 million a year for substitutes with similar protein content (World Bank, 2000).

The impact of long-term trends in climate change, in particular related to global warming, is less well-understood in fisheries but is beginning to receive attention (FAO, 2007a). Climate change and rising sea levels are likely to impact on marine resources through their effects on corals and reef ecosystems. Coral bleaching could increase as a result of increased temperatures and there are concerns about the possible increase in ciguatera poisoning due to increased temperatures of the oceans, marine pollution from land-based activities and sedimentation of the coastal areas and water run-off.

Changes in ocean circulation patterns, may affect fish populations and the aquatic food web as species seek conditions suitable for their lifecycle. Higher ocean acidity (resulting from carbon dioxide absorption from the atmosphere) could affect the marine environment through deficiency in calcium carbonate, affecting shelled organisms and coral reefs (ibid).

The damage to coral reefs from cyclone events can be considerable as was the case with reefs around Efate from TC Ivy in 2003. Several outbreaks of the crown of thorns have been reported since the cyclone but it is difficult to say if this was directly related to the cyclone damage.

MANGROVES

Mangroves are productive ecosystems that are important to the livelihoods of coastal communities. Many fish and other marine species breed and live in mangrove areas and yet, many such areas are being destroyed or converted to other uses.

Mangrove forests also play an essential role in protecting the coast against storms and inundation. Mangrove areas are believed to be declining in Vanuatu, even in certain isolated areas where population densities remain low. Pollution from land-based activities is perceived as the most common threat to mangrove areas although land clearing is also a threat.

Mangrove ecosystems will certainly be affected by climate change events. Sea-level rise could affect growth and productivity while storms and associated heavy rain can cause pollution thereby affecting breeding and spawning grounds for many fish species that live in mangrove areas.

TYOLOGY OF LIKELY CLIMATE CHANGE IMPACTS ON AGRICULTURE AND FOOD SECURITY

The likely impacts of climate change on agriculture and food security in Vanuatu has been discussed extensively in the foregoing parts of this study. The following matrix presents a summary of such impacts and the socio-economic response potential to the identified impacts.

TABLE 4: POTENTIAL IMPACTS OF CLIMATE CHANGE ON AGRICULTURE AND FOOD SECURITY

THREAT	IMPACT	POTENTIAL RESPONSE
Cyclones	<ul style="list-style-type: none"> ~ Wind damage to agricultural crops and forest trees ~ Erosion of coastal areas due to wave surges and flooding ~ Damage to crops from salt spray and rising sea levels ~ Inundation of groundwater sources by salt water ~ Destruction of farm shelters and rainwater storage facilities ~ Loss of animals due to falling coconut trees ~ Damage to corals and reefs ~ Outbreaks of crown of thorns ~ Outbreaks of invasive species ~ Low fish catches 	<ul style="list-style-type: none"> ~ Introduce wind resistant crops and varieties ~ Replant and protect coastal vegetation ~ Introduce salt tolerant species ~ Broaden genetic base of traditional crops ~ Improve rainwater catchments and storage capacity ~ Apply groundwater protection measures ~ Relocate farms if necessary ~ Strengthen quarantine and invasive species control measures
Sea-level rise	<ul style="list-style-type: none"> ~ Salt water inundation and flooding of agricultural lands ~ Inundation of habitats for coconut crabs ~ Inundation of coastal springs and underground water sources ~ Erosion of soil and coastal areas ~ Increase salinity of agricultural lands 	<ul style="list-style-type: none"> ~ Introduce adaptive agriculture management approaches ~ Introduce salt tolerant species ~ Broaden genetic base of traditional crops ~ Apply groundwater protection measures ~ Replant and protect coastal vegetation ~ Develop coastal management plans

[→]

[→] Table 4 continued

THREAT	IMPACT	POTENTIAL RESPONSE
Increased rainfall (including precipitation)	<ul style="list-style-type: none"> ~ Erosion of soil and soil nutrients ~ Flooding of agricultural lands ~ Pollution of underground water sources and coastal areas ~ Alleviate water shortage especially on small islands ~ Create favorable conditions for growth of less desirable pasture species ~ Create conditions favorable for spread of pest and diseases ~ Sedimentation of reefs and lagoons affecting fishery 	<ul style="list-style-type: none"> ~ Restore degraded lands ~ Introduce tolerant varieties ~ Apply groundwater management and protection measures ~ Improve rainwater catchments and storage facilities ~ Apply pasture management techniques ~ Apply pest management control ~ Construct coastal protection infrastructures
Drought (including increased temperature and declining rainfall)	<ul style="list-style-type: none"> ~ Plant and animal stress ~ Water shortages for agriculture purposes ~ Affect health, production and reproductive capacity of animals ~ Slow growth and low yields from food crops ~ Low productivity of farmers ~ Increased risk of fires 	<ul style="list-style-type: none"> ~ Introduce tolerant varieties and crops ~ Broaden genetic base of traditional crops ~ Local processing of food products ~ Increase/improve water storage capacity ~ Apply water conservation measures ~ Adopt risk/adaptive management approaches

OTHER FACTORS CONTRIBUTING TO THE VULNERABILITY OF AGRICULTURE AND FOOD SECURITY IN VANUATU

Vanuatu possesses significant land and marine resources. It has areas of fertile soil, substantial (though declining) forest cover, attractive and diverse landforms and productive coastal environments. Moreover, climatic conditions in Vanuatu are ideally suited to the development of its agriculture sector. Vanuatu therefore places a heavy emphasis on the sustainable development of agriculture, forestry and fisheries, all of which are reliant on the natural environment.

However, Vanuatu is vulnerable to natural disasters that can affect the sustainable management and rational use of natural resources. There is evidence of environmental degradation through the over-exploitation of land-based resources such as timber. On the basis of information available, it is suggested that there will be a gradual increase in temperature that will be more pronounced in the

south of the country. A gradual decrease in rainfall has also been predicted for Vanuatu. Under these circumstances, the future management of the use of the country's resources will need to take into account the impacts of climate change on the natural environment, human health and the development sector. The other factors that are likely to contribute to the vulnerability of the agriculture sector and are likely to impinge on food production and food security in Vanuatu are discussed below.

- ~ Declining productivity of small farms. Vanuatu is a highly diversified group of islands. For this reason it is extremely difficult to service the large number of small farms scattered over the islands from Port Vila especially given the poor road conditions, the long distances and the irregular air and boat links that exist at present. These linkages will be disrupted in times of natural disasters and this will seriously affect agriculture production and trade and subsequently food security in the entire country.
- ~ Loss of traditional farming techniques. There are a number of traditional crops in Vanuatu that the people have depended on for their needs particularly during times of natural disasters. Wild yams, taro and sweet potatoes have been staple food crops for ni-Vanuatu for ages but have not been yielding as much as they used to in recent years. Apart from changes in climatic conditions, the loss of traditional planting techniques is believed to be largely responsible.
- ~ Resistance to change. Small scale local farmers know from experience the best seasons to plant and harvest certain species and varieties of traditional food crops. Some of these farmers now realize that the seasons are shifting but are still planting and harvesting during the same periods they are used to. There is resistance to change the way they farm and harvest believing that what they are going through now is just a "cycle" that will return to normal in a year or two.
- ~ Influence of large scale, single crop farming. It is difficult to travel around the larger islands of Vanuatu such as Efate, Santo and Malekula without being impressed by the sight of some of the biggest cattle farms and gardens in the Pacific islands. Compared to the small farms that are common but struggling throughout the country, the large, self-sustained farms are the symbol of success and understandably, influences the way small farmers do business.

- ~ Loss of interest in traditional crops such as coconuts, etc. Declining local and international market prices for commodities such as copra, cocoa and coffee have seen the loss of interest by local farmers in the development and harvesting of these crops. People are not collecting coconuts except to feed their pigs and this has resulted in a loss of income for small farmers who used to sell dried copra as an additional source of income for the family. Climatic events such as cyclones and sea-level rise will add to the demise of these traditional crops unless there is a significant effort to revive interest through alternative profitable uses.
- ~ Poor understanding of the country's forest resources. Knowledge of Vanuatu's forest resources is based on outdated forest inventories that have not been updated in recent years. Detailed, up-to-date inventories of the nation's forests do not exist and this will make planning for the effective management of this valuable resource difficult. The effects of recent cyclones and other natural disasters on the forest resources are poorly understood and it is feared that the latest estimates of areas still under forest may be grossly overstated.
- ~ Lack of a sustainable forest management plan. For many years, the forestry industry has been operating in an unplanned manner and while some logging plans have recently been developed, considerable work needs to be done to ensure current and future plans are sustainable and that they meet the standards expected in the Code of Logging Practice. Forest management plans should provide a strategic overview of how the nation's forests will be managed including the economic use of salvaged timber or other forest products from cyclones and other natural or man-made causes.
- ~ Imbalance between forest utilization and reforestation. At present, there is very little effort to replant logged or cyclone-damaged forest areas in Vanuatu. Knowledge of the survival and growth of natural forests is at best very limited and this will continue to hamper future efforts to manage indigenous forest areas in a sustainable manner. While there is considerable interest in commercial plantations of the fast growing and highly-valued sandal wood, there has so far been little interest in replanting other local species such as white wood which is believed to be highly resistant to natural disasters.
- ~ Lack of understanding of the impact of climate change on fisheries resources. While there are a number of projections and forecasts about how fisheries

and coastal resources will be affected by climate change and variability, it has been difficult for local officials to establish the connection between what is happening now and climate change. This is particularly so as there has been, until recently, no attempt to monitor changes to the health of marine ecosystems and to establish the connection between such changes and climatic events that affected the country over the years.

- ~ Destruction of productive coastal ecosystems. Mangroves, corals and coral reefs are subjected to the effects of land-based development, pollution and poor land management in many parts of Vanuatu. If continued unchecked, these productive ecosystems will be totally destroyed and converted to other uses. This will in turn affect food production and subsequently food security for the many people and communities that depend on the coastal ecosystems for their daily subsistence.
- ~ Lack of understanding of the impact of climate change on livestock. How climate change and climate variation actually impact on livestock is less understood compared to other sectors. Increased precipitation and rainfall may improve pasture growth but could also enhance the growth of less desirable and less nutritive pasture species that may over time, dominate and replace the desired species.
- ~ Lack of capacity to service the livestock industry. At present, the Livestock Division of the Ministry of Agriculture is unable to provide veterinary service to small farmers on the outer islands due to limited capacity and resources. Given this situation, a major outbreak of any animal disease will be disastrous for Vanuatu's livestock industry. Any climate change induced health risks to farmed animals in the country could pose severe risk to animal production and food security in the country.
- ~ Limited ground water supply. Despite the abundance of rainfall that average about 2 200 millimeters per year, Vanuatu has few perennial streams probably as a result of the islands small size and rugged topography. Prolonged dry spells and droughts can easily result in the exhaustion of the limited supply of water available, especially on the small outer islands in the northern part of the country. Data collected by the Department of Geology, Mines and Water Resources (DGMWR) suggest that increased rainfall does not necessarily result in increased ground water recharge and this must surely be a concern for the country's overall development.

- ~ Destruction of ground water sources. Many underground water sources on the outer islands of Vanuatu have been rendered useless by salt water intrusion, flooding or through overuse. Water levels in the few rivers that exist on the larger islands are also reported to be declining and this trend will continue in light of projected declines in rainfall. Such situation will adversely affect agricultural production and food supply in Vanuatu and calls for urgent attention by the government and its development partners.

CLIMATE CHANGE RELATED ACTIVITIES OF OTHER UN, CROP AND OTHER AGENCIES IN VANUATU

A number of climate change related projects and activities have been implemented in Vanuatu in the past few years. Those that are of relevance to the agriculture sector are summarized below.

- ~ Regional Programme for Food Security and Sustainable Livelihoods in the Pacific Islands. In addition to many other programmes and projects supported by FAO in the region, this programme, endorsed at the Sixth and Seventh FAO South West Pacific Ministers of Agriculture Meetings, aims to address agriculture trade, food quality and safety, and climate change focusing on the urgent need for preparedness, and putting in place adaptation and mitigation strategies and actions. The Sub-Programme 2.3. – Natural Disasters and Climate Change Preparedness, Adaptation and Mitigation – has four components dealing with (i) Agriculture Diversification; (ii) Integrated Coastal Management; (iii) Land and Water Management and Use; and (iv) Technical Coordination Support. Interventions of the expanded programme will target:
 - ~ enhancing food production;
 - ~ rural infrastructure development; and
 - ~ strengthening agricultural trade and policy, climate change adaptation and mitigation and support for project planning and programme development.

The Programme has an indicative budget of US\$72 million for a period of 7 years. Sub-programme 2.3 is estimated to cost about US\$5.07 million (FAO, 2007b).

~ Global Environment Facility (GEF). The GEF has funded a number of enabling activities in Vanuatu in the past few years and is continuing its support for activities identified by the government as priorities for GEF support. In a recent communication to the government of Vanuatu, the CEO and Chairperson of the GEF indicated that the RAF allocations in GEF-4 will offer increased opportunities for the 15 Pacific island countries including Vanuatu. GEF's current programming priorities in the climate change focal area include support for energy efficient buildings and appliances, energy efficiency in industry, on-grid renewables, sustainable biomass for energy, and sustainable transportation (Barbut, 2007). It is understood that government is currently in the process of identifying its priorities for GEF-4 financing.

To increase efficiency and effectiveness of GEF support to Pacific island countries thereby enhancing the achievement of both global environment and national sustainable development goals, a GEF-Pacific Alliance for Sustainability (GEF-PAS) programme has been proposed. The GEF-PAS is a comprehensive regionally coordinated and nationally executed strategic investment programme that reflects country priorities for achieving sustainable development goals. It would deliver significant global and local environmental benefits, reflecting the importance of the Pacific in terms of conservation of biological diversity, prevention of land degradation, protection of international waters, sound management of chemicals and mitigating and adapting to the effects of climate change. The GEF-PAS will bring together the GEF Secretariat, the Implementing Agencies and the regional organizations to define and deliver an investment programme to achieve the above benefits. The GEF-PAS will help build PIC capacity to more effectively access GEF resources.

~ Capacity Building for the Development of Adaptation Measures in Pacific Island Countries (CBDAMPIC). The CBDAMPIC is a climate change adaptation project funded by the Canadian International Development Assistance (CIDA) and executed by SPREP in 4 Pacific Island Countries: Cook Islands, Fiji, Samoa and Vanuatu. It is a continuation of the previously concluded SPREP-funded Pacific Islands Climate Change and Adaptation Project (PICCAP) which involved several Pacific island countries. In Vanuatu, the CBDAMPIC was

piloted in three selected locations namely, Lateu Community in the Torres Group of islands, Luli Community on Paama island, and Panita Community on Tongoa in the Shepherds Group of islands. The CBDAMPIC was the first step towards building the capacity at the institutional and community levels to better understand the adverse impacts of climate change and how to improve local capacity to adapt to any adverse impacts. The project carried out assessments of the likely impacts of climate change on agriculture and other sectors of the three communities and looked at adaptation options the government and communities could consider.

- ~ Development of a National Forestry Policy Statement. This policy was completed in June 1999 following wide consultations carried out in 1996 and 1997. Many recommendations of the Policy Statement have since been implemented and the Policy continues to guide the work of the Department of Forests to the present date.
- ~ The Pacific Islands Renewable Energy Programme (PIREP) is executed by the Department of Energy with funding from the GEF. Under this project an assessment of the key energy issues, barriers to the development of renewable energy to mitigate climate change, and capacity building development needs for removing the barriers was undertaken.
- ~ The Pacific Islands Energy Policies and Strategies Action Planning (PIEPSAP) Project aimed to assist Pacific Islands with the development of national energy policies and action plans to implement these policies. The project was funded by the Danish Government and was implemented through the SOPAC. An Energy Policy for Vanuatu was developed under the project and has been approved by the Vanuatu Cabinet.
- ~ The Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP) was funded by the GEF and executed by the Department of Energy. It aimed to reduce growth of GHG emissions from fossil fuel use in the Pacific Island Countries through widespread and cost-effective use of renewable energy resources.
- ~ The Pacific Islands Global Climate Observing Systems (PIGCOS) was funded by the NOAA and implemented by SPREP. The project was designed to enhance observation of climate change and provide more comprehensive

data base for more accurate predictions and decision making. Due to funding constraints, there has been little work done on this project in Vanuatu.

- ~ With financial assistance from GEF and UNEP, Vanuatu is developing its National Implementation Plan (NIP) through the enabling activities of the Stockholm Convention. The NIP seeks to control the importation, use and release of Persistent Organic Pollutants (POPs) in Vanuatu.
- ~ With funding from the GEF, the National Advisory Committee on Climate Change (NACCC) is in the process of developing Vanuatu's Second National Communication report to the UNFCCC. The NACCC is under the chairmanship of the Director of Meteorology and comprises representatives from a number of government Ministries and Departments. The SNC will highlight actions taken to meet Vanuatu's obligations under the UNFCCC.
- ~ Through an Italian/Pacific SIDS Cooperation arrangement, a US\$10 million Climate Change and Vulnerability project has been developed for implementation in 2008 (Philips, *pers. com.*). Vanuatu intends to participate fully in this project.
- ~ The Live and Learn NGO has Climate Change as its Thematic Programme Area 5 that aims to heighten climate change awareness and advocacy. Activities under this Programme Area focus on the mobilization of long term carbon credit programs involving climate change education, reforestation and regional networking. It also involves the provision of information and education to local groups to advocate nationally and internationally for responsible policies on climate change.
- ~ With funding from AusAID, the South Pacific Sea Level and Climate Monitoring Project (SPSLCMP) has from 1992, installed a number of SEAFRAME stations in several Pacific island countries to provide accurate and long term sea level records. A SEAFRAME gauge was installed in Port Vila in January 1993. It records sea level, air and water temperature, atmospheric pressure, wind speed and direction. The SPSLCMP was a response to concerns raised by FORUM leaders over the potential impacts of an Enhanced Greenhouse Effect on climate and sea levels in the Pacific region.

SUCCESS STORIES AND LESSONS LEARNED

THE SUCCESSES

Although Vanuatu has made important strides in its efforts to address climate change issues and concerns, much still remains to be done. It is however encouraging that government has recognized the importance of the issue to national development and is well on its way to making sure that climate change issues and concerns are taken into consideration in the development and implementation of national projects and plans.

It is particularly difficult to identify ‘successes’ from completed climate change projects and activities in Vanuatu firstly because such successes if any have not been documented and secondly, because there has been a relatively short history of climate change initiatives in the country. Nevertheless, it is possible to highlight some of the achievements and decisions that have been made which could, with a bit more effort and support, pave the way for success in preparing the country for the adverse impacts of climate change and sea-level rise.

- ~ The “no-regrets” approach. In January 2005, His Excellency, the President of the Republic of Vanuatu, declared that the “ideal approach to adaptation in Vanuatu is a pro-active, no-regrets approach which encompasses measures and strategies which can be implemented in the present with the aim of reducing vulnerability in the future”. This approach has guided local efforts to address climate change, climate variability and sea-level rise initiatives over the past few years. For a country whose people and economy are interwoven, shaped and driven by climate sensitive sectors, the effects of climate change and sea level change are already very real and pose a tangible threat to the future socio-economic well-being of Vanuatu. By reducing the vulnerability of Vanuatu’s vital sectors and communities now to current climate related risks (the no-regrets approach), the country will be in a better position to adapt to future climate change impacts.
- ~ Establishment of the NACCC. The Lack of coordination amongst government agencies, NGOs, the private sector and communities has been identified as the major stumbling block to the effective implementation of environmental projects in the past. The establishment of the National Advisory Committee

on Climate Change (NACCC) by government to oversee the coordination of all climate change initiatives and programmes emanating from the UNFCCC process was a timely response to this situation. The Committee is operating effectively and is drawing the necessary expertise available to advise on key issues and concerns discussed by the Committee.

- ~ Prioritized list of projects for NAPA Implementation. Through an extensive consultative and participatory process, a prioritized list of projects for NAPA implementation was finalized. From an original list of about 20 proposals, the following five projects were considered priorities for implementation. They are: (i) agriculture and food security; (ii) water management policies; (iii) sustainable tourism; (iv) community-based marine resource management; and (v) sustainable forestry management. The prioritization process enabled the verification of what the stakeholders believed were the most urgent and immediate concerns of Vanuatu in relation to adaptation to climate change and was a solid basis for planning and allocating the limited national resources available for this work.
- ~ Improved capacity to undertake climate change impact assessment. Vanuatu, through the Meteorological Division and Working Groups formed under the NACCC has shown that it now has the capacity to undertake preliminary assessment of the impacts of climate change on the environment. Assessments have been completed on a number of small islands under the CBDAMPIC and the Vanuatu Vulnerability and Adaptation projects and these will form the basis for future assessments in other parts of the country. More investment in human resource development is still needed to cater for future staff movement and this is anticipated through future projects and programmes of government and funding agencies.
- ~ Advanced work on alternative energy sources. While Vanuatu has potential to use a range of alternatives as substitutes for fossil fuel, work on coconut oil as a substitute for diesel in the transport sector is particularly encouraging. Declining market prices have resulted in people turning away from collecting coconuts as it was no longer economical for them to do so. The production of coconut oil as a substitute for or supplement to diesel could potentially see the revival of the coconut industry which will in turn benefit the nut collectors and farmers especially in the rural areas.

THE LESSONS

Except for the Lessons Learned from UN System Cooperation with Vanuatu (UNDAF 2003–2007), there has not been a lot of lessons documented from the various projects implemented in the country. However, from the review of reports and through consultations held during the course of this study, the following lessons can be drawn from the Vanuatu’s experience in dealing with climate change issues.

- ~ Make population planning an intricate part of national strategies to adapt to climate change. It is very obvious that the high population growth rate of Vanuatu has not been considered a serious problem to future efforts to deal with the impacts of climate change. With a population that is expected to double every 20 years, a lot more pressure will be placed on coastal ecosystems, water supply systems and infrastructure making them more vulnerable to extreme events. Moreover, many more people will be affected by climatic events such as cyclones, flooding, and drought. Government does not have the resources to adequately provide for the current population and will be in an even worse state to provide for twice as many people 20 years from now.
- ~ Reduce complexity of programmes and project designs. While Vanuatu now has some capacity to implement technical projects, it does not yet have the expertise to design and implement complex and complicated initiatives. Projects and programmes for Vanuatu should therefore be designed from the outset to be flexible and to match local capabilities to implement and manage. They should be less complex and more focused. Expected outputs should be prioritized, transparent, clear and measurable.
- ~ Build partnerships for effective project implementation. With 80 islands scattered over a huge area of open waters, implementing national projects in Vanuatu will always be a difficult challenge. Government services are extremely limited or absent on some islands and this will compound the problem. On the other hand, some NGOs have been active in rural areas and are best placed to assist government carry out some of its projects in such areas. To do this would require the establishment of a working partnership between the parties to ensure their roles and responsibilities are clearly identified and understood. Similar arrangements with local communities may also prove beneficial.

- ~ Enhance public awareness and understanding of climate change and its likely impacts on their livelihood. While public awareness about global warming is improving through the media, public awareness about the impact of climate change on the peoples' livelihood is very extremely limited. Such awareness and understanding is crucial to fostering effective partnerships with local communities on efforts to adapt to climate change.
- ~ Mainstream climate change adaptation into physical planning and development initiatives. Previous initiatives to adapt to climate change in Vanuatu have had limited success because they were planned and carried out in an ad hoc manner. While the NACCC has ensured that this will not happen again, there still remains the need to mainstream climate change adaptation into the physical and development plans of the country as a whole. There is also a need for key sectors like agriculture, tourism, forestry and fisheries to integrate adaptation measures into their own sector plans and programmes.
- ~ Importance of regional and sub-regional climate change initiatives. Climate change will affect all Pacific island countries. Vanuatu should therefore continue to explore with its Pacific neighbors opportunities for regional or sub-regional initiatives through which additional support for local implementation of climate change adaptation projects could be secured. Working with UN agencies (such as FAO, UNDP and UNEP) and regional organizations such as the FORUM Secretariat, SPREP, SOPAC and SPC will be useful in this regard.
- ~ Importance of working with local communities. Involving local communities in the planning and implementation of climate change adaptation projects will be key to the long term success of such projects. The development and inclusion of an appropriate consultative mechanism for the project proponents and the communities to consult with each other is an important step in formulating an effective and efficient working relationship between them.
- ~ Strengthening service delivery to rural areas is crucial to nation-wide efforts to minimize the impacts of climate change on the environment. Poor transport and communication networks are hampering efforts to engage rural communities in climate change adaptation initiatives. As a result, past climate change initiatives have concentrated on urban areas while those in rural areas miss out on training and other benefits from such initiatives.

Improving access (land, air and boat links) to rural communities is crucial to the success of climate change adaptation efforts in areas that are often neglected by government programmes.

EXISTING INSTITUTIONAL MECHANISMS AND POLICY TO RESPOND TO CLIMATE CHANGE AND CLIMATE VARIABILITY IN AGRICULTURE AND FOOD SECURITY

INSTITUTIONAL ARRANGEMENTS

Although the government of Vanuatu is continuing to implement a Comprehensive Reform Programme (CRP) designed in 1997 to address key governance issues with emphasis on improving the transparency and accountability of the public sector, much remains to be done to strengthen key institutions of government to promote community participation in the decision-making processes.

Most of the necessary institutional structures to deal with climate change and other environmental issues are in place although many have become ineffective because of lack of resources or delays in staff appointments. An important example is the Environment Unit of the Department of Lands and Environment which has shrunk to just two staff and without a Principal Officer to lead its activities. Other relevant agencies are not much better off and this is a problem the government will have to look into as a matter of urgency in order to ensure that it has the required capacity to deal with the broad range of climate change issues that are likely to impact on the country's development in the long term.

As a developing country, most organizations in Vanuatu have limited capacities in terms of staff numbers, numbers of technical staff, access to technical equipment and financial resources. Government agencies focus on immediate and practical priority issues and have difficulty maintaining current level of services in key sectors such as agriculture. While recognizing the long term importance of reducing GHG emissions and preparing for climate change, it is difficult for government to take the longer term economic decisions necessary.

There are several government agencies, NGOs and other organizations in Vanuatu who are and should continue to play key roles in addressing climate

change concerns in Vanuatu. The roles of the following agencies and organizations are particularly relevant to the agriculture sector.

- ~ The NACCC⁵ is the principal body responsible for all climate change activities in Vanuatu. The NACCC was established by decision of the Council of Ministers and brings together the range of expertise that is available in various government and non-government agencies to plan and develop strategies and actions necessary to address climate change issues affecting Vanuatu. The NACCC has been responsible for the preparation of the INC and is now working on the Second National Communication (SNC).
- ~ Until recently, the Environment Unit of the Ministry of Lands and Environment (MLE) has been the principal agency responsible for environmental issues in Vanuatu. However, staff departures and limited resources have seen the downsizing of the Unit to just three staff members with limited experience in the disciplines under the Unit's mandate. Government's intention with regards the role of the Unit remains unclear but it is unlikely that the situation will improve much in the next year or so. An assessment of Vanuatu's capacity to meet its obligations under the CBD, UNFCCC and UNCCD was implemented by the Unit in the past three years.
- ~ The Meteorology Department has played a key role in the implementation of climate change projects and activities in Vanuatu. It currently holds the chair of the NACCC and has participated fully in the preparation of the NAPA and Vanuatu's INC. Through the NACCC, the Department is actively involved in all climate related activities in Vanuatu and has carried out vulnerability assessments of more than ten small islands in the country. The impact of climate change on the agriculture sector received important emphasis in these studies.
- ~ The current emphasis of the work of the Agriculture Department is increasing productivity of small farms around the country and the development of efficient domestic and export marketing systems for traditional food crops, livestock and high value specialty crops. The Department has not been directly

5 Members of the NACCC include: Meteorological Services (Chair), Ministry of Foreign Affairs, Environment Unit, Department of Agriculture, Department of Forestry, Department of Fisheries, Department of Energy, Ministry of Health, and Department of Lands.

involved in implementing climate change related projects but is well aware of the potential impact of climate change on its efforts to increase productivity and marketing systems. There is work underway looking at selection programs for crops and varieties that are more resistant to changing weather patterns as well as pests and diseases that are likely to become prevalent due to more favorable breeding conditions.

- ~ Although it has not been directly involved in implementing any climate change projects in Vanuatu, the Fisheries Department has played an important role in supporting a number of projects and activities that are important to understanding the impact of climate change on fisheries habitats. The Department has recently established monitoring sites to assess the impact of pollution from land-based activities on coastal ecosystems around Efate and is looking at replicating this work in other islands of Vanuatu. The Department is also involved in the NACCC and provides technical advice to the NACCC’s working group on matters pertaining to fishery.
- ~ The Forestry Department has participated in a number of environmental projects in Vanuatu including climate change through the NACCC. In 1997, the Department produced a National Forest Policy Statement “to ensure the sustainable management of Vanuatu’s forests in order to achieve greater social and economic benefits for current and future generations”. The Conservation Unit of the Department formulates and coordinates environmental projects that are compatible with the interests of climate change projects and in this way contributes to national efforts to address climate change issues in the country.
- ~ The Department of Geology, Mines and Rural Water Supply is charged with the responsibility to conserve, protect and manage the minerals and ground water resources of Vanuatu. The Department has been working with other government departments to monitor the condition of the bay and lagoons around Efate and has been looking to secure equipment for carrying out heavy metal residue tests on bivalves and gastropods within these areas. Through a UNESCO-funded initiative, the Department has been implementing water resource and land-use monitoring activities with the communities of Epule (on Efate), Fanafo (on Santo) and Talise (on Maewo). Ground water monitoring work is particularly important to understanding the impact of climate change and it is expected that

this Department will continue to play a key role in future efforts to address the impacts of climate change on Vanuatu's water resources.

- ~ Although not involved with the NACCC, the Foundation for People of the South Pacific (FSP) Vanuatu has a long history of involvement in resource management and training especially with rural communities throughout Vanuatu. Some of the projects the FSP has carried out that are of relevance to climate change include (a) a disaster management project; (b) community vulnerability reduction training; and (c) participatory natural resource management.
- ~ The Vanuatu Association of NGOs (VANGO) was established in 1994 as an umbrella NGO for all locally registered NGOs. VANGO promotes and supports NGO efforts to achieve equitable and sustainable human development within Vanuatu and currently hosts the Pacific Islands Association of Non-Governmental Organizations (PIANGO). With a grant of 3 million vatus, VANGO coordinated emergency relief for victims of an earthquake that affected the Tafea and TORBA provinces.
- ~ The Wan Smol Bag Theatre (WSBT) is well known throughout Vanuatu and the Pacific for its popular dramas and plays with environmental themes. WSBT plays are based on needs and concerns raised by communities, government and other groups. Past plays have focused on waste management awareness, river management and turtle monitoring. Other plays have focused on AIDS and other social issues affecting youths in the Pacific. The WSBT remains an effective avenue for raising understanding and awareness of climate change issues provided it is given the financial support it requires.

While the national government lacks capacity to respond to climate change, capacity at the Provincial level is even more limited. Provincial administrators have few trained technical staff, none have dedicated environmental officers or planners, and all have extremely limited resources. However, the need for participation at this level in implementing decisions and plans that help people prepare for climate change is crucial to the success of national initiatives to adapt to climate change. As more information becomes available, it will be important to develop skills and support for the preparation of climate change action plans for Vanuatu on both provincial and island by island level.

At the community level, there is very little understanding of the concepts of greenhouse gas induced climate change. Although several programmes had focused on public and community awareness in the past, these have not been followed up due to limited resources. It is unlikely that the general public will have the scientific literacy to fully understand concepts underpinning the climate change and sea-level rise issues. Hence activities that are specifically focused at the community level where the transfer of skills in disaster preparedness, community planning and adaptation to climate change are promoted will, in many cases be more productive than attempts to raise understanding.

POLICIES AND LEGISLATION

Article 7 (d) of Vanuatu’s Constitution categorically states that every person has a fundamental duty “... to protect Vanuatu and to safeguard the national wealth, resources and environment in the interest of present and future generations”. In March 1993, the Republic of Vanuatu ratified the UN Framework Convention on Climate Change (UNFCCC) and submitted its INC in October 1999. Following the preparation of the INC, initial efforts to create an institutional set-up that seeks to mainstream climate change issues into the national frameworks were initiated.

At the Seventh Conference of the Parties to the UNFCCC (COP 7), it was resolved that the work programme for least developed countries (LDCs) to prepare and implement National Adaptation Programmes of Action (NAPA) be supported, including meeting the full cost of preparing the NAPAs. As an LDC, Vanuatu took advantage of this support and in October 2004, NAPA activities for Vanuatu commenced.

The objective of the NAPA project for Vanuatu was to develop a country-wide programme of immediate and urgent project-based adaptation activities in priority sectors, in order to address the current and anticipated adverse effects of climate change, including extreme events. The NAPA also served as an avenue to raise understanding at all levels in society, with respect to vulnerability and adaptation issues of greatest significance to the country. At the completion of nation-wide consultations, the final list of projects for implementation under the NAPA was determined as follows:

- ~ agriculture and food security (preservation/processing/marketing, modern and traditional practices, bartering);
- ~ water management policies/programmes (including rainwater harvesting);
- ~ sustainable tourism;
- ~ community-based marine resource management programmes (modern and traditional aquaculture); and
- ~ sustainable forestry management.

The NAPA provides a comprehensive listing of climate change issues and vulnerabilities as well as adaptation options for the various provinces of Vanuatu and as such, is seen as a key guide to government and all other sectors in addressing the impacts of climate change in the country.

In addition to the NAPA, efforts have also been made to prepare sector-specific policies for dealing with climate change. The following initiatives are worth noting:

- ~ Climate Change Policy for Vanuatu. Because climate change will affect most sectors, it is important and appropriate that Vanuatu takes an integrated, short and long term approach to dealing with climate change issues affecting the country. A Climate Change Policy Framework paper has been prepared for consultation purposes but it is expected that the final policy will be considered and approved shortly.
- ~ National Forest Policy Statement. Published in June 1999, the National Forest Policy Statement serves to guide the work of the Department of Forestry, to provide signals to both the investors and donors about how forestry will be managed in Vanuatu and to provide the direction for a much needed review of the Forestry Act. Sadly, the Policy Statement makes no mention whatsoever of impact of climate change on the sector and what actions, if any, will have to be taken to minimize any impacts on the industry and people who depend on the sector for their livelihood.
- ~ Vanuatu National Communication to the UNFCCC. The National Communication is the primary mechanism through which Vanuatu's international commitments will be met. Implementation of the Initial National Communication (INC) has fostered better understanding and guidance in policy and planning developments towards achieving national objectives consistent with meeting international commitments. The INC demonstrates Vanuatu's commitment to bear its fair share of the burden in the worldwide effort to

combat Global Climate Change while recognizing that national interest lies in protecting jobs and improving the quality of life for all ni-Vanuatus.

- ~ The Environment Bill 2002 strengthens the policy development and advisory roles of the Environment Unit. The functions of the Director include amongst others, the development of national environmental policies and plans for the sustainable management of the environment. Unfortunately, with its limited capacity at present, it is unlikely that the Unit will be able to carry out its functions without a substantial injection of funding and qualified staff.
- ~ The Water Resource Management Act (2002) provides the option for the development of a Water Resource Management Policy and a National Water Resource Management Plan should the Minister consider these instruments appropriate for the efficient and effective planning and development of the nation's water resources. It also provides for the declaration of water protection zones – both rural and urban – where action is necessary to prevent or restrict development and expansion into areas from which water supply is drawn.
- ~ Comprehensive Reform Programme (CRP). In an effort to address several structural problems within its economy, Vanuatu began implementation of a comprehensive reform programme in July 1998 following its adoption by a broad range of community representatives at a national summit in Port Vila in July 1997. Environmental issues are given some prominence under the CRP. Key environmental issues can be classified as those arising as a consequence of human impact and those that fall under the areas of environmental conservation and enhancement. Issues falling under human impact include population pressure and urban development, waste management and global warming and sea-level rise.
- ~ Research Priorities for Agriculture, Forestry and Fisheries in Vanuatu. Although the official status of this document is not known, it refers to several policy recommendations that have been formulated while attempting to draft an action plan for the development of the agriculture sector in Vanuatu. The exercise enabled the stakeholders to reach consensus on six major issues:
 - ~ the area of agriculture with the greatest potential to benefit the majority of the ni-Vanuatu, as well as the nation, lies in improving the production and market access to smallholders producing traditional crops;

- ~ the expansion of the market for traditional foodstuffs and for high value specialty niche products depend on improving smallholder productivity and domestic market systems;
 - ~ there is a limited number of crops that are candidates for further development;
 - ~ increasing the production of traditional food crops and livestock and improving the marketing systems for these is an important priority considering the future doubling of the population;
 - ~ despite the falling prices of copra, it is necessary to refocus attention on the development of the coconut and non-copra uses;
 - ~ there is an urgent need to control the quality and to put in place conditions conducive to increased smallholder production of kava.
- ~ National Adaptation Plan for Action (NAPA). As pointed out elsewhere, the NAPA is perhaps the most important plan of action there is for addressing urgent adaptation issues in Vanuatu. Its main objective was to develop a country-wide programme of immediate and urgent project-based adaptation activities in priority sectors in order to address the current and anticipated adverse effects of climate change, including extreme events. After extensive consultations and field visits, the NAPA has identified the priority projects for Vanuatu as follows:
- ~ agriculture and food security (preservation/processing/marketing, modern and traditional practices, bartering);
 - ~ water management policies/programmes (including rainwater harvesting);
 - ~ sustainable tourism;
 - ~ community-based marine resource management programmes (modern and traditional, aqua-culture); and
 - ~ sustainable forestry management.

NATIONAL STRATEGY TO MITIGATE AND ADAPT TO CLIMATE CHANGE CHALLENGES AND OPPORTUNITIES FOR AGRICULTURE AND FOOD SECURITY

MITIGATION

Mitigation refers to measures that will reduce the national release of GHGs. Vanuatu is a very minor producer of GHG emissions both in terms of total emissions and emissions per head of population. Mitigation measures will enable Vanuatu to minimize any increase in its GHG emissions, but due to existing needs for social and economic development, a reduction in releases is not an immediate goal for the government.

Most mitigation measures either reduce people's demand for GHG emitting products or else control their supply. They can incorporate education and awareness raising initiatives, fiscal measures such as financial incentives, taxes and charges, legislation to prohibit certain activities and policy measures. Some mitigation options of relevance to the agriculture sector are discussed below.

- ~ Decrease dependency on fossil fuels. Diesel generators provide the majority of electricity in Vanuatu, particularly in the two urban centers, Port Vila and Luganville. Vanuatu however has potential to use a range of alternatives for generation of electricity such as geothermal, hydro, solar and wind. Both hydro and solar systems require substantial initial investment and this will make them less attractive. Increased use of biofuel (e.g. coconut oil) in the transport sector has shown promise in Vanuatu while promoting the use of fuel wood as a substitute for cooking gas would benefit rural areas where fuel wood is in abundant supply.
- ~ Promote forest conservation. Forests can be considered sinks for GHG. Vanuatu remains almost 70 percent forested, with non-forested areas primarily used for agriculture, gardening and settlements. Government policies and changing economic needs in recent years had resulted in large tracks of forested lands being converted to agriculture and other uses. Further conversions are inevitable and will be hard to stop. The option therefore is to promote agro-forestry and multi-cropping on converted lands as opposed to single crop monoculture systems that involves wholesale clear felling of forest areas.

- ~ Improve operating efficiency of agriculture equipment and appliances. Many farming/forestry machinery, vehicles and appliances operate at less than optimal conditions due to rugged conditions, and poor maintenance and repair. Improvements in operating efficiency will require greater awareness of the cost savings that result to the user and training of technical personnel in the maintenance and repair of heavy machinery.
- ~ Decentralize services and economic activities. Increased decentralization of services and economic activities coupled with greater development of the local markets would do much to reduce the current dependence on inter-island transport between Port Vila and Luganville as the hubs. Such a change would be facilitated by economic incentives for skilled workers and entrepreneurs to establish themselves locally rather than being based in one of the two urban areas. The majority of small farmers are rural-based and will benefit from not having far to go to sell their produce. Gains from reduced emissions from inter-island transports are, however likely to be offset by increased vehicle use as local cash economies become better established.

ADAPTATION

Adaptation refers to changes in technologies, practices and policies that can prepare a country for the impacts of climate change resulting from GHG emissions. While Vanuatu's vulnerability to climate change and sea-level rise will be determined by the decisions and actions that are made today with respect to the management of the country's resources and the nature of its social and economic development, Vanuatu is nevertheless in a position to adopt pro-active adaptation strategies that can be implemented immediately and sustained over the years to effectively reduce its vulnerability. However, there are three main obstacles to be considered:

- ~ in the present socio-economic climate, it is difficult to identify national resources that could be redirected to climate change adaptation activities from immediately pressing social development needs;
- ~ climate change issues are, in general, poorly understood; and
- ~ despite efforts to make climate change planning multi-sectoral, it has not been incorporated into the mainstream planning activities of governments and sectoral organizations (GoV, 1999).

Given the poor state of knowledge and understanding of climate change issues that exist today, coupled with limited financial resources and low levels of technology, Vanuatu, like many other SIDS face a considerable challenge to adapt to the impacts of climate change. Some adaptation opportunities considered appropriate and achievable for Vanuatu’s agricultural sector are discussed below.

- ~ Diversify root crops. Vanuatu’s subsistence and commercial agriculture are based on a small number of crops. Diversification of root crops will help increase the resilience of agriculture systems to climatic extremes.
- ~ Improve research and understanding of subsistence food crops. The productivity, growth requirements and pathogens of many of Vanuatu’s subsistence food crops are poorly understood compared to commercial horticultural crops. Better understanding of the horticulture of the subsistence food crops will provide a foundation for adaptation by enabling the selection and promotion of crop varieties suited to changed climatic conditions or resistant to particular pathogens. Crops of particular interest include yam, taro, manioc, kumara, banana and island cabbage.
- ~ Improve land use and physical planning mechanisms. Land use and physical planning that take into consideration the possible impacts of climate change and sea-level rise provides a powerful tool for reducing vulnerability. Planning mechanisms can be used to direct or regulate all new investments in infrastructure, housing construction and agriculture outside hazard zones to minimize vulnerability, reduce repair costs and decrease disruption to economic activities.
- ~ Prohibit extractive activities from vulnerable sites such as coastal areas. The destruction of mangroves and sand extraction from coastal areas leave them vulnerable to the impacts of wave surge and sea-level rise. Replanting littoral vegetation in cleared or degraded coastal areas on the other hand would restore their protective functions.
- ~ Promote agro-forestry regimes. Preventing further large scale conversion of forest areas would reduce GHG emissions but would be difficult for economic and political reasons. Promoting agro-forestry regimes that enable the maintenance of standing biomass would be a more appropriate option.
- ~ Improve management of water catchment areas. Better management of Vanuatu’s water catchment areas will help maintain water quality and maximize ground water recharge. This will in turn help minimize the impact of climate change

on water resources while providing immediate benefits to areas that are already suffering from seasonal shortages of water.

- ~ Regulate the extraction of freshwater from coastal aquifers. The introduction of policies that allow the extraction of freshwater from coastal aquifers only where there are no feasible alternatives would reduce the vulnerability of coastal communities and reduce the need to replace infrastructure should salt water intrusion occur.

In light of the vulnerabilities identified and the adaptation options discussed above, a national strategy to mitigate and adapt to climate change is suggested in Table 5.

TABLE 5: A NATIONAL STRATEGY TO MITIGATE AND ADAPT TO CLIMATE CHANGE

CLIMATE CHANGE ISSUE AND VULNERABILITIES	MITIGATION STRATEGY	ADAPTATION STRATEGY
ROOT CROPS		
Declining crop production as a result of changing climatic conditions	<ul style="list-style-type: none"> ~ Promote adaptive management approaches ~ Increase public awareness about potential impacts of climate change on agriculture and food security ~ Review breeding strategies and regulations concerning varieties release and seed distribution ~ Support agriculture research especially on traditional food crops ~ Encourage and support local processing of food crops (e.g. cassava chips and flour, coconut oil, etc.) 	<ul style="list-style-type: none"> ~ Diversify root crops ~ Select crops and cultivars that are tolerant to abiotic stresses ~ Increase support for plant breeding programme ~ Broaden genetic base of traditional food crops ~ Develop locally-adapted crops ~ Adopt agro-forestry practices ~ Promote low tillage and permanent soil cover on agriculture lands ~ Construct safe food storage facilities ~ Identify alternative food sources including imports ~ Research on farming systems including soil/land husbandry
Increased pest activities due to changes in temperature and rainfall	<ul style="list-style-type: none"> ~ Promote adaptive management and risk-coping production systems ~ Review quarantine control measures for local distribution and propagation of food crops ~ Strengthen research capacity of Ministry of Agriculture 	<ul style="list-style-type: none"> ~ Select crops and cultivars with pest and disease resistance traits ~ Adopt agro-forestry practices ~ Identify alternative crops for specific ecologies ~ Broaden genetic base of traditional food crops ~ Identify and document pests and pest activities

[→]

[→] Table 5 continued

CLIMATE CHANGE ISSUE AND VULNERABILITIES	MITIGATION STRATEGY	ADAPTATION STRATEGY
Salt spray and rising sea levels affecting home gardens and crops	<ul style="list-style-type: none"> ~ Impose bans on clearing of coastal vegetation ~ Develop national land use plan ~ Develop coastal infrastructure management plans 	<ul style="list-style-type: none"> ~ Move gardens away from low-lying areas ~ Plant littoral vegetation as buffers against salt spray ~ Undertake cost-benefit analysis of various coastal protection measures ~ Identify and select suitable species for coastal rehabilitation
Shifts in weather patterns affecting planting and harvesting regimes	<ul style="list-style-type: none"> ~ Put in place early warning and risk management systems ~ Apply adaptive management and risk-coping production systems 	<ul style="list-style-type: none"> ~ Adjust planting and harvesting timetables to prevailing conditions of past 3-4 years ~ Revive traditional food preservation techniques ~ Undertake assessment of impact of shifting weather patterns of traditional food crops ~ Crop improving programs focusing on climate change adaptation
FORESTRY		
Increased pest activities due to changes in temperature and rainfall	<ul style="list-style-type: none"> ~ Promote adaptive management and risk-coping production systems ~ Review quarantine control measures for local distribution of tree seeds and seedlings ~ Increase research capacity of Department of Forestry 	<ul style="list-style-type: none"> ~ Select tree species with pest and disease resistance traits for plantation purposes ~ Adopt multi-cropping as against mono-cropping ~ Enhance the preservation and use of local genetic resources ~ Carry out silvicultural research on main forestry species
Loss of forests due to cyclones and wind damage	<ul style="list-style-type: none"> ~ Reduce GHG emissions from deforestation through more effective management of forest resources ~ Review forest policy to make replanting of logged over forests a condition of logging licenses ~ Carry out feasibility studies of salvage logging of cyclone affected forests 	<ul style="list-style-type: none"> ~ Expand genetic selection to include other priority species such as <i>Santalum austro caledonicum</i> (sandalwood), <i>Agathis Macrophylla</i> (kauri), etc. ~ Select seed provenances for altered climatic conditions ~ Promote mixed species plantations ~ Carry out salvage logging in wind-damaged forest areas
Limited understanding of the impact of climate change on forests	<ul style="list-style-type: none"> ~ Develop media and public awareness campaigns ~ Incorporate climate change science in school curriculum 	<ul style="list-style-type: none"> ~ Intensify forest assessments and monitoring and establish new tools and indicators to rate forests and species vulnerability

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[→] Table 5 continued

CLIMATE CHANGE ISSUE AND VULNERABILITIES	MITIGATION STRATEGY	ADAPTATION STRATEGY
FISHERIES		
Increased sea temperature could affect biological properties and distribution of fish species thereby affecting fish catches and food security	<ul style="list-style-type: none"> ~ Develop resilient and adaptive fishery management systems ~ Prepare awareness raising initiatives to help communities make appropriate decisions about their management of marine resources ~ Increase research capacity of Fisheries Division 	<ul style="list-style-type: none"> ~ Promote marine or freshwater aquaculture ~ Modify fishing effort and catches according to the state of the stocks ~ Promote alternative sources of protein and economic activities for communities during lower productivity phases ~ Promote coastal area management approaches
Increased ciguatera incidences	<ul style="list-style-type: none"> ~ Improve public awareness and understanding about connection between climate change and ciguatera 	<ul style="list-style-type: none"> ~ Continue monitoring of incidences of ciguatera outbreaks ~ Identify and document linkages between ciguatera and climate change
Negative impacts from more frequent storm surges, decreased salinity during high intensity rainfall events and increased coastal erosion on mangroves, sea grass and other near shore ecosystems	<ul style="list-style-type: none"> ~ Develop adaptation strategies to any reduction in harvests of marine resources including replacing fishing with alternate sources of protein ~ Impose ban on clearing of coastal vegetation 	<ul style="list-style-type: none"> ~ Promote alternative sources of protein during lower fishery productivity phase ~ Promote marine or freshwater aquaculture ~ Modify fishing effort and catches according to the state of the stocks
Limited understanding of the long term trends in climate change, especially related to global warming, in fisheries	<ul style="list-style-type: none"> ~ Develop awareness programs based on existing knowledge targeting politicians, schools and coastal communities 	<ul style="list-style-type: none"> ~ Collect and document evidence of changes in fisheries to enable better understanding of climate change on the fishery sector
LIVESTOCK		
Increased temperatures could affect health, productivity and reproductive efficiency of livestock	<ul style="list-style-type: none"> ~ Consider animal husbandry changes such as ruminant diets and stocking ratios ~ Increase research capacity of Livestock Division 	<ul style="list-style-type: none"> ~ Promote animal breeds or varieties that can best resist changing conditions ~ Promote locally adapted livestock breeds
Climate variability could enhance growth of less nutritious pastures	<ul style="list-style-type: none"> ~ Monitor fodder and pasture effects on livestock 	<ul style="list-style-type: none"> ~ Identify and support appropriate pasture management practices

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[→] Table 5 continued

CLIMATE CHANGE ISSUE AND VULNERABILITIES	MITIGATION STRATEGY	ADAPTATION STRATEGY
WATER SUPPLY		
Variability in river flows and aquifer recharge resulting from climate change	<ul style="list-style-type: none"> ~ Develop appropriate water management regimes ~ Encourage mulching and zero tillage in areas where there is intense rainfall ~ Develop laws to protect watershed areas ~ Awareness raising programs 	<ul style="list-style-type: none"> ~ Promote land and forest conservation techniques ~ Increase rainwater catchment and storage capacity ~ Establish appropriate water distribution facilities ~ Control issuance of logging licenses ~ Formulate land and water use policies
Increased salinity of ground water sources resulting from salt water intrusion, overuse and flooding	<ul style="list-style-type: none"> ~ Develop water management policy especially for small islands in the group ~ Promote water and forest conservation 	<ul style="list-style-type: none"> ~ Increase rainwater catchment and storage capacity ~ Establish water distribution facility ~ Regulate use of irrigated systems
OTHER FACTORS		
Loss of traditional farming techniques	<ul style="list-style-type: none"> ~ Revive use of traditional farming techniques ~ Promote research on traditional food crops 	<ul style="list-style-type: none"> ~ Conduct training workshops on use of traditional farming techniques ~ Document traditional farming techniques for future use
High population growth rate	<ul style="list-style-type: none"> ~ Promote public awareness and education campaigns to draw attention to the impact of a fast growing population on the socio-economic development of the country 	<ul style="list-style-type: none"> ~ Develop and enforce a population policy for Vanuatu ~ Introduce family planning initiatives especially in rural areas ~ Provide incentives to control family sizes
Resistance to change	<ul style="list-style-type: none"> ~ Support public awareness raising initiatives ~ Develop incentives programme in support of change 	<ul style="list-style-type: none"> ~ Improve understanding of the need for change in accordance with changing conditions and circumstances ~ Carry out demonstrations in support of need for change
Influence of large scale, single crop farms	<ul style="list-style-type: none"> ~ Increase support for small scale farming ~ Consider incentive scheme (e.g. subsidy) in support of small farmers ~ Support establishment of a small farmers association 	<ul style="list-style-type: none"> ~ Diversification of crops ~ Concentrate on traditional crops ~ Decentralize food crop breeding programme ~ Increase support for small farmers

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[→] Table 5 continued

CLIMATE CHANGE ISSUE AND VULNERABILITIES	MITIGATION STRATEGY	ADAPTATION STRATEGY
Loss of interest in traditional crops such as coconuts	<ul style="list-style-type: none"> ~ Review and promote sustainable use of traditional crops ~ Support local processing of certain food crops (cassava, taro, coconut, etc.) 	<ul style="list-style-type: none"> ~ Invest in alternative economic use of traditional crops (e.g. coconut oil as an alternative to fossil fuel) ~ Improve genetic material from traditional crops ~ Improve market access for small farmers ~ Build national capacity and knowledge on plant propagation techniques and agro-forestry systems
Lack of a sustainable forest management plan	<ul style="list-style-type: none"> ~ Support development of a national sustainable forest management plan ~ Increase research capacity of Forestry Division 	<ul style="list-style-type: none"> ~ Update existing information on the country's forest resources ~ Prepare sustainable forest management plan taking into account potential impact of climate change
Imbalance between forest utilization and reforestation	<ul style="list-style-type: none"> ~ Support development of a sustainable forest management plan ~ Encourage agro-forestry practices 	<ul style="list-style-type: none"> ~ Set sustainable cut targets ~ Include reforestation as condition of logging licenses ~ Support replanting of fast growing high value species such as sandalwood, whitewood, etc.
Lack of capacity to service livestock industry	<ul style="list-style-type: none"> ~ Build capacity of veterinary unit within Ministry of Agriculture 	<ul style="list-style-type: none"> ~ Expand and decentralize veterinary service ~ Offer training in animal husbandry for small farmers ~ Seek support from regional institutions such as SPC

RECOMMENDATIONS

The following recommendations are considered appropriate for consideration by the government of Vanuatu, its development partners and other stakeholders in order to improve the capacity of Vanuatu to adapt to climate change and climate variations especially in relation to their impacts on agriculture and food security in the country.

- ~ More attention to population growth. Vanuatu's population is growing at an average rate of 2.6 percent per annum. At this rate, it is predicted that the current population of almost 210 000 will double in 20 year's time. As the population increases, more and more people will be concentrating on coastal areas putting more pressure on these vulnerable locations, increasing the demand on the limited services available there. It is recommended that the government give more attention to controlling the population growth as an important part of its strategy to reduce the impact of climate change on the social and economic wellbeing of the country.
- ~ Need to focus on fewer, better defined priorities. Given Vanuatu's limited financial and technical resources, it will be impossible for the government to effectively address the wide range of issues and actions necessary to respond to climate change. It is therefore recommended that the government strategically address a limited number of clearly identified priorities and actions based on the greatest needs and risks from climate change.
- ~ Value of the National Coordinating Committee. In Vanuatu, the National Advisory Committee on Climate Change (NACCC), a multi-disciplinary team that draws its membership from different government agencies, civil society and other relevant stakeholders is mandated by government to oversee the coordination of all climate change initiatives emanating from the UNFCCC process. The NACCC has been very effective in performing this role and it is recommended that the government should continue to support the work of this Committee as an effective means of advocacy for the UNFCCC and other climate change related agreements.
- ~ Need for continued human resource development. GEF-funded regional and national climate change related projects have provided a wide variety of training

and human resource development in past years. FAO, SPC and the European Union have also supported capacity building initiatives in the agriculture sector and these have contributed enormously to Vanuatu's overall capacity to address environmental concerns and to meet its obligations under international conventions. However, due to the high rate of occupational mobility, retirement and migration, it is recommended that human resource development initiatives need to be continued and expanded if Vanuatu is to be able to deal with the growing and complex issues associated with climate change.

- ~ Difficulty of servicing remote, rural farmers. Financial constraints and poor transport and communications are hampering efforts to reach out to the rural farmers particularly the smallholders that are in most need of support especially during natural hazards such as droughts and cyclones. It is strongly recommended that improving service delivery to rural areas be made an explicitly higher priority for donor-funded development projects in future. Decentralization of the plant breeding programme and the veterinary services of the Ministry of Agriculture should inevitably follow the improvement of transport and communication services to rural areas of the country.
- ~ Improve awareness and understanding of local communities about the connection between climate variability and agriculture crop productions. Several farmers have noted significant changes to the fruiting and flowering seasons of a number of traditional plants and crops while others have complained about low productions over the past few years. Most if not all speculate that the changing weather patterns have something to do with this but do not quite understand or appreciate the connection. To ensure that local communities and farmers do understand and appreciate the relevance of climate change to the products of their labor, it is recommended that efforts be continued to improve their awareness and understanding of the impacts of climate change on their livelihood.
- ~ Need to apply lessons from within Vanuatu. The government, with assistance from bilateral and international projects and programmes, has carried out assessments of the impacts of climate change on a number of locations throughout Vanuatu. The studies also identified appropriate adaptation strategies to respond to such impacts. The studies showed that climate change impacts on agriculture were almost identical for all the targeted locations

and it is therefore recommended that in the absence of site-specific data and information, the findings and lessons from the studies already completed be used to guide future efforts to develop responses to climate change in other relevant parts of the country.

- ~ Increase the number of smallholders, not the size of existing farms. During the formulation of a draft action plan for the development of the agriculture sector in Vanuatu, the Ministry of Agriculture, Forestry and Fisheries together with the other stakeholders involved in the exercise agreed that (i) improving the production and market access for the smallholders producing traditional crops has the potential to benefit the greatest number of ni-Vanuatu, and the country as a whole; (ii) the expansion of the market for traditional foodstuff and of high value specialty niche products depend on improving smallholder productivity and domestic market systems; and (iii) increasing the production of traditional food crops and livestock and improving the marketing systems for these is an important priority considering the future doubling of the population. In view of the priority given to the role of smallholders in ensuring food security in Vanuatu, it is recommended that efforts be made to increase the number of smallholders while at the same time, promote traditional food crops, and provide support to make food gardens more sustainable.
- ~ Improve and expand plant breeding programme. Poor roads coupled with irregular air and sea linkages between the islands have a significant effect on the distribution of planting materials from the Ministry's headquarters in Vila to other parts of Efate and to other islands in the archipelago. All food crops distributed by the Ministry are asexually propagated and some of them (e.g. sweet potato) do not last a boat voyage to the outer islands. Airfreight is safer but extremely expensive. Given these conditions, it is recommended the plant breeding programmes by the Ministry of Agriculture be improved and expanded by decentralization (see 5 above) and by broadening the genetic base of traditional crops as well as by providing basic training for rural farmers, especially those in outer islands.
- ~ Value of NGOs. In Vanuatu, NGOs are required to register in order to be recognized by government and to have better access to external assistance. A number of NGOs (e.g. VANGO, FSPI and Live and Learn) are already working well with government but there is still some way to go for other

NGOs to establish such relationships. Despite the presence of some NGOs in remote islands and areas where government services are limited or absent, only a few government-managed projects in these areas have involved NGOs. This is due in part to weak financial accountability even where service delivery is adequate. Local NGOs are unlikely to be effective in supporting projects in remote islands unless they are supported by government. In this regard, it is recommended that government provide support to NGOs and CSOs to strengthen their accountability and general project management skills and knowledge especially in areas where government service is limited or absent. Care should however be taken to make sure that this support is not done in a way or scale that will overwhelm them.

CONCLUSIONS

Changing weather patterns are already having a negative impact on agriculture production in Vanuatu and most evidence point to the fact that they will be exacerbated by climate change related events in future. Vanuatu has already taken some preemptive measures to address the various threats to, amongst others, the agriculture sector and the government is to be congratulated for its foresight. However, much still needs to be done to ensure that Vanuatu is able to reduce the impact of climate change on areas that are already vulnerable and at the same time effectively protect others that are at risk from future changes.

Information on population growth and distribution as well as land use data are important for future planning irrespective of the precise nature and pace of climate and sea level change. Such data would facilitate the identification of not only the number of people but also the types of land-based development likely to be affected by a particular event. Collecting and analyzing these data should form an important part of future efforts to address climate change impacts in Vanuatu.

The inter-related nature of climate change and agriculture production suggests that both short and long term views must be taken into account when considering adaptation measures for Vanuatu. While the desirable approach would be to address the original causes of global environmental changes and sea-level rise, the reality is that small islands like Vanuatu that contribute so little to the cause

of the problem and have the least capacity to deal with it, is being forced to deal with the effects. For this reason, the international community has an obligation to Vanuatu and other small island nations to assist them with the development and implementation of plans and activities which will, to the extent possible, alleviate the adverse impacts associated with climate change and sea-level rise.

Adapting to climate change, variability and sea-level rise is a serious and urgent need for Vanuatu. And the ideal approach to adaptation for Vanuatu at this time is a pro-active, no-regrets approach which encompasses measures and strategies that can be implemented now with the aim of reducing vulnerability in the future. As the President of the Republic said in his opening address during the first National Conference on National Adaptation Programme of Action in January 2005, “a no-regrets approach is one which would be beneficial to Vanuatu even in the absence of climate change and sea level change”.

The main problem with assessing the impact of climate change and in identifying a cost-effective response is the uncertainty surrounding estimates of the time and magnitude of the changes to be expected. The difficulty lies in the complexity of predicting the changes, the short history and variability of the historical data, and the problem of clearly distinguishing between cyclical effects (climate variability) and long-run climate change from which there would be no escape. Given these uncertainties, the “no-regrets” measures adopted by the government of Vanuatu make sound economic and financial sense.

Vanuatu, like many rural Pacific Islanders combine selling products or labor for cash, and gardening, fishing and sometimes hunting, to meet their food needs. Such diversity of livelihood assures a degree of food security, as it means one or two of these activities can still meet basic food needs even if one activity ceases to do so. This is why severe disasters do not result in mass mortality, even in the poorest communities of the Pacific, as is often the case in other less developed regions of the world. But climate change may cause chronic and or sporadic contractions in the food people are able to access through agriculture, fisheries and in the market place. Thus, through impacts on food production, the ability of the country to import food, and its effect on human health, climate change puts at risk the very basic and universal need of the Vanuatu people to have access to sufficient, safe and nutritious food at all times.

TABLE 6: **VULNERABILITY ASSESSMENT OF SOME SMALL ISLANDS OF VANUATU TO CLIMATE CHANGE AND CLIMATE VARIABILITY**⁶- 6 a: **HIU ISLAND (TORRES GROUP)**

Vulnerability assessment to climate change and climate variability

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Agriculture	Increased temperatures will induce heat stress, wilting and crop failure. Wild yam used to grow wild and abundant but is no longer widespread. Wild yam is resilient to drought. Yams planted in normal planting season (Nov to March) no longer do well due to shifts in weather patterns	Increases could also see increase in average rainfall, causing flooding and pollution of coastal waters	Increased rainfall would increase water availability for agriculture and other uses. Decline in rainfall will cause plant stress, reducing productivity and harvest and affect food security	Vulnerability is low as most cultivation is concentrated on raised plateau away from the coast	A major threat to agriculture. Increased rainfall associated with cyclone events can lead to flooding and loss of fertile top soil - an invaluable commodity on islands
Forestry	Warm temperatures may cause plant stress. Fall in agriculture production could see increase in deforestation as more people resort to logging as alternative revenue source	Increased precipitation is seen as largely beneficial for forest crops. Forest degradation is also contributing to the decline in coconut crab populations	Increased rainfall may induce plant growth but could also encourage invasion by less desirable species. Decline in rainfall will affect forest growth	Coastal forests have been severely affected, however inland forests are safe as they are concentrated on raised plateau	Cyclones and associated wave surges have contributed to the loss of coastal forests which in turn leave coastal communities and environments exposed to future events

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6 Table constructed with information extracted from Climate and Sea Level Change Vulnerability and Adaptation Assessment of the Torres, Shepherds and Tafea Groups by Brian Philips and the CBDAMPIC report by CIDA and SPREP.

[→] Table 6 a continued

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Fisheries	Warm temperatures could increase incidence of coral bleaching	Increased precipitation could lead to erosion of coastal areas	Increased rainfall could lead to increased sedimentation and pollution of coastal areas affecting subsistence fishing	Increased sea levels have resulted in inundation of coconut crab habitats on island causing numbers to drop. Coconut crabs are the major source of income for the community	Past cyclones have destroyed coral and reefs which are important fishing grounds for the community
Livestock	Warm temperatures may affect growth, production and reproductive efficiency of livestock animals by causing body temperature to rise above animal's zone of comfort	Increased precipitation could lead to availability of more water for livestock	Increased rainfall could lead to more water but may result in rapid growth of less nutritious pasture for livestock. Reduced rainfall could affect growth and production	Impact is minimal or nil due to high island elevation	Limited to damage of infrastructure and some pasture land
Water supply	Increased temperatures may lead to availability of more water but may cause flooding of rivers and streams	Increased precipitation, coupled with future La Niña conditions and increase in cyclone frequency may increase average rainfall	Increased rainfall may lead to flooding, soil erosion and pollution of groundwater supplies. Low rainfall will compound water shortage problem	Rises in sea level will cause inundation of coastal water springs which are an alternative source of water during low tide	Past cyclones have caused considerable damage to coastal areas including coastal springs that communities used to depend on

- 6 b: LOH (TORRES GROUP)

Vulnerability assessment to climate change and climate variability

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Agriculture	Increased temperature likely to increase rainfall causing additional areas of coconut patches to become inundated. Warmer temperatures could also cause plant stress, wilting and decrease production which in turn threatens food security	Likely to increase water-logging of productive land. Could cause erosion and create favorable conditions for pests and diseases	Flooding from heavy and prolonged rain is common occurrence in last 5-10 years. 4-5 ha of coconut patches permanently inundated as a result. Reduction in rainfall on the other hand would cause plant stress and low production	Part of island subsided as result of 1998 earthquake causing coconut patches on northern coast to submerge. Rise in sea level will add to the problem of soil and coastal erosion	Remain a major threat to agriculture crops and government facilities on island
Forestry	Increased temperatures could cause plant stress and reduced growth	Increase soil moisture needed for forest tree growth. May create conditions favorable for pests and diseases	Increased rainfall could cause inundation affecting coastal vegetation of mangroves, casuarinas and sea oaks. Drop in rainfall could affect forest growth	Part of vegetation on northern side already submerged and will be further affected by sea-level rise	Northern part of island where vegetation are dying particularly vulnerable to cyclones and sea-level rise
Fisheries	Commercial fishery unlikely to be affected. Coral bleaching may increase with warmer temperatures	Unknown but likely to be minimal	Apart from inundation of mangroves from flooding, impact of increased rain is considered minimal	Sedimentation causing muddy conditions perfect for Caledonian crabs and small fiddler crabs to flourish	Exposed areas on northern side of island are likely to be seriously affected by future cyclones

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[→] Table 6 b continued

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Livestock	Except for pigs and chickens, no livestock are raised on island. Dry conditions could affect pig fodder	Wet conditions may increase incidence of intestinal infection of free roaming pigs	May increase incidence of water borne diseases by free roaming pigs. Less rain however could affect pasture growth	Minimal due to high elevation of island	Minimal
Water supply	Likely to increase rainfall causing further flooding and pollution of ground water supplies	Likely to increase availability of water for local community	Increased and prolonged rainfall already causing flooding of coconut plantation. Could also cause pollution of ground water. Prolonged dry spells could affect ground water lens	Sea-level rise will exacerbate problems for northern part of island that is already submerged	Water supply for exposed northern part of island will be seriously affected by future cyclones

- 6 c: TONGARIKI ISLAND (SHEPHERD GROUP)

Vulnerability assessment to climate change and climate variability

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Agriculture	Suspect to cause die-back of island cabbage after one or two harvests. Usually species die after several harvests. Warm temperatures could cause stress and wilting of root crops and vegetables and thus threaten food security	Could lead to water-logging, erosion and loss of soil nutrient. Could create favorable conditions for pest and disease outbreaks	Impact is expected to be positive for plant growth but could also cause inundation of food crops and induce growth of pathogens. Dry spells will affect plant growth and food production	Impact is low to medium due to basalt bolder rocks which make up most of coastline. There is interest in mining the rocks which could leave island vulnerable to sea-level rise	Vulnerability of sector to cyclones is high
Forestry	Warmer temperatures could be favorable for growth and spread of invasive species <i>mikania spp</i> which could cause considerable damage to forest areas	Increased precipitation could lead to spread of pest and diseases affecting forest species	Increased rainfall could create conditions favoring spread of invasive species and low value species. Prolonged dry spells will affect forest growth	Minimal except for salt spray associated with strong winds and cyclones	Could cause forest damage and salt spray to coastal vegetation
Fisheries	Could cause coral bleaching and reduce productivity of reef systems	Could result in erosion and pollution of coastal areas	Induce flooding and pollution of coastal areas important for subsistence fishing	Could enhance coastal erosion although impact will be limited due to natural protection of basalt bolder rocks	Strong wave action associated with cyclones could cause recession of coastline and damage to fishing grounds

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[→] Table 6 c continued

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Livestock	Goats are the main livestock on island although there are also a small number of singly-raised cattle. Warmer temperatures could affect growth and reproductive efficiency especially of cattle	Increased precipitation could create conditions suitable for grazing livestock	Increased rainfall could enhance pasture growth but could also cause water-logging of graze land. Low rainfall will affect animal growth and productivity	Impact is limited to salt spray affecting coastal vegetation that serves as shade for free roaming goats	Cyclones pose a threat to animals raised under coconut trees
Water supply	Increased temperatures will add to current problem of water shortage	Increased precipitation might improve water supply situation	Increased rainfall will be beneficial to island if catchment and storage facilities are improved. Low rainfall will add to water shortage problem	Salt spray may affect water storage on island	Cyclones could cause damage to storage facilities

- 6 d: **BUNINGA ISLAND (TORRES GROUP)**

Vulnerability assessment to climate change and climate variability

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Agriculture	No surface water so increased temperature will compound problem. Manioc the only root crop that grows abundantly on island but monoculture practice may heighten vulnerability to pests and diseases. Island soil can only support specific crops	Increased precipitation likely to be beneficial to water-starved island	Increased rainfall will alleviate water shortage for agriculture and may increase food production and security. Projected drop in rainfall will have serious implications for agriculture on island	Relatively safe from sea-level rise due to solid bolder coast	TC a major threat and may cause short term food shortages resulting in short term dependence on imported food from other islands
Forestry	Increased temperature may cause heat stress and heighten vulnerability to forest pests and diseases	Increased precipitation is likely to have a positive effect on forested areas	Increased rainfall will help forest growth especially after periods of severe water shortage. Reduced rainfall will have reverse effect	Impact will be minimal to nil as island is well protected by bolder coast	TC can still cause severe damage to secondary forests on island
Fisheries	Increased temperature could cause coral bleaching and fish poisoning in some areas	Not known but any impact is expected to be minimal	Increased rainfall could cause water run-off affecting coastal fisheries	Could cause coral and reef damage thus affecting coastal fisheries. Coastal erosion will be minimal due to solid bolder coast	TC will remain a threat to coastal areas and hence fishery

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[→] Table 6 d continued

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Livestock	Due to small size and topography of island, no livestock animals are reared on island	n.a	n.a	n.a	n.a
Water supply	There is no surface water on island so increased temperatures will only add to water problem. Rainwater is the sole source water as ground water sources are not safe for use	Positive impact expected as this will help alleviate water shortage	Heavy and persistent rain could cause water run-off affecting fisheries. Dry spells will have serious impact on water supply	Could increase salinity of existing ground water but island is generally safe from sea-level rise due to solid bolder coastline	Heavy rain associated with cyclones could cause water run-off affecting coastal fishery

- 6 e: **MAKIRA ISLAND (SHEPHERD GROUP)**
Vulnerability assessment to climate change and climate variability

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Agriculture	Periods of prolonged drought has resulted in poor growth and harvest of root crops and fruit trees. Agriculture sector highly vulnerable to increased temperatures and El Niño episode. Slash and burn has been abandoned while legumes have are being integrated with root crops	Sector could benefit from increased precipitation as this will increase soil moisture necessary for plant growth	Village has moved twice in last 80 years due to inundation during cyclone events in 1940 and 1972. Increased rainfall will cause further inundation, but declines in rainfall repeat problems encountered during drought	Loss of coastal vegetation has given way to salt spray and coastal erosion. Impact on agriculture will be low as gardens are situated on high grounds	Cyclones remain a major threat to agriculture. Several invasive species are well established following previous cyclone events
Forestry	Increased temperatures could affect forest growth and production	Impact is likely to be positive given experience with droughts in the past	Increased rainfall will be beneficial for forest growth although heavy rainfall associated with cyclone events could have adverse effects	Except for coastal vegetation, most forests are on high grounds safe from sea-level rise	Past cyclones have had devastating effects on coastal vegetation. Invasion of open forests by less desirable species is evident after cyclones
Fisheries	Increased temperatures could result in coral bleaching which in turn could affect fisheries	Impact if any is likely to be minimal	Increased rainfall could cause further coastal erosion	Coastal erosion resulting from sea-level rise could cause pollution of coastal areas affecting fisheries	Cyclone damage to coastal vegetation could result in coastal recession and pollution affecting fishing grounds around the island

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[→] Table 6 e continued

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Livestock	Livestock is limited to pigs, goats and chicken. Pigs and goats are reared while chickens are free roaming. Increased temperatures will affect growth and reproduction efficiency and hence food security	Increased precipitation is likely to benefit livestock but may create conditions favorable for spread of diseases by free roaming animals	Increased rainfall would improve water availability for animals. Dr conditions on the other hand could affect animal growth and availability of local feed	Sea-level rise is likely to impact on water supply for people and their livestock	Salt spray associated with wave action during cyclone event could affect fodder for animals on island
Water supply	Increased temperature could lead to dry conditions affecting water supply for the island	Expected increase in precipitation could result in more rain alleviating water problems	Increased rainfall caused landslides that partly buried underground springs the community depended on. Reduce rainfall will affect rain water supply	Sea-level rise could cause further inundation of ground water and coastal springs	Heavy rainfall associated with cyclone events could cause pollution of water source

- 6 f: **EMAE ISLAND (SHEPHERD GROUP)**

Vulnerability assessment to climate change and climate variability

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Agriculture	Increased temperature believed to be responsible for decreased crop production. Wild yam is not doing well under current conditions and grows to only about 1 meter nowadays. Warmer temperatures will affect plant growth, cause heat stress and reduce production	Increased precipitation could result in greater availability of water for the sector. This could help boost crop production	Mavae and another village have moved from original sites due to inundation resulting from heavy rain associated with cyclone event in 1944. Old village sites are permanently under water. Drop in rainfall could affect plant growth and production	SRL could threaten coastal settlements and their crops. Could also cause soil erosion thus affecting agriculture crops	Believed to contribute to introduction of invasive species harmful to agriculture such as African snail and "mile a minute" vine. A. snail first appeared after 1919 tidal wave but widespread invasion was seen after recent cyclone when food was sent from other islands
Forestry	Increased temperatures could affect forest growth and production	Given the paucity of water supply on island, increased precipitation will be of benefit	Increased rainfall will be beneficial given dry conditions on island. Prolonged dry conditions will have serious impact of forest and vegetation	Sea-level rise could cause damage to coastal forests. Tree planting are undertaken to curb coastal recession	TC is a major threat to forestry. Cyclone-damaged forests are vulnerable to invasion by creepers and less desirable species
Fisheries	Increased temperatures could cause coral bleaching reducing productivity of corals and reefs	Increased precipitation could add to coastal erosion during wet season	Increased rainfall could result in pollution of coastal fisheries areas	Sea-level rise may affect coastal fisheries as result of damage to fringing reefs	Wave action associated with cyclones could cause damage to coral reefs and coastal fisheries

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[→] Table 6 f continued

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Livestock	Cattle (raised singly) and pigs are the main livestock on island. Warmer temperatures will affect growth and reproductive efficiency and will in turn affect food security	Increase precipitation is likely to be beneficial to animals which are raised under coconut plantations	Increased and prolonged periods of rain could cause inundation of more land available for agriculture and animal grazing	Animals are raised on high grounds and should be safe from impact of sea-level rise	Like in the past, the aftermath of future cyclones could see the introduction of more invasive species to the island
Water Supply	Increased temperatures could result in serious water shortage on island	Could help alleviate water shortage	Rainfall will certainly alleviate water shortage on island	Sea-level rise may increase salinity of ground water and destroy coastal springs	Wave action associated with cyclones could result in salt water intrusion into ground water sources

- 6 g: **ANIWA ISLAND (TAFEA GROUP)**
Vulnerability assessment to climate change and climate variability

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Agriculture	Cultivation of sweet orange is vital to island economy but drop in production has led to extensive clearing of land resulting in introduction of leucaena and other invasive spp. Increased temperature blamed for low production of oranges	Increased precipitation may help alleviate water shortage problems although prolonged wet conditions will affect rock salt production	Increased rainfall will help improve water situation on island and increase availability of water for agriculture purposes. It could also create conditions favorable for the growth and spread of pests and diseases	Sea-level rise will enhance soil erosion especially of low-lying areas suitable for village gardens	Wave action associated with cyclone events could result in inundation of village gardens, increase soil salinity and cause erosion of valuable top soil
Forestry	Cleared forest areas are invaded by leucaena. Increased temperatures will enhance growth of such species and may lead to smothering of valuable forest species	Increased precipitation and rainfall will enhance growth of forest species along with less desirable invasive species	Increased rainfall may help forest growth. However, decreased rainfall could affect forest growth and production	Likely to affect coastal forests	A major threat to forestry causing damage and defoliation making trees vulnerable to pests and diseases
Fisheries	Introduction of conical mangrove shellfish led to displacement of <i>Cardisoma carnifax</i> . Drop in numbers may also be caused by increased temperatures. Decline in reef fisheries mainly due to poor management and contemporary techniques	Increased precipitation may contribute to coastal erosion during periods of heavy rain	Prolonged wet conditions could result in erosion of coast causing pollution of productive fishing grounds	Could enhance coastal erosion affecting corals and reef systems	Heavy rainfall associated with cyclone events could result in coastal erosion. Wave action could cause coastal recession and damage to mangroves

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[→] Table 6 g continued

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Livestock	Cattle and pigs are the main livestock. Cattle farming integrated with coconut plantations which could provide shade during hot and dry spells	Increased precipitation could help alleviate water supply problem	Increased rainfall could enhance growth of less desirable pasture feed while decreased rainfall could affect animal growth and production	Sea-level rise will add to water supply problem on island which is affecting livestock production	Salt spray associated with wind and wave action during cyclones could affect grazing land for livestock
Water supply	Increased temperatures add to water supply problem on island. Dry spells in 1992/93 saw shipment of water from Tanna and Port Vila. All groundwater sources are brackish and unsafe for use	Increased precipitation will be beneficial given water shortage on island	Could alleviate water shortage frequently experienced on island. Reduced rainfall will compound water problem on island	Sea-level rise will likely increase salinity of groundwater sources and inundation of coastal springs	Wave surge associated with cyclones may result in inundation of groundwater sources

- 6 h: ANEITYUM ISLAND (TAFEA GROUP)

Vulnerability assessment to climate change and climate variability

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Agriculture	Shifts or changes to climate conditions causing delays in planting seasons resulting in low production. Increased temperatures could result in more rain causing erosion and leaching of soil nutrients	Increased precipitation could increase erosion which ultimately affects crop production	Extensive rain could cause flooding and erosion which is a major problem for agriculture on the island. Locals noted increase in flooding during last 10 years	Sea-level rise could enhance soil erosion and threaten coastal infrastructure	Cyclones are a big threat to agriculture on island
Forestry	Logging in the 50s and 60s left most of island bare of natural vegetation. Increased temperatures could lead to hot conditions affecting growth of plantation forests that were planted to curb soil erosion problem	Increased precipitation could cause erosion of barren soils left after logging	Heavy rainfall will accelerate soil erosion which is still a major problem for the island despite considerable efforts to re-vegetate logged areas. Reduction in rainfall will affect plantation growth	Sea-level rise could enhance damage to coastal forests as a result of increased water salinity and inundation	Cyclones are a threat to pine plantations established after logging in the 1950s and 1960s
Fisheries	Increased temperatures could cause coral bleaching which could in turn affect coastal fisheries. Seaweed cultivation has been introduced as an alternative food source but may be affected by increased warm temperatures	Increased precipitation may enhance soil erosion and pollution of productive fishing grounds	Heavy and prolonged rainfall could cause erosion affecting productivity of reef systems. Mass death of corals due to soil erosion has been reported	Sea-level rise could enhance coastal erosion affecting productivity of reef systems	Cyclones and associated wave action could cause damage to reefs and coastal fishery

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[→] Table 6 h continued

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Livestock	Increased temperature may affect growth, production and reproductive efficiency of livestock. May also create conditions favorable for spread of diseases	Increased precipitation is likely to have positive impact on livestock and pasture	Increased rainfall may lead to increased growth of less low valued pasture. May also create conditions favorable for spread of animal diseases	Limited impact on livestock but may affect pasture land close to coast	Limited impact on livestock but may cause damage to pasture land
Water supply	Increased temperatures expected to have minimal impact on water supply which is plentiful on the island	May add to soil erosion, a major problem for the island	Water is abundant on island so increased rainfall could lead to contamination of water sources	Sea-level rise could cause salt water intrusion of ground water sources	Heavy rainfall associated with cyclones will cause flooding and pollution of ground water sources

- 6 i: LATEU, LULI AND PANITA ISLANDS

Vulnerability assessment to climate change and climate variability

SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Agriculture	Crop production has decreased as result of increased temperatures. More frequent and prolonged dry conditions have affected yields of staple food crops such as yam and manioc in past 5-10 years	Increased precipitation will be beneficial to agriculture especially during dry season. However this might create favorable conditions for the tuber-eating beetle that induces rot in yams and other root crops	Increased variability of rainfall observed. Prolonged rain resulted in falls in yield of fruit trees. Landslide a major threat during heavy rainfall. Volcanic induced acid rain has been destructive to vegetable gardens	Salt spray is a major concern especially during cyclones. Salt spray render iron roofing impractical for rainwater catchment and this reduces water availability for agricultural purposes	Cyclones and strong winds affect agriculture crops. Heavy rains and salt spray associated with cyclones are particularly harmful to agricultural crops
Forestry	Warm temperatures may cause plant stress thereby affecting forest yield	Projected increase in humidity and wet conditions may create favorable conditions for weed growth, invasive species and pests	Increased rainfall will help forest growth including those of invasive species. Forest pests and diseases may also flourish in wet conditions	Coastal forests are affected by salt spray and sea-level rise	Coastal erosion will be heightened during cyclones and storm surges affecting coastal forests
Fisheries	Increased temperatures are likely to induce coral bleaching of reef systems that may trigger a decline in productivity levels and affect the physical functions of the systems	Increased precipitation could lead to erosion of the coastal areas important for fishing in the islands	Severe and rapid erosion of the coastal areas is a major problem for the islands and this will worsen with increased and prolonged rainfall	Increased sea levels will affect coral growth and this will impact on fisheries. Coastal erosion may increase as a result of rising sea levels	Coastal erosion will be heightened in the event of storm surges associated with cyclones. Anecdotal data suggest loss of coastal land as high as 100 meters in some areas during past 50 years

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SECTOR	LIKELY IMPACT				
	Temperature	Precipitation	Rainfall	Sea-level rise	Cyclones
Livestock	Increased temperatures may affect growth, production and reproductive efficiency of livestock animals on the islands	Projected increase in humidity and wet conditions may create favorable conditions for animal pests and diseases and induce growth of less nutritive pasture species	Increased rainfall could cause soil erosion and leaching valuable soil nutrients important for pasture growth	Sea-level rise could affect pasture growth. Salt spray may affect pasture land and water supply for livestock	Cyclone induced storm surges and flooding could result in inundation of farm lands while cyclones can cause destruction to infrastructure and equipment
Water supply	Increased temperatures coupled with incidences of El Niño episode may result in possible water shortages given the high dependence of island communities on rainwater. Prolonged drought in the past had resulted in people traveling by canoe as far as Liro to fetch water	Increased precipitation could help water shortage often experienced on the islands especially dry season	Increases in rainfall will alleviate water shortage provided there is adequate capacity to capture and store water effectively. However increased rainfall could also cause pollution of underground wells and creeks that are important during dry season	Sea-level rise will cause salt water intrusion into underground wells and coastal springs	Salt spray associated with storm surges and cyclones have rendered iron roofing impractical for rainwater catchment and storage. Flooding associated with cyclones may result in the pollution of wells and other water sources on the islands

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