ST. LUCIA COUNTRY PAPER

ON

NATIONAL CLIMATE CHANGE ISSUES

Towards the Implementation of CPACC Component 4: Formulation of a Policy Framework for Integrated (Adaptation) Planning and Management

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NATIONAL CLIMATE CHANGE ISSUES

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LIST OF TABLES AND ILLUSTRATIONS

LIST OF ABBREVIATIONS & ACRONYMS

CPACC	-	Caribbean Planning for Adaptation to Climate Change
GCMs	-	General Circulation Models
GHG	-	Greenhouse Gas
IPCC	-	Inter-governmental Panel on Climate Change
LBSMP	-	Land-Based Sources of Marine Pollution
MAFF	-	Ministry of Agriculture, Forestry and Fisheries
MARPOL	-	Marine Pollution (Convention)
MOH	-	Ministry of Health
MOL	-	Ministry of Labour
MOP	-	Ministry of Planning
MPDEH	-	Ministry of Planning, Development, Environment and Housing
NCA	-	National Conservation Authority
NDC	-	National Development Corporation
NISEE	-	National Information Service for Earthquake Engineering (University of California, Berkeley)
RBDC	-	Rodney Bay Development Company
RSLPF	-	Royal St. Lucia Police Force
SIDS	-	Small Island Developing State(s)
SLASPA	-	St. Lucia Air and Seaports Authority
SLNT	-	St. Lucia National Trust
UDC	-	Urban Development Corporation
UNFCCC	-	United Nations Framework Convention on Climate Change
WASCO	-	Water and Sewerage Company

Executive Summary

It is now generally accepted that anthropogenic Global Climate Change is a reality and not a hypothetical, abstract concept. There are signs worldwide that this phenomenon is already in motion. Researchers cite as examples, the higher average global temperatures recorded during the last part of the 20th Century and melting polar ice caps and glaciers. Recent research suggests that the 1990s was the warmest decade and 1998 the warmest year. In late 2000, the Inter-governmental Panel on Climate Change (IPCC) announced that estimates for the magnitude of global warming were being revised upwards (6-10 degrees on average over the next 100 years).

While research continues on the causes and extent of climate change, there is great concern about the ultimate impacts of this phenomenon on ecosystems, natural processes and human life. If, for example, climate change is expected to result in increased atmospheric temperature and sea level rise, what effect will these have on natural and human systems?

Research and analysis is attempting to provide answers to the foregoing, and other, questions. For example, it is anticipated that increased temperatures will result in the bleaching of corals with dire consequences for coral ecosystems. It is also expected to contribute to increased frequency and intensity of cyclones and droughts. Sea level rise, in turn, is expected to result in the "drowning" of corals and inundation of coastal lands. These in turn are expected to impact on human settlements, fisheries and tourism, to name a few.

The impacts of climate change can be difficult to predict on a regional or local level for the Caribbean for a number of reasons. These include:

- The low resolution of most climate change computer models currently in use. The General Circulation Models (GCMs) are limited to the extent that they can recognize only fairly large spatial areas;

- Inherent problems in trying to "map" all the micro-climatic peculiarities of a particular area;

- The fact that climate change research, as a science, is still evolving and there are still many uncertainties.

As a Small Island Developing State (SIDS) St. Lucia needs to be especially concerned about climate change and its impacts. As a nation, it contributes only a miniscule amount of greenhouse emissions, on a global scale. However, because of various factors, including its small size, a high concentration of infrastructure and other resources in coastal areas and an open, fragile economy, it is at great risk from the effects of climate change. This is compounded by the financial and human resource constraints that impinge on St. Lucia's capacity to respond adequately to the climate change phenomenon.

At present, global negotiations on concrete steps to address climate change offer little encouragement, given slow progress on the Kyoto Protocol and other issues. In addition, and perhaps more critically, it is generally accepted in scientific circles, that even if all human emissions of green house gases (GHGs) were to cease with immediate effect, the trend of climate change would continue well into the 21st Century.

As Party to the United Nations Framework Convention on Climate Change (UNFCCC), St. Lucia is committed to the reduction of global GHG emissions. However, given the seeming inevitability of climate change and its consequent impacts, St. Lucia and countries in similar circumstances, would clearly be well advised to focus as much, or more, on adapting to the effects of this phenomenon.

Adaptation should not be seen as a piecemeal, incremental and reactive exercise. It should, instead, be based on a holistic plan which incorporates the needs, and input, of all sectors and stakeholders. To the greatest extent possible, it should be predicated upon a well-defined policy and be integrated into the overall national (sustainable) development process.

This document attempts to identify some of the key climate change issues of concern to St. Lucia. It lays no claim to being a comprehensive Vulnerability and Adaptation (V&A) study as more detailed work has been undertaken through other initiatives. It does endeavour, however to provide the broader context with respect to climate change and to point the way forward with respect to the formulation of a National Climate Change Policy for St. Lucia.

1.0 INTRODUCTION

St. Lucia is a small-island developing state (SIDS) located in the Eastern Caribbean. Its existence and development as a nation is constrained by such factors as limited land space, an open fragile economy and limited human resources.

1.1 Physical Characteristics

St. Lucia is the second largest of the Windward Islands. It lies between 13^{o}43' and 14° 07' North and 60^{o} 05' West. It is situated 24 miles south of Martinique and 21 miles north of St. Vincent.

St. Lucia is located on a submerged volcanic ridge connecting Martinique to the north with St. Vincent to the south. This is known as the St. Lucian Sill.

St. Lucia is 27 miles (42 km) long at its longest point and 14 miles (22 km) at its widest point, and has a total area of 238 sq miles (616 sq. km). The highest peak is Mount Gimie (3,145 feet). The Barre de L'Isle Ridge rises from the southern center of the island extending to the northeast and southwest and is 24 km (15 miles) long and 850 feet above sea level.

Numerous Valleys exist. The Roseau Valley has the largest watershed, 49 sq km and the longest river, 19 km.

The Soufriere area on the west coast of the island is a collapsed caldera with domes and solfataric activity. Its' most recent eruption occurred some 50,000 years ago. However St. Lucia lies on the Antillean Arc of Islands and is therefore subject to effects of the eruption of other active volcanic islands. These effects include earthquakes.

1.2 Climate

St. Lucia is located within the Trade Wind belt. These winds approach from directions between the east-north-east to east-south-east. Stronger, more northerly winds are common from December to May. Average temperature is about 78 ^{o} F (27 degrees C). Relative humidity is 75%, with little variation.

The island's climate is characterised by a dry season which runs from January to May, and a wet season from June to December. The hurricane season extends from late June to the end of November. The island has been hit by a number of storms and hurricanes during the last several decades. During heavy rains, flooding often occurs in low-lying areas.

1.3 Ecosystems, Flora & Fauna

Despite its small size, St. Lucia possesses a high degree of ecosystem diversity and is home to a wide range of flora and fauna. The most endangered terrestrial species of St. Lucia occupy the coastal and inland habitats. Examples of these include the white breasted thrasher (*Ramphocinclus brachyrus*), a bird species found on the East Coast of St. Lucia and endemic only to St. Lucia and Martinique; the St. Lucia racer (*Liophis ornatus*), a snake restricted to Maria Island, its last refuge in the entire world; the *Acalypha elizabethae*, a rare

endemic plant species found on Petit Piton; and *Beilschmieda pendula*, of which a single specimen found in the rainforest at Des Cartiers is being monitored for fruit production.

1.3.1 Forests & Wildlife

The rainforest is home to a wide variety of flora and fauna. There are five (5) endemic wildlife species confined to St. Lucia's forests. These include one of the rarest birds in the world, the St. Lucia Parrot (*Amazona versicolor).*

Table 1: Watershed Land Use by Category

Land Use Type	**Category**	**Area (Ha)**	**Percentage**
Natural	Forest (tropical moist plantation)	12572	20.4
	Scrub	7515	12.2
	Mangrove	352	0.6
	Open Woodlands	1302	2.1
	Sub-total	21741	35.3
Farming	Intensive	17576	28.5
	Mixed	16205	26.3
	Eroded Land	234	0.4
	Sub-total	34015	55.2
	Settlements	5384	8.7
	Rock & Exposed Soils	426	0.7
	Water (Marina & Compton Dam)	95	0.1
	Sub-total	5905	9.5
	TOTAL	61661	100.00

Table 2: Forest Area by Category

Category	Total (hectares)	Percentage
Natural Forest	12,088	55
Mangrove	355	2
Scrub Forest	7514	35
Grass & Open Woodlands	1302	6
Plantation	505	2
Total	21,764	100

About fifty-six percent (56%) of natural forest is found in the forest reserves and forty-three percent (43%) on private lands. Scrub forests and mangroves are mainly found on private lands. There is a total of 256 hectares of plantation forest existing within the forest reserves consisting of three main timber tree species, namely: Blue mahoe (*Hibiscus elatus*);

Honduras mahogany (*Swietenia macrophylla*) and Caribbean pine (*Pinus caribbaea*). There are also two species of Christmas trees in the reserve: the cypress (*Cupressus lusitanica*) and the araucaria (*Araucaria excelsa*).

The wetlands of St. Lucia are relatively small but they are representative of most wetland ecosystems. The total area of St. Lucia's wetlands has been reduced from 320 hectares to 193 hectares, with some areas currently under considerable stress. (Devaux, 1988). The wetlands in St. Lucia are made up of four types of systems: estuarine, riverine, palustrine and lacustrine. (Portecop and Benito-Espinal 1985). The estuarine system is referred to as a fringing mangrove swamp and is considered to be the most productive wetland, while the riverine mangrove swamp is the most common wetland in St. Lucia. The palustrine and lacustrine systems are important habitats for water birds.

The biological diversity of the island of St. Lucia possesses at least 1,310 known species of flowering plants, cycads and gymnosperms belonging to 143 families. This includes 105 plants of known medicinal value and 241 recorded forest tree species. There are 118 fern species with the majority being found within the forest ecosystem. Seven fern plant species are considered endemic to St. Lucia.

There are twenty-seven endangered plants recorded in St. Lucia, most of which are found in the coastal and lowland habitats. Of the twenty-seven plants, two species (*Tetrazygia angustifolia* and *Myrcia leptocelda*) are at immediate risk of extinction because their limited habitat is threatened by urban development. Three species associated with freshwater swamps are also at risk due to the disappearance of their habitat. They include: *Pavonia paludicola*, *Machaerium lunatum* and *Montrichandia arborecens* (Graveson, 1998).

There are nine (9) endemic plants in St. Lucia. One of these, palitivye wouj (*Chrysochlamys caribaea*), a small stilt-rooted tree, grows along riverbanks in sheltered valleys where natural forest still occurs, such as along the Roseau River, above the John Compton Dam site and in the rainforest. Another endemic plant, *Acalypha elizabethae*, is a small shrub found on the Pitons and in a river valley close to Anse-la-Liberte. Because of its Caribbean coastal habitat, it is threatened by land clearing for development. Lowye Canelle (*C. elongatum*), balata (*M. bidentata*) and latanye (*Coccothrinax barbadensis*), are other endemic plants which are threatened as a result of over-exploitation and extensive destruction of habitat.

There are over one hundred and fifty (150) bird species, seventeen (17) reptiles, nine (9) mammals and four (4) amphibians found in the forests and terrestrial environment of St. Lucia. The island is home to five endemic species of birds: the St. Lucia Parrot or *Jacquot* (*Amazona versicolor*); the St. Lucia blackfinch or moisson pied–blanc (*Melanospiza richardsoni*); Semper's Warbler or pied blanc *(Leucopeza semperi*); the St. Lucia Oriole or carouge (*Icterus laudabilis*); (St. Lucia Pewee or gobe-mouche (*Contopus oberi*).

The St. Lucia Blackfinch is widely distributed in all habitats but uncommon everywhere and regarded as threatened (Collar and Andrew, 1988).

St. Lucia is home to two endemic sub-species which are also endangered: the St. Lucia White Breasted Thrasher (*Ramphocynclus brachyrus*) and St. Lucia Rufous Nightjar (*Caprimulgus rufus*), while another sub-species, the house wren (*Troglodytes aedon mesoleucus*) is rare and endangered. The St. Lucia Rufous Nightjar, a sub-species of the South American species, is found only in St. Lucia, in the Caribbean. The species is nocturnal and occurs in the dry scrub forest or woodlands at Grande Anse, Caille Des,

Louvet and near Petite Anse River. Internationally the white breasted thrasher is considered to be under greater threat than the St. Lucia Parrot.

Another bird species, the St. Lucia Forest Thrush (*Cichlerminia lherminieri sanctae-luciae*) is also rare and on the decline, possibly due to hunting pressures. It is said to be shy and secretive.

The three bird sub-species all occupy the dry scrub woodland habitat in the coastal areas and in some cases, along dry river valleys. Over ninety percent (90%) of their habitat is found on private lands.

Many sea-birds, ground-nesting birds and other avian species breed on the offshore islands and caves where they are not disturbed and their nests remain safe.

The island possesses five endemic reptiles, one endemic sub-species, (the St. Lucia Boa Constrictor) and six regionally endemic reptiles.

There is one known threatened invertebrate sub-species of the hercules beetle (*Cymnastes hercules reidi*) which is confined to the montane areas.

Another well-known invertebrate associated with the forest environment and in particular, the river ecosystem, is the freshwater shrimp, commonly known as 'crayfish'. It lives in streams and ponds, hiding under stones during the day and coming out to feed at night.

1.3.2 Coastline

St. Lucia possesses a coastline of astounding beauty and natural wealth. It comprises sandy beaches and rocky shores, mangals and cliff areas. Nearshore reefs, though limited in size are quite diverse. Being a small island, St. Lucia depends heavily on these coastal resources for tourism and fisheries. According to Mitchell and Gold (1982), over thirty percent (30%) of the island's revenue is generated from the marine sector including sand mining, fishing, transport and tourism.

Photo 1: Fish Landing Site

Beaches along the west coast of St. Lucia are washed by the relatively calm waters of the Caribbean Sea, while those of the east coast are washed by the much rougher waters of the Atlantic Ocean. In an inventory conducted in 1996/1997 sixty (60) beaches were recorded along the west coast and forty-two (42) beaches along the east coast. Beach length accounted for about 16.78% of the shoreline of St. Lucia. An inventory of beaches in 1996/1997 showed total beach length in St. Lucia to be about 34.88km with 12.5% being mined for sand. The east coast beaches account for 72.8% of that figure.

The rough waters of the Atlantic Ocean constantly wash driftwood, seaweed, seagrass, boat and land-generated waste onto the east coast beaches. In contrast, litter on west coast beaches is mainly land generated. The calmer waters of the Caribbean Sea make west coast beaches ideal for recreational activities and thus approximately 26% of these beaches have hotel and/or restaurant facilities as opposed to only seven percent of east coast beaches. Worthy of note is the fact that 90% of these facilities are located on the northwest coast.

Beaches along the west coast are more readily accessible by land and sea. They thus play a vital role in St. Lucia's economy. Beaches are one of the island's main tourist attractions. They are extremely important to coastal stability. Further they serve as a habitat for a number of invertebrates such as crabs and bivalves and provide a nesting area for green, hawksbill and leatherback turtles.

Beaches have suffered sand loss from natural disasters over the years. Beach monitoring has shown that beaches are not recovering fully from natural disasters, probably due to anthropogenic activities. It is important to note that reef destruction and dredging alters the bathymetry of the nearshore (bay), thus changing wave action.

1.3.3 Mangals

Mangroves represent about 0.29% of the island's landmass. Mangal systems of St. Lucia range from a few scattered scrub patches to the more diverse riverine and/or fringing mangal systems. There are five species of mangrove found in the island namely: red mangrove (*Rhizophora mangle*), white mangrove (*Laguncularia racemosa*), two species of black mangrove (*Avicennia germinans* and *A. schaurenia*) and buttonwood or paltivye (*Conocarpus erecta*).

Very few mangroves are currently found along the west coast due in large measure to touristic and other developments undertaken along the coastline. In 1986, a number of mangroves on the island were declared marine reserves. However, most mangroves in St. Lucia have never been legally delineated.

1.3.4 Coral Reefs

Reef systems along the west coast are more diverse than those of the east coast. In general, fringing reefs are located mainly along the southeast (Anse des Sables), central west (off the districts of Anse-la-Raye, Soufriere and Laborie), and northwest coasts (Choc Bay). The healthiest and most diverse reefs are found along the Central west coast off Soufriere. Reefs of St. Lucia are under threat from high levels of sedimentation and other land-based pollutants and, therefore, nearshore fisheries are also threatened. Natural disasters such as hurricanes and storms have also taken a toll on St. Lucia's reefs.

Fishing banks in the north and south of the island are exploited for snapper, grouper and other bank species.

1.3.5 Seagrass Beds

Seagrass beds are common along St. Lucia's coast and are composed mainly of turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*) and to a lesser extent, shoal grass (*Halodule wrightii*) species. In general, larger and denser seagrass beds are found off the east coast, compared to the infrequent and sparsely covered seagrass patches along the west coast.

1.3.6 Turtles

Three species of sea turtle are known to nest in St. Lucia: the hawksbill (*Eretmochelys imbricata*), the green turtle (*Chelonia mydas mydas*) and the leatherback (*Dermochelys coriacea*). The Grande Anse beach is the largest nesting site on the island for leatherback turtles.

1.4 Socio-Economic Circumstances

Saint Lucia's population was estimated at 153,819 in 1999. The population growth rate declined from 1.6 percent in 1998 to approximately 1.2 percent in 1999. Crude birth and death rates stood at 22.2 and 6.2 respectively in 1999. Economically active adults represented 60.8 percent of the population.

St. Lucia is classified as a lower-middle income country, with a *per capita* GDP of EC $11,830 (US$4,354). Source: World Bank Classification.

St. Lucia has an open economy, with the value of trade (the sum of imports and exports) as a percentage of GDP recorded at 113.3 percent in 1999. As a percentage of GDP, imports of Goods and Non-Factor Services were recorded at 57.9 percent, while Exports of Goods and Non-Factor Services were 55.4 percent.

St. Lucia's major employer is agriculture and bananas constitute the islands major export. However, banana production has declined in recent years and tourism is now the largest earner of foreign exchange. There is also an important manufacturing sector and international financial services is seen as a potential growth area.

Table 3 : Banana Exports 1994-99

EXPORTS						
	1994	**1995**	**1996**	**1997**	**1998**	**1999**
BANANAS						
Qty (000 kg)-	**91,960**	**112,834**	**102,167**	**73,451**	**87,459**	**65,840**
Value -	**126,409**	**151,178**	**142,359**	**93,211**	**53,538**	**87,725**

(Values in 000's EC$)

1.5 Other Factors

St. Lucia is considered to be potentially at risk from *tsunamis* which might occur, due for example, to the activity of "Kick 'em Jenny", the submarine volcano located south of St. Vincent. There is also the possibility of *tsunamis* resulting from earthquakes originating from within or outside of the Caribbean. For example, waves generated as a result of the Lisbon Earthquake of 1755 were felt in Antigua, Barbados and Martinique. (NISEE).

Given its location in the Antillean Archipelago, St. Lucia could be affected by volcanic activity occurring in other Caribbean islands. Volcanoes occur on several islands including Martinique, Dominica, St. Vincent and Montserrat and many have shown signs of activity during the last hundred years. It is also conceivable that the Soufriere volcano in St. Lucia could once more become active in the future.

St. Lucia is located within a tectonically active area. Therefore, the possibility of significant earthquakes is a real one. In recent years several small tremors have been recorded.

St. Lucia is vulnerable to tropical storms and hurricanes which occur in the Western Atlantic between the months of July and November each year. This vulnerability is increased by the high concentration of infrastructure (hotels, ports, roads, settlements) located along the coast, often in low-lying reclaimed areas.

2.0 KEY ISSUES WITH RESPECT TO CLIMATE CHANGE

While some skeptics question the occurrence of anthropogenic climate change, most experts now agree that there is a discernible pattern of change. Many are of the view that some of these effects are already manifesting themselves. They cite as evidence, the increased average global temperatures of the last years of the 20th Century; the melting of the Polar ice caps and the increased frequency and intensity of cyclonic events in the Caribbean.

A number of key effects have been ascribed to climate change. These include:

- Increased global temperatures;
- Sea level rise;
- More frequent and intense weather phenomena such as hurricanes and droughts;
- Changing rainfall patterns.

Implications for St. Lucia

If it can be accepted that Climate Change is indeed occurring, the question can be asked: What are the implications for St. Lucia? As a Small Island Developing State, St. Lucia is potentially at relatively greater risk in a general perspective, given, *inter alia*:

- Its limited land space;
- Its vulnerability to the effects of changes in marine conditions, due to its "wrap-around" coastline;
- Limited human and economic resources to address adverse impacts;
- The location of the population and the critical infrastructure on low lying reclaimed land;

- The cultural barriers to scientific literacy;
- St. Lucia's location within the hurricane belt.

The nature and scale of the effects of climate change are difficult to predict at the global, regional and local levels. Nevertheless, it is possible, and indeed necessary, to make certain predictions and assumptions. For the purposes of this paper, it is assumed that the following will occur:

- An increase in mean temperature;
- An increase in sea level;
- Changes in the frequency and intensity of extreme weather phenomena, particularly drought and hurricane;
- More severe storm surges;
- Changes in rainfall distribution (spatial and temporal), intensity and duration.

The foregoing changes are expected to affect St. Lucia's physical, economic and social landscape. Some of the possible impacts are discussed below. The impacts mentioned do not constitute an exhaustive list but serve to highlight major areas of concern as well as interactions between resources and sectors.

2.1 Potential Impact of Climate Change Parameters on Key Environmental Components and Economic Sectors

i. Beach and Shoreline Stability:

There are several sandy beaches along St. Lucia's east and west coasts. Many of these are of great socio-economic importance as they serve as recreation areas for nationals and are seen as a key ingredient in the tourism product. Historically they have also served as landing sites for fishing boats and have been the source of construction aggregate. Unfortunately, this latter function has resulted in the undermining or disappearance of many beaches around the island.

Given their highly dynamic and unconsolidated nature, beaches are the sections along the coastline likely to indicate changes in coastal processes as a result of climate change.

The key factors which will impact on the coastal stability are sea level rise, storm surges and changes in hurricane patterns. The storm surges from Hurricane Lennie washed huge amounts of sand onto the streets of Soufriere. On the other hand, beaches at Rodney Bay were seriously eroded resulting in the undermining of some tourism infrastructure. Much of the sand on the affected beaches has since returned. However, the exact impact of a particular event will depend on a number of factors including wind speed and direction.

Photo 2: Beachfront Construction

It cannot be predicted exactly what impact sea level rise will have on coastal stability but it is not unlikely that it will result in accelerated erosion in some areas.

ii. Marine and Coastal Ecosystems

A number of ecosystems occur in St. Lucia's coastal and marine space. These include coral reefs and seagrass beds. Beaches can also be considered as ecosystems given the biological interactions which occur. Given their location, these ecosystems are likely to be directly affected by sea- level rise. However, some are also likely to be affected by temperature, rainfall, hurricanes and storm surges.

Table 4:

CHANGE FACTOR	ECOSYSTEM			
	Coral Reefs	**Seagrass Beds**	**Mangrove**	**Beaches**
Sea-Level rise	Submergence of light-sensitive coral reefs.	Submergence and loss of seagrass beds.	Inundation of mangals resulting in reduced acreage. However, could make areas once too high, suitable for development of mangals.	Erosion and reduction in extent of beaches. Nesting/feeding of turtles and other species may be affected.
Hurricane	Increased mechanical destruction of reefs	Mechanical damage to seagrass beds	Increased mechanical stress on and short-term dying off of mangals.	Temporary or permanent loss of beaches.
Storm Surge	Increased mechanical destruction of reefs	Mechanical damage to seagrass beds.	Increased mechanical stress on and short-term dying off of mangals.	Temporary or permanent removal of sand.
Rainfall Patterns	Changes in rainfall could affect salinity especially near river mouths due to altered water discharge. Reefs are sensitive to salinity. Increased river flow could increase sedimentation which could result in stressing or die-off of reefs	Reduced salinity due to increased river flow could stress beds in the case of increased rainfall. Increased sedimentation which	Changes in salinity could affect species interactions	Siltation plumes Increased in size and frequency in the case of increased rainfall in the near shore regions.
Temperature	Reefs are very sensitive to temperature. Increased temperatures could lead to bleaching and death of reefs.			Nesting of turtles may be affected, as male/female sex ratios are temperature dependent.

The impacts listed above are likely to be exacerbated by a number of historical and recent anthropogenic activities in the coastal zone which have undermined the stability and resilience of coastal ecosystems. These include, but are not limited to:

- Beach sand mining
- Dredging of near-shore areas
- Harvesting and clearing of mangroves
- Dynamiting and over-fishing of coral reefs
- Mechanical damage to reefs caused by diving and anchoring of yachts.

Corals in particular tend to grow extremely slowly and as such they may be unable to keep up with the rate of sea level rise.

iii. Hydrological Characteristics and Water Resources

St. Lucia is dependent upon surface water (mainly rivers) for its municipal and agricultural water supply. To date no detailed studies have been conducted on available ground water resources in St. Lucia. At this time little use is made of whatever ground water resources may exist. Over the years, the country has experienced reduced volume in many rivers due, in large measure, to the clearing of forest cover for agriculture, housing and other purposes. Already, given the growing demand for water for domestic, commercial, agricultural and touristic uses, significant investments, such as the Roseau Dam have had to be made to meet the present and projected needs.

Changes in rainfall patterns will cause concern from two standpoints, namely, total precipitation and temporal distribution. If precipitation patterns are affected as a result of climate change, it is possible that drought periods may become more frequent. This will have obvious impacts for a water supply regime which is already under stress. If there is increased rainfall, for example due to increased cyclonic activity, the following are likely to happen:

1. During rainy periods more water will be available. However, the problem of storage may arise if the existing reservoirs are unable to hold the surplus water for later use.

2. Dams and reservoirs may be negatively impacted by extreme rainfall events. They may become choked by siltation and vegetation or may even be destroyed, as was the case with Tropical Storm Debbie in 1994. There will therefore be an increased social and economic cost to ensure that these facilities are maintained.

3. If there is more intense rainfall at certain times of the year, then there will be more regular occurrences of flooding as rivers overflow their banks. There will also be a greater incidence of surface runoff and corresponding erosion as a result of the soil's inability to absorb rainfall at a sufficiently rapid rate.

4. While there is little use of sub-surface water at this time, some low-lying coastal areas may be affected by saline intrusion from the sea as a result of increased sea levels.

iv. Food and Nutrition: Agriculture and Fisheries:

iv.i Agriculture. Agriculture, as a major pillar of the economy and as the largest employer, is a sector which will be the subject of great concern in the context of the aforementioned conditions. This is because the various effects, singly or in combination could have significant impacts on crop production. The following table highlights some of the possible effects.

Table 5: Impacts of Climate Change on Crop Production

Change Factor	Impact	Implications
Sea-Level	Possible salinization of low-lying coastal lands. Increased threat of inundation.	Reduced agricultural yields and possible abandonment of lands. Economic cost of erecting coastal defenses to protect lands
Hurricane	Increased hurricane frequency and intensity will lead to more occurrences of intense rainfall which will in turn result in increased rain and wind damage to crops, flooding and soil erosion.	Reduced output, increased cost of production, sedimentation of reefs resulting in reduced fisheries yield and ecological functions.
Storm Surge	Limited risk of destroying crops in low-lying coastal areas.	Reduced production.
Rainfall Patterns	More intense showers could result in greater risk of flooding of fields, increased soil erosion, landslides, crop felling (e.g. bananas). More intense droughts could cause stress for key numerous crops including bananas and vegetables. Impacts could be exacerbated by increased temperatures.	Loss of fertility. Reduced yield unless protective measures are introduced, increased cost of production
Temperature	Increased temperatures could result in increased stress on crops especially in the context of reduced rainfall. Could increase the presence of pests.	Reduced yields. Increased economic costs to combat effects e.g. through use of increased levels of fertilizers and pesticides. This could have downstream knock-on effects such as increased pollution and eutrophication.

One other factor of concern with respect to the impacts of climate change on agriculture is the effect of changing levels of carbon dioxide on photosynthesis.

iv.ii Fisheries. The possible impacts of climate change on coastal ecosystems are described earlier. Wetlands such as mangroves; seagrass beds and coral reefs are some of the primary producers of nutrients in the marine environment. Coastal/estuarine and marine species are all to some extent dependent on the output of these "nutrient engines". It is therefore not inconceivable that if productivity of these is impaired then fish production will be negatively impacted in some way.

Mangroves, seagrass beds and reefs serve as nurseries and habitat for a range of commercially important fin and shellfish. The reduced extent and productivity of these systems will affect the life cycles of lobsters, conch, tarpon and other species and will impact negatively on the respective fisheries. Coastal and ocean pelagics may also be similarly affected.

It is possible that changing climatic patterns will affect oceanographic processes such as upwelling. This process is key to cycling of nutrients from colder depths of the ocean to the surface. This alone could significantly affect the life cycles and abundance of ocean pelagics.

The possibility exists that increased sea surface temperatures may lead to the proliferation of algal blooms which may in turn lead to the occurrence of *ciguatera*, which occurs when toxins from certain marine alga accumulate in the tissues of some fish species. Consumption of ciguatoxic fish can lead to severe fish poisoning. While this phenomenon has not yet been recorded in St. Lucia, the future occurrence, as a result of climate change, cannot be ruled out.

The earlier discussions on river flows can be considered in the context of freshwater fisheries in St. Lucia. The river fishery is not very significant but there is some aquaculture carried out. Any impacts on the water supply will ultimately affect productivity.

v. Settlements and Infrastructure:

The major settlements on St. Lucia are located along the coast. For example over 60% of the entire population resides along the Castries-Gros Islet corridor on the north-west coast of the island. Much of Castries is built on low-lying reclaimed land and the city centre is prone to flooding during heavy rains.

Commercial and industrial development is also concentrated on the coastal belt. In the town of Soufriere, for example, all that separates a particular petrol station from the sea is a wall and a few meters of beach.

St. Lucia currently has numerous commercial, fishing and tourism ports, most of which are located along the west coast. In addition, the island's two airports and many roads lie on flat coastal lands, in some cases, only a few meters from the sea.

It can be safely said that for many years, urban growth in St. Lucia occurred in the absence of a proper planning regime. Moreover, even with specific efforts

to address this situation, beginning in the early 1970's, the pre-existing conditions, the inadequacy of the planning legislation itself, and the difficulties in achieving enforcement thereof, the current state of spatial development of in general and in coastal areas in particular, is less than ideal from a planning perspective. For example, many structures are erected in the absence of appropriate setbacks. In some instances, construction occurs within the Queen's Chain itself. Some squatter settlements are erected in flood plains or in areas cleared of mangals.

Given the existing scenario, it is possible, and indeed likely, that urban settlements and infrastructure will be significantly impacted as a result of the effects of climate change. In November 1999, the storm surges alone from Hurricane Lennie caused in excess of EC$6 million damage to coastal settlements and infrastructure. Jetties were destroyed, dwelling houses were washed into the sea and the petrol station mentioned earlier had to be totally rebuilt. If the effects of Hurricane Lennie are a foretaste of things to come, then St. Lucia has already witnessed some of the impacts of climate change. In short, some of the expected impacts of climate change on urban settlements are as follows:

Table 6: Expected Impacts of Climate Change on Urban Settlements

Change Factor	Impact	Implications
Sea-Level Rise	Backing-up of rivers Possible flooding of low-lying areas	Impeded drainage and exacerbated flooding in low-lying communities Economic cost of putting coastal defenses to protect lands
Hurricanes	Increased hurricane frequency and intensity will lead to more occurrences, resulting in increased damage to housing, commercial buildings and infrastructure due to wind damage. Increase in collapse of structures on slopes due to wind damage and landslides. Increased likelihood of flooding	Increased risk of loss of life. Economic cost of reconstruction. Loss of earnings due to damaged infrastructure such as tourist jetties. Increased costs of reinsurance. Economic cost of coastal protection and relocation of infrastructure
Storm Surge	Damage/Loss of property	Economic implications as above
Rainfall Patterns	Increased rainfall duration/intensity could result in greater incidence of flooding.	Damage to property; disruption of economic activity; increased number of landslides and loss of life; increased costs of reinsurance; may need to relocate some settlements
Temperature	Increased temperatures may result in personal discomfort. May increase the incidence of, or contribute to stress, heat stroke. May contribute to greater localized incidence of vectors. May increase the risk of random fires, especially in Castries region where minimum allowable house lot size is 300 sq feet as opposed to 5000 sq. ft elsewhere. .	Economic cost of improved ventilation and air conditioning in buildings; Increased personal and public health costs. Replacement, insurance costs due to fire.

With respect to the above table, it must be noted that measures such as relocation are likely to be influenced by the absolute limit of available land as well as the by the island's rugged topography.

Case Study: Tropical Storm Debbie

Date	9/9/94
Rainfall	10 inches in 10 hours
Damage	EC$250 M (US$92.6 M)
Return Period	1 in100 years

Source: National Emergency Management Organisation

vi. Tourism

The tourism sector, which is a critical component of St. Lucia's economy, is likely to be significantly impacted by the changes listed above. The effects on beach and shoreline stability, food and nutrition, human health indirectly impact on the sector. By way of example, reduced vegetable production could result in increased importation of such produce, with concomitant economic impacts.

In St. Lucia, the majority of hotels are located along, or within close proximity of, the beach. This is so largely due to the fact that like most other Caribbean islands, the beach is one of the key marketing tools and as such all visitors are expected to require easy access to the beach.

Changes in sea level, hurricane patterns and storm surges are likely to have direct implications for hotel infrastructure. The serious damage wrought along the west coast by Hurricane Lennie in 1999 is clear demonstration of the potential for damage and destruction.

St. Lucia has a thriving dive-tourism industry along the west coast. The effect of sea-level rise on coral reefs will therefore be of concern to the tourism sector, as the smothering of reefs will mean a significant loss of business and revenue. In addition, reef-dependent fish species of importance to the tourism

sector will also be affected. Possible impacts should be considered in light of the following:

- The tendency to build in the queen's chain with inadequate setbacks;
- The tendency to promote mass beach-based tourism;
- Weak planning laws/enforcement;
- Heavy use of water in the sector by visitors. Coastal erosion makes beaches less attractive;
- The cost of protection and the issue of sea defenses as opposed to setbacks;
- The bleaching of reefs and productivity/attractiveness;
- The effect of higher temperatures in temperate latitudes on tourism arrivals;
- The increased size of the siltation plumes observed during periods of heavy rainfall which make the beaches unattractive for tourists.

vii. Human Health Implications

St. Lucia's geographical location in the tropical belt means that temperatures are warm year-round. This has implications with respect to the interaction between the effects of climate change and human health. Firstly, temperatures in the tropical Caribbean are favourable to the existence of many agents of disease including mosquitoes and bacteria. Increased temperatures may therefore increase the reproductive rate of these agents.

Sea level rise, in combination with increased storm surges may lead to infiltration of liquid waste disposal systems. This may in turn result in contamination of the coastal environment which has health implications.

The increased incidence of hurricanes may have an impact on human health in the following ways:

- Damaging water supply systems. This could cause a shortage of potable water. This in turn could impact negatively on hygiene and sanitation standards, resulting in the outbreak of disease. The possibility of this occurring is increased in the hurricane-shelter situation.

- Contamination of water supplies. This could have a similar end effect, thus resulting in the outbreak of cholera, gastro-enteritis and other diseases.

- Increased mental and physical stress in the post-hurricane situation. Lack of "basic" everyday amenities such as electricity and water may

lead to frustration and other forms of stress which impact on human health.

- Increased incidence of vectors. This could arise when mosquitoes and other vectors breed in drums and other water receptacles and result in the spread of diseases such as dengue fever.

- Increased rainfall may produce greater contamination of coastal and fresh water supplies leading to a greater incidence of skin, eye and ear diseases.

Drought conditions resulting in the limited availability of water could have similar impacts by increasing stress levels, compromising sanitation and hygiene standards and encouraging the breeding of vectors in water storage receptacles. Should the drought conditions, however, become so severe as to seriously affect food production, this could have the direct effect of reducing the availability of certain foods for daily nutrition. It could also affect the economic and ultimately physiological well-being of farmers, especially those involved in marginal or subsistence agriculture. Drought conditions may also lead to increased concentration of pesticides and other soil contaminants and this may impact negatively on human health.

Increased temperatures may, inter alia, result in more rapid proliferation of harmful micro-organisms in water bodies. This may increase the occurrence of water-borne diseases.

Due to the effects of climate change, it may be necessary to relocate settlements. If this is not carefully, implemented, over-crowding may occur, creating more favourable conditions for the spread of communicable and vector-borne diseases.

Mention has been made earlier about the possible decrease in food production due to climate change. Human health may therefore be negatively affected by protein or other food deficiency especially among the very young and elderly. who would be more at risk.

viii. Forestry & Biodiversity

A significant proportion of St. Lucia is covered by forest of different types. These vegetated areas serve as reservoirs of flora and fauna. The rainforest also serves as a primary storage for the country's water supply. Climate change could impact on forests in the following ways:

- Increased temperatures and altered precipitation patterns could make marginal areas unsuitable for certain species resulting in the retreat of forests from these areas. This would also impact the fauna of the forest habitat. Increased rainfall can cause increased landslides in the forest as occurred with Tropical Storm Debbie.

- Greater hurricane frequency and intensity could subject the forests to increased stress and damage and place certain plant and animal species at risk. While hurricanes are part of the natural cycle, anthropogenic changes in their occurrence and intensity could affect the sensitive natural balance and lead to irreversible damage. With respect to fauna, the occurrence of Hurricane Allen contributed significantly to the endangerment of the St. Lucia Parrot (*Amazona versicolor*). However, it must also be remembered that deforestation and other human activities also negatively affected the parrot population at that time.

ix. Financial Sector

Cyclones such as Hurricane Andrew caused severe damage on the American mainland and contributed significantly to a rise in insurance rates. The Caribbean Basin was affected by these increases as it forms part of the same zone, for reinsurance purposes, as Florida and adjacent American states.

In Antigua, following the passage of numerous hurricanes in the 1990's, the cost of insurance for many coastal properties became prohibitive as a result, with many owners opting not to insure.

The issue of insurance is a serious one, especially in disaster prone regions such as the Caribbean. If persons cannot afford to insure their properties, especially in the face of increasing risk due to climate change, the cost of rebuilding can be high. The situation is also one of concern for re-insurers who may opt not to insure.

The financial sector as a whole, may come under pressure to make funding available for reconstruction, retrofitting and for adaptation measures. This may result in an increase in interest rates due to the risk involved. It may also result in limited financial resources being diverted away from productive sectors. Finally, the cost of having to take protective measures may push up the cost of living for the population as a whole.

2.2. Identification of Priorities: The identification of priorities is predicated on the significance to the overall economic, social and physical development of the country. While all the issues identified will be significant concerns, some are likely to be assigned higher priority, in an overall national context.

Ranking of Issues by Magnitude & Significance

Predicting the magnitude of the impacts of climate change is difficult, due, *inter alia*, to:

- The nature and complexity of the interactions and processes involved;
- The uncertainty surrounding the level of climate change parameters.

Nevertheless, the following matrix attempts to rank key issues, not so much relative to each other but in "absolute" terms

Table 7: Magnitude of Ultimate Impacts of Climate Change

Issue/Area	Ranking	Comments
Coastal Zone	5	Will impact on fisheries, tourism, human settlements, water. May require major adjustments.
Fisheries	4.5	Will affect nation's ability to feed itself. May require major adjustments.
Agriculture	4.5	Will affect nation's ability to feed itself. Will be affected by water situation. May require significant adjustments.
Financial Sector	3.5	Hurricanes and surge damage will affect insurance/re-insurance. Sector will have a key role in funding the cost of rebuilding as well as adaptation measures.
Human Settlements	4	Will be affected by water, human health, coastal zone processes
Human Health	3.5	Will require strengthening of existing systems.
Water/ Hydrology	5	Water problems already occur. Climate Change impacts will further exacerbate the situation. Water problems will affect agriculture, health and all other aspects of existence and might require costly infrastructure. Water is the basis of all life.
Biodiversity	5	In the long term, will affect all aspects of life. Will affect ecosystem productivity and ultimate survival. Will ecosystems and species adapt quickly enough?

***** 1= Lowest Significance; 5= Highest Significance

3.0 INSTITUTIONAL AND LEGAL ARRANGEMENTS FOR RESPONDING TO ISSUES

3.1 Allocation of Responsibilities

A number of agencies have responsibility for coastal management, directly or indirectly. The following tables attempt to identify the key bodies and functions.

Table 8: Agency Responsibility for Coastal Management

	COASTAL MANAGEMENT FUNCTION	AGENCY RESPONSIBLE	GOVERNMENT MINISTRY
1	Building development control within coastal area	Physical Planning Department	Ministry of Planning, Development, Environment and Housing
2	Regulation/Design/Construction of Civil Works	Engineering Department	Ministry of Communications, Works, Transport and Public Utilities
3	Protection/Management of coral reefs, seagrasses and mangroves	Fisheries Department	Ministry of Agriculture, Forestry and Fisheries
4	Sand mining and Mineral Extraction	Engineering Department	Ministry of Communications, Works, Transport and Public Utilities
5	Water quality monitoring-setting of coastal water quality standards	Public Health Inspectorate	Ministry of Health, Human Services and Gender Affairs
6	Enforcement /Marine Surveillance	Marine Division of Police	Ministry of Legal Affairs, Home Affairs and Labour
7	Legal Support	Attorney General's Chambers	Ministry of Legal Affairs, Home Affairs and Labour

3.2 Key Legislation Relating to Coastal Management

Table 9: Coastal Management Legislation

Name of agency responsible	Legal Instrument	Date	Issue
MAFF	Agriculture Small Tenancy	1983	Regulations requiring sound soil and water conservation practices on small holdings
SLASPA	Air and Seaport Act	1981	Development and management of the nation's air and seaports
Ministry of Planning	Crown Lands Ordinance	1946	Establishes the Crown Land Committee to allocate/use of Crown Land
Ministry of Labour	Employers Occupational Health and Safety Act	1985	Provides inspection of food handling premises
Fisheries Dept/MAFF	Fisheries Act	1984	Management of Fisheries and marine reserves
Forestry Dept/MAFF	Forest, Soil and Water Conservation Ordinance	1946	Management of forests; establishment of forest reserves and protected forest; and, soil and water conservation programs to protect forested areas
UDC	Housing and Urban Development Corporation Act	1971	Planning and development of housing projects
Physical Planning/MPDEU	Land Development Act	1971	Regulates land use planning and development control
MOH	Litter Act	1983	Control of litter in public or private places
NDC	National Development Corporation Act	1971	Promotes economic growth and industrial development
	Merchant Shipping Act	1981	Introduces the Law of England with regard to Merchant Shipping
SLNT	St. Lucia National Trust Act	1975	Regulates preservation of buildings, objects and areas of natural or scenic importance
MAFF	Pesticides Control Act	1975	Regulates import, use, labelling and storage of pesticides
MOH	Public Health Act	1975	Regulates oversight for sewage, industrial and solid waste disposal
MAFF	Plant Protection Act	1988	Regulates control of pests and diseases and prevents introduction of exotic species
MCWT&PU	Radioactive Minerals Act	1957	Authorises exploration and mining
RBDC	Rodney Bay Development Act	1970	Authorises land improvement works

LEGISLATION RELATING TO COASTAL MANAGEMENT (Cont'd)

Table 9: Coastal Management Legislation (cont'd)

Name of agency responsible	Legal Instrument	Date	Issue
Physical Planning/MPDEU	Slum Clearance and Housing Ordinance	1946	Regulates management of slum areas
Forestry Dept/MAFF	Timber Industry Development Act	1984	Development and promotion of timber industry
St. Lucia Tourist Board	Tourist Industry Development Act	1981	Promotion and development of tourist industry
MOPDEH	Town and Country Planning Ordinance	1946	Physical Planning and Building Control
WASCO/Water and Sewerage Commission	Water and Sewerage Commission Act	1999	Regulates water supply, sewerage management and protection of water surfaces
Forestry Dept/MAFF	Wildlife Protection Act	1980	Provides for conservation of wildlife, wildlife reserves and enforcement of hunting regulations
NCA	National Conservation Authority Act	1999	Provides for protection of beaches and protected areas
RSLPF/MCWT&PU	Beach Protection Act	1967	Regulation of sand mining

Key:

MAFF : Ministry of Agriculture, Forestry and Fisheries
SLASPA : St. Lucia Air and Seaports Authority
RSLPF : Royal St. Lucia Police Force
MOP : Ministry of Planning
MOL : Ministry of Labour
UDC : Urban Development Corporation
MPDEH : Ministry of Planning, Development, Environment and Housing
MOH : Ministry of Health
NDC : National Development Corporation
SLNT : St. Lucia National Trust
RBDC : Rodney Bay Development Company
WASCO : Water and Sewerage Company
NCA : National Conservation Authority

Table 10: Governmental Agencies with Responsibility for Environmental Management

AGENCY	RESPONSIBILITY RE: COASTAL/MARINE ISSUES
Attorney General Chambers, Ministry of Legal Affairs, Home Affairs and Labour	Legal Support and advice
Customs and Excise Department, Ministry of Finance	Control of imports/exports and carry out surveillance activities around the island
Department of Environment, Ministry of Health, Human Services, Family Affairs and Gender Relations	Pollution monitoring, including water quality control
Department of Forestry, MAFF	Management of rivers and mangroves
Development Control Authority, MPDEH	Development and Planning
Ministry of Communications, Works, Transport and Public Utilities	Coastal infrastructure and sand mining on beaches
Ministry of Tourism, Civil Aviation and International Financial Services	Support to control sport fishing, whale watching, dive establishments and submarine operations
National Conservation Authority	Control, maintain and develop beaches
St. Lucia Air and Sea Ports Authority	Management of leisure Ports, some legislation base regarding oil pollution, establishing of infrastructure in the marine environment and co-management of the Soufriere Marine Management Area (SMMA)
St. Lucia Development Bank (SLDB)	Financing fishing enterprises
Royal St. Lucia Police Force, Ministry of Legal Affairs, Home Affairs and Labour	Enforcement of marine and coastal related issues

NON-GOVERNMENT AGENCIES IN ST.LUCIA AND THEIR RESPECTIVE RESPONSIBILITIES IN COASTAL/MARINE MANAGEMENT

Table 11: NGOs with Responsibility for Environmental Management

AGENCY	RESPONSIBILITY
Fishermen's Cooperative	Facilitate arrangements for financial and other incentives/concessions, such as duty-free fuel for members
National Development Corporation (NDC)	Management of the St. Lucia Fish Marketing Corporation and development of vested lands
Soufriere Regional Development Foundation	Collaborative management of SMMA
St. Lucia Game Fishing Association	Coordination of tag and release program for a few commercially exploited fish species
St. Lucia National Trust	Management of some protected areas
St. Lucia Naturalists' Society	Beach monitoring, mangrove surveys, turtle nesting and monitoring

3.3 INTERNATIONAL AGREEMENTS RELATING TO MARINE MANAGEMENT IN ST. LUCIA

Table 12

Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks
Basel Convention on the Control of trans-boundary Movements of hazardous wastes and their disposal
Convention concerning the Protection of the World Cultural and Natural heritage
Convention for the protection and development of the Marine Environment of the Wider Caribbean Region and Protocol on Cooperation in combating oil spills
United Nations Convention on Biological Diversity
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
Convention on the prevention of Marine Pollution by Dumping Wastes and other Matter (as amended)
International Convention for the Regulation of whaling
Montreal Protocol on substances that deplete the Ozone Layer
United Nations Convention on the Law of the Sea
United Nations Framework Convention on Climate Change
Vienna Convention for the Protection of the Ozone layer
MARPOL
LBSMP Protocol
Convention on Wetlands of International Importance (RAMSAR)

3.4 OTHER ISSUES

- The obvious positive socio-economic impacts of development often take precedence over any negative impacts of these activities on the environment. Very often, it is not until problems manifest themselves that action is taken. This situation has been aggravated by less-than-adequate co-ordination between environmental management bodies. With respect to coastal management in particular, there is currently no agency with the mandate for addressing coastal management from a holistic standpoint. However, if resources allow, it is anticipated that a Coastal Zone Management Unit will be established within the Department of Fisheries, Ministry of Agriculture, Forestry and Fisheries.

- There are often inadequate facilities and human resources available in agencies to effectively undertake their mandate.

- Inter-sectoral linkages among relevant agencies are grossly inadequate due to:

Unclear jurisdiction due to overlaps and gaps in the legislative framework; for example as occurs with the Department of Fisheries and the National Conservation Authority vis-à-vis the management of beaches and the Department of Forestry and the Department of Fisheries as regards mangroves.

4.0 TOWARDS AN ADAPTATION POLICY

A number of possible climate change impacts have been discussed in foregoing sections. These may be due to individual climate change factors or to the interactions between factors. There may also be knock-on effects in one sector arising from direct impacts of climate change on another. In short, the overall impact of climate change on the physical, economic and social landscape will be a complex combination of individual and inter-related effects.

Any attempt to address the impacts of climate change must recognize the complicated nature of the problem and adopt a holistic, integrated approach. Due consideration must be given to the options and strategies employed as mal-adaptation may create as many problems as no adaptation at all.

4.1 Adaptation Options

Adaptation refers to policies, strategies and actions aimed at mitigating or obviating the impacts of climate change. These may be local/ site specific, national, or regional, depending on the issues or needs.

In the broad context, there are five basic types of adaptation:

Relocation;- Shift current activities or structures to another location
Accept Loss- Implement no vulnerability measures and bear the burden of loss;
Prevent Loss-Reduce vulnerability to climate change through engineering or other measures;
Spread loss- Disribute the burden of losses through property insurance, government emergency relief and other measures;
Change the Activity- Replace current activities with more sustainable ones.

In addition to the foregoing options, the following, will, in most cases be vital to the success of adaptation interventions:

Public Awareness and Education- Sensitise, and increase the knowledge of, the populace, including selected target audiences, to obtain support, assistance, or change in behaviour.

Research & Monitoring- Improve knowledge of processes through data and information gathering and observe trends in order to inform the adaptation process.

The foregoing definitions are simplistic. Some strategies or measures may have elements of more than one option as the use of a particular option does not necessarily preclude the use of another. Further, many adaptation options may have to be supported by legislative, regulatory, fiscal and other adjustments.

The following tables summarise possible measures for adapting to climate change. While they do not provide an exhaustive list, they identify some of the actions that could be implemented. Such measures should be seen in the context of a holistic approach towards building and maintaining the resilience of natural, social and economic systems to cope with Climate Change.

Table 13: Options for Addressing Climate Change Impacts

OPTIONS							
Impact	**Relocation**	**Accept Loss**	**Prevent Loss**	**Spread Loss**	**Change Activity**	**Supporting Activities**	**Time frame**
Strategies & Measures							
Sea level rise on coral reefs, sea grass beds, mangroves and beaches			Land use controls Buffer Zones Management to enhance resilience	Environmental taxes/ funds	Reduce sand mining and other extractive activities. Promote non-extractive use. Enforce existing land use controls	Public Education Research, Monitoring & Data Collection	2002-
Hurricane impact on above ecosystems			Coastal defences. Beach re-nourishment Land use controls Buffer Zones Management to enhance resilience	Environmental taxes/ funds	Reduce sand mining and other extractive activities. Promote non-extractive use. Enforce existing land use controls	Public Education Research, Monitoring & Data Collection Early warning systems	2002-2005
Storm surge impacts on above ecosystems	Setbacks		Land use controls Buffer Zones Management to enhance resilience	Environmental taxes/ funds	Reduce sand mining and other extractive activities. Promote non-extractive use. Enforce existing land use controls	Public Education Research, Monitoring & Data Collection Early warning systems	2002-2005
Rainfall impacts on above ecosystems			Management of ecosystems to enhance resilience Artificial wetlands	Environmental taxes/ funds	Enforce existing land use controls	Public Education Research, Monitoring & Data Collection Early warning systems	2002-2005
Temperature impacts on above ecosystems	Turtle ranching Mariculture		Management of ecosystems to enhance resilience		Mariculture	Public Education Monitoring & Data Collection Early warning systems	2002-2005

Table 13: Options for Addressing Climate Change Impacts (cont'd)

Table 1

Impact	Relocation	Accept Loss	Prevent Loss	Spread Loss	Change Activity	Supporting Activities	Time frame
Impacts on Water Resources	Abandonment of unproductive catchments Exploration of ground-water.	Insurance	Reinforce existing, build stronger infrastructure Reforestation of catchments New storage & distribution infrastructure	Insurance/ fiscal measures	Water Management practices	Early warning systems Public Education Research, Monitoring & Data Collection Policy on water management practices and enforcement	2002-2005
Impacts on Agriculture, forestry and fisheries	Abandonment of unproductive lands or flooded areas Mariculture & Aquaculture	Crop and gear Insurance	Coastal Defences Contour farming/ terracing	Farmer/ fisher Insurance/ Emergency Funding Fiscal measures	Agroforestry Reforestation Mariculture & Aquaculture Rehabilitation of degraded lands	Public Education Monitoring & Data Collection	2002-2006
Impacts on Tourism	Relocation of hotels and other infrastructure	Property Insurance	Building codes/ Development Control Setbacks	Group Insurance/ reinsurance	Low-density/no infrastructure Enforcement of existing and new land use controls	Public Education Monitoring & Data Collection	2002-2006
Impacts on Human Health	Relocation of health facilities at risk	Insurance	Relocation of health facilities at risk. Vector control and other preventative measures such as primary health care	Group and other Medical/ Life Insurance Fiscal measures for health Care Sector	Vector control. Promotion of healthy lifestyles especially to adapt to expected changes	Public Education Monitoring & Data Collection	2002-2006
Impacts on Human Settlements	Relocation of roads and other infrastructure	Property insurance	Building codes/ Development Control Setbacks Coastal protection	Fiscal measures to promote appropriate behaviour	Land Use controls Buffer zones Enforce existing and new land use controls	Public Education Monitoring & Data Collection	2002-2006

Table 14

OPPORTUNITIES AND CONSTRAINTS	ADAPTATION OPTIONS/ MEASURES
Presence of monitoring stations provided by CPACC Project and SMMA; Persons trained in Coastal Resources Management; Development of new building codes; Inadequate human resources; Inadequate financial resources, land tenure situation; Incipient development of land use policy	Establishment of monitoring stations to identify vulnerability of mangroves, seagrass beds, coral reefs and beaches; Beach nourishment; land use control and enforcement.
New building codes; Development of national environment education network (NEEN); Increasing participation of public in development; Disaster mitigation legislation and plan	Land use control and enforcement; Public education; Public participation in development.; Enforcement of building codes.
Development of land use policy, development of NEEN; National Emergency Management Operations System; Watershed Environment Management Project and attempts at landslide hazard mapping; Inadequate human and financial resources; Disaster mitigation legislation and plan	Land use control and enforcement; Public education; Early warning systems; Enforcement of EIA regulations and inclusion of Climate Change issues therein. Revisiting of policy re minimum size for house lots.
Establishment of Water Resources Management Unit; More vigorous collection and management of data; Development of local GIS systems; National training in hazard mapping by FAO; Inadequate human and financial resources	Public education, Early warning systems; Establishment of monitoring stations to check patterns and trends; Flood control measures such as cleaning water courses and drains; Hazard mapping to identify vulnerable areas.
Establishment of monitoring stations by CPACC Project and SMMA; Establishment of turtle management project by Department of Fisheries; inadequate human and financial resources	Ranching of turtles; Establishment of monitoring stations; Public education; Enforcement of existing regulations
Establishment of Water Resources Management Project in Ministry of Agriculture, Fisheries and Forestry; Establishment of water catchment groups and watershed management practices by one group; Development of NEEN; Implementation of World Bank WASCO project; Development of land use policy; Establishment of Integrated Coastal Areas and Watershed Management Project in collaboration with CEHI; Existence of Land Conservation Act; Inadequate human and financial resources; Initial ground water exploration; Disaster mitigation legislation and plan	Undertake ground water studies; Improve WASCO infrastructure and operational efficiency; Develop and implement appropriate land use policy; Public education; Increase island-wide storage of rainwater; Policies to control water pollution.
Ongoing Restructuring of Agriculture Ministry; Establishment of water resources management project in Ministry; Proposed establishment of coastal zone management unit; Existence of Wildlife Unit with trained wildlife management officers in Department of Forestry; Officers trained in use of greenhouse technology; Enabling political will; Inadequate human and financial resources; Existing watershed soil conservation project	Relocate inland; Redesign construction of infrastructure; Run utility lines underground or further inland; Construct and reinforce defensive and berthing structures; Implement appropriate wildlife management measures; Implement water based and water protection farming; Improve and enforce Land Conservation Act; Improve research and cultivation of salt resistant and salt tolerant crop varieties such as pineapple and bananas;

Existence of vibrant Hotel and Tourism Association working closely with the Caribbean Alliance for Sustainable Tourism (CAST) to improve environmental sustainability of tourism plants; Development of new EIA legislation and Physical Planning Act; inadequate human and financial resources; participation in multilateral environmental agreements/conventions (MEAs); disaster mitigation legislation and plan	Public education; Establishment and enforcement of land use policy and regulations/legislation; construction of sea defence structures; Public participation in tourism development; Strengthen legislative frameworks including EIA legislation/regulations; Decentralise coastal tourism development;
Existence of Environmental Health Branch of Ministry of Health; Development of NEEN; Establishment of Solid Waste Management Authority; Inadequate human, financial and land resources; Enabling political will	Public education; Increased medical supplies; Increased enforcement of health legislation; Increase efficiency in solid waste management systems including appropriate adaptation and relocation of landfill sites;
Restructured Adult Education Program; Development of new building codes; Proposed presence of Ministry of Education on National Climate Change Committee; Inadequate human and financial resources; Enabling political will	Include climate change in the curricula at all levels including continuing education and adult education programs; Development and enforcement of new building codes, Standards and regulations for infrastructure;

Table 14 (cont'd)

Table 15

IMPACTS	ADAPTATION MEASURES
Sea level rise on coral reefs, sea grass beds, mangroves and beaches	Establishment of monitoring stations to identify vulnerability of mangroves, seagrass beds, coral reefs and beaches; beach nourishment; Land use control and enforcement.
Hurricane impact on above ecosystems	Land use control and enforcement; public education; Public participation in development.
Storm surge impacts on above ecosystems	Land use control and enforcement; public education; early warning systems
Rainfall impacts on above ecosystems	Public education, early warning systems; Establishment of monitoring stations to check patterns and trends; flood control measures such as cleaning water courses and drains; Hazard mapping to identify vulnerable areas.
Temperature impacts on above ecosystems	Ranching of turtles; Establishment of monitoring stations; Public education; Enforcement of existing regulations
Impacts on water resources	Undertake ground water studies; Improve WASCO infrastructure and operational efficiency; Develop and implement appropriate land use policy; Public education; Increase island-wide storage of rainwater;
Impacts on agriculture, forestry and fisheries	Relocate inland; Redesign construction of infrastructure; Run utility lines underground or further inland; Construct and reinforce defensive and berthing structures; Implement appropriate wildlife management measures; Implement water based and water protection farming; Improve and enforce Land Conservation Act; Improve research and cultivation of salt resistant and salt tolerant crop varieties such as pineapple and bananas;
Impacts on tourism	Public education; Establishment and enforcement of land use policy and regulations/legislation; Construction of sea defence structures; Public participation in tourism development; Strengthen legislative frameworks including EIA legislation/regulations; Decentralise coastal tourism development;

Impacts on human health	Public education; Increased medical supplies; Increased enforcement of health legislation; Increase efficiency in solid waste management systems including appropriate adaptation and relocation of landfill sites; Population policies.
Impacts on Educational System	Include climate change in the curricula at all levels including continuing education and adult education programs; development and enforcement of new building codes, standards and regulations for infrastructure;

Table 15 (cont'd)

Table 16

OPPORTUNITIES AND CONSTRAINTS	ADAPTATION OPTIONS
Presence of monitoring stations provided by CPACC Project and SMMA; Persons trained in Coastal Resources Management; Development of new building codes; Inadequate human resources; Inadequate financial resources, land tenure situation; Incipient development of land use policy	Establishment of monitoring stations to identify vulnerability; Acknowledgement of expanding mangroves and need to develop same sustainably; Establishment and enforcement of coastal setbacks; Beach nourishment; Zoning regulations; Land use control and enforcement
New building codes; Development of national environment education network (NEEN); Increasing participation of public in development; Existence of disaster management legislation and plan	Establishment of coastal setbacks; Public education; Public participation in development
Development of land use policy, development of NEEN; National Emergency Management Operations System; Watershed Environment Management Project and attempts at landslide hazard mapping; Inadequate human and financial resources; Existence of disaster management legislation and plan	Land use control and enforcement; Public education; Early warning systems. Improve Disaster Response Systems
Establishment of Water Resources Management Unit; More vigorous collection and management of data; Development of local GIS systems; National training in hazard mapping by FAO; Inadequate human and financial resources	Public education, early warning systems; Establishment of monitoring stations to check patterns and trends; Flood control measures such as cleaning water courses and drains; Hazard mapping to identify vulnerable areas
Establishment of monitoring stations by CPACC Project and SMMA; Establishment of turtle management project by Department of Fisheries; Inadequate human and financial resources	Mariculture; Establishment of monitoring stations; Public education; Enforcement of existing regulations
Establishment of Water Resources Management Project in Ministry of Agriculture, Fisheries and Forestry; Establishment of water catchment groups and watershed management practices by one group; development of NEEN; Implementation of World Bank WASCO project; development of land use policy; Establishment of Integrated Coastal Areas and Watershed Management Project in collaboration with CEHI; Existence of Land Conservation Act; inadequate human and financial resources; Initial ground water exploration	Undertake ground water studies; Improve WASCO infrastructure and efficiency; Restore and rehabilitate riverbanks and wetlands; Develop and implement appropriate land use policy; public education; Establish policy of integrated watershed management; Increase island-wide storage of rain water; Adjust price rates; Reward conservation efforts; Raise roads and highways; Establish and enforce buffer zones on rivers and wetlands; Avoid construction in flood prone areas; Relocate to hillier areas

Ongoing Restructuring of Agriculture ministry; Establishment of water resources management project in ministry; Proposed establishment of coastal zone management unit; Existence of wildlife unit with trained wildlife management officers in Department of Forestry; Officers trained in use of greenhouse technology; Enabling political will; Inadequate human and financial resources; Existing watershed soil conservation project	Relocation inland; Redesign construction; Introduce more hydroponics into farming; Construct defensive structures; Reinforce jetties and docks; Run utility lines underground or further inland; Implement habitat rehabilitation; Increase captive breeding; Monitor populations; Increased use of greenhouse technology; Enforcement of Land Conservation Act; Cultivation of more salt resistant and salt tolerant crops such as pineapple; Improve research in salt resistant varieties of bananas and other crops; Increased soil conservation measures; Improved legislation to enforce soil conservation measures
Existence of vibrant Hotel and Tourism Association working closely with the Caribbean Alliance for Sustainable Tourism (CAST) to improve environmental sustainability of tourism plants; Development of new EIA legislation and Physical Planning Act; inadequate human and financial resources; Participation in multilateral environmental agreements/conventions (MEAs); Existence of disaster management legislation and plan	Public education; Establishment and enforcement of land use policy and regulations/legislation; Construction of sea defence structures; Public participation in tourism development; Strengthen legislative frameworks; Develop and enforce EIA legislation/regulations; Decentralise coastal tourism development; Develop and enforce building codes
Existence of Environmental Health Branch of Ministry of Health; development of NEEN; Establishment of Solid Waste management Authority; Inadequate human, financial and land resources; Enabling political will; Existence of disaster management legislation and plan	Public education; Increased medical supplies; Increased enforcement of health legislation; Monitoring and increased surveillance; Increase efficiency in collection and disposal of solid waste; Monitoring of landfill sites; Reengineering of disposal sites to withstand possible inundation; Relocation of landfill sites further inland
Restructured Adult Education Program; Development of new building codes; Proposed presence of Ministry of Education on National Climate Change Committee; Inadequate human and financial resources; Enabling political will	Include climate change in the curricula at all levels including continuing education and adult education programs; Improve design of educational infrastructure to better withstand natural disasters; Development and enforcement of new building codes, standards and regulations; Increased number of water tanks in schools

Table 16 (cont'd)

Table 17: Strategies, Actions Tasks & Resources for Addressing Climate Change Impacts

Impacts	Adaptation Options	Activity	Tasks	Resources	Time Frame
Sea level rise on coral reefs, sea grass beds, mangroves and beaches	Establishment of monitoring stations to identify vulnerability of mangroves, seagrass beds, coral reefs and beaches; beach nourishment; land use control and enforcement	A. Establishment of monitoring stations	Undertake regular monitoring activities in the seagrass beds and mangroves; Continue and expand monitoring activities in the coral reefs and beaches; Train community members and school groups to assist in the monitoring; Purchase monitoring equipment; Establish equipment where necessary in appropriate locations; Establish mechanism for analysis and dissemination of monitoring records and information and development;	Monitoring equipment Officers skilled in monitoring activities	2002-2005

			Identify and prioritise beaches requiring nourishment from monitoring information;		
		B. Beach nourishment	Establish mechanism for accessing beach nourishment materials and implementing activity;	Beach nourishment materials: sand Labourers Equipment;	2002-2005
			Implement activity	Officers skilled in administering beach nourishment	
		C. Land use control and enforcement	Continue development of land use policy;	Committee working on development of land use policy;	
			Enhance and strengthen legislation and develop zoning regulations;	Legal officers to improve legislation and regulations;	
			Establish and enforce coastal setbacks;	Enforcement officers;	
			Public education on monitoring activities and enforcement of legislation and regulations;	Public education officers;	2002-2005

Impacts	Adaptation Options	Activity	Tasks	Resources	Time Frame
Hurricane impact on above ecosystems	Land use control and enforcement; public education; public participation in development	A. Land use control and enforcement	Same as above	Same as above	Same as above
		B. Public Education	Establish committee to undertake public education; Select target groups; Design action plan for each group; Implement Action Plan;	Transportation, Writers, Video and radio documentary producers, Brochure designers, Brochures, Bumper stickers, Jingles;	2002-2005
		C. Public participation in development	Develop and implement policy on public participation in development	Legal draftsman Enforcement officers	2002-2005
Storm surge impacts on above ecosystems	Land use control and enforcement; public education; Early warning systems	A. Land use control and enforcement	Same as above	Same as above	Same as above
		B. Public education	Same as above	Same as above	Same as above
		C. Early warning systems	Establish early warning equipment systems at appropriate locations around island;	Early warning equipment; Personnel to train others in its use;	2002-2005

			Train persons in use and response to system and maintenance of it; Establish mechanism for local and island-wide response to early warnings	Equipment for local and island wide response to early warnings;	
Rainfall impacts on above ecosystems	Public education Early warning systems Establishment of monitoring stations to indicate patterns and trends Flood control measures Hazard mapping	A. Same as above B. Same as above C. Establishment of monitoring stations to indicate patterns and trends	Same as above Same as above Purchase equipment; Locate equipment at appropriate stations island-wide; Train persons in use of equipment, recording and analysis of data; Publicise information to relevant bodies;	Same as above Same as above Monitoring equipment; Transportation; Persons to train others; Mechanism for publicising information;	Same as above Same as above 2002-2005
Temperature impacts on above ecosystems	Ranching of turtles; Establishment of monitoring stations; Public Education; Enforcement of existing regulations;	A. Ranching of turtles	Select appropriate locations; Train persons in management of ranching of turtles;	Persons to train and be trained; Turtles;	2003-2006

			Obtain turtles for commencement of ranching;	Land;	
Impacts on water resources	Undertake ground water studies; Improve WASCO's infrastructure and operational efficiency; Develop and implement appropriate land use policy; Public education; Increase island-wide storage of rainwater;	A. Undertake ground water studies	Contract experts in ground water exploration; Train locals to understudy these experts; Analyse and publish results;	Finance Appropriate personnel	2003-2006
		B. Improve WASCO infrastructure and operational efficiency	Continue the process begun in these areas at WASCO; Adjust price rates;	WASCO resources	
		C. Develop and implement appropriate land use policy	Ensure that water resources are effectively protected in this policy; Restore and rehabilitate riverbanks and wetlands Establish policy of integrated watershed management;	Planting and geo-textile material; Community mobilisation; Legal draftsman	

		D. Public education E. Increase island-wide storage of rainwater	Reward conservation efforts; Raise roads and highways; Establish and enforce buffer zones on rivers and wetlands; Prevent construction in flood-prone areas; Relocate to hillier areas; Same as above Improve legislation and building codes; Public education; Enforce new legislation	Appropriate rewards Legal draftsman and enforcement officers plus skilled personnel; Community mobilisation Community mobilisation Legal draftsman Same as above Enforcement officers	

Impacts on agriculture, forestry and fisheries	Relocate inland; Redesign construction of infrastructure; Run utility lines underground or further inland; Construct and reinforce defense and berthing structures; Implement appropriate wildlife management measures; Implement water-based and water protection farming technology; Improve and enforce Land Conservation Act; Improve research and cultivation of salt resistant and salt tolerant crop varieties;	A. Relocate inland B. Redesign construction of infrastructure C. Run utility lines underground or further inland	Community mobilization; Improve and enforce legislation; Provide alternative housing for relocated population; Carry out studies on appropriate designs; Implement new Designs Carry out studies Implement results of studies Reinforce jetties and docks;	Community development officers; Legal draftsman Enforcement officers Land and building materials Contract skilled personnel; Appropriate personnel to understudy experts; Contract skilled personnel; Appropriate personnel to understudy experts; Contract skilled personnel;	2003-2006

		D. Construct and reinforce defense and berthing structures; E. Implement appropriate wildlife management measures;	Carry out impact assessment and construct sea defense structures; Carry out survey of status of habitats; Implement habitat rehabilitation; Increase and improve captive breeding measures; Monitor populations	Appropriate personnel to understudy skilled personnel; Wildlife officers Appropriate planting material; Land; Wildlife officers	
Impacts on tourism	Public Education Establishment and Enforcement of land use policy and legislation/ regulations Construction of sea defense structures Public participation in tourism development Strengthen legislative frameworks including EIA legislation/ regulations	A. Public Education B. Establishment and enforcement of land use policy and regulations/ legislation C. Construction of sea defense structures D. Public participation in tourism development	Same as above Same as above including decentralising coastal tourism development Same as above Develop policy and draft legislation to implement it by series of community and national consultations;	Same as above Same as above Same as above	2003-2006

			Enforce legislation; Educate public about benefits of participation in that process; Series of community and national consultations with special regard to EIA legislation and its importance; Include their submissions in amended legislation Public education on the new legislation; Enforce legislation	Legal draftsman to legislate policy produced; Committee to mobilise consultations; Enforcement/ Public education officers; Transportation; Audiovisual equipment; Committee to oversee consultations; Audiovisual equipment; Transportation; Public education and enforcement officers	
Impacts on human health	Public education; Increased medical supplies; Increased enforcement of health legislation; Increased efficiency in solid waste	Public education; Increased medical supplies;	Same as above Survey medical supply needs of country; Source supplies; Purchase supplies	Same as above Officers skilled in the process; Finance	2003-2006

	management systems; Including appropriate adaptation and relocation of landfill systems	Increased enforcement of health legislation;	Increase number of health officers employed; Increase rate of monitoring and surveillance; Mobilise support from judiciary through consultations; Vigorous public education on health legislation	Finance Skilled personnel Record keeping materials; Finance; Facilitator; Public education Officers; Transportation Audiovisual materials and equipment	
		Increased efficiency in solid waste management systems including appropriate adaptation and relocation of landfill systems	Increased efficiency in collection and disposal of solid waste; Increase number of service providers; Increase training for service providers; Increased enforcement of service providers;	Finance; Skilled personnel Finance Skilled personnel Increase number of Enforcement officers employed;	

			Increase Public education on correct methods of collection and disposal of solid waste; Monitoring of landfill sites; Re-engineering of disposal sites to withstand possible inundation; Relocation of landfill sites further inland	Finance; Audiovisual materials and equipment; Transportation; Skilled personnel; Skilled personnel; Finance; Land; Finance	
Impacts on educational system	Include climate change in the curricula at all levels including continuing education and adult education programs Development and enforcement of new building codes, standards and regulations for school infrastructure	Include Climate Change in all age curricula;	Local and national consultations with target groups; Drafting of new additions to curricula; Training of teachers and facilitators in imparting new curricula; Production of materials to impart new curricula;	Committee; Finance; Transportation; Audiovisual materials; Facilitators; Skilled personnel to write new curricula; Finance Skilled personnel	2002-2005

			Public education on new addition to curricula	Public education officers; Transportation Audiovisual materials and equipment	
		Development and enforcement of new building codes	Consultations with contractors and school officials to improve design of educational infrastructure to better withstand natural disasters; Include increased number of water tanks in schools;	Committee to undertake consultations; Facilitators Transportation Audio-visual equipment;	
			Drafting of new School Building Codes;	Finance and/or skilled proposal writer; Legal draftsman	
			Training for contractors;	Facilitators; Audiovisual equipment;	
			Enforcement of codes	Enforcement officers Finance	

4. POLICY CONSIDERATIONS

In view of the fact that climate change will affect all aspects of life on St. Lucia, it might well be appropriate to formulate a National Climate Change Policy. This policy should feed directly into a National Development Policy for the island. This climate change policy will set the backdrop for the development of a comprehensive climate change adaptation plan and strategy that will address the issues in the foregoing tables in a comprehensive coordinated manner. The National Development Policy will provide further support to the successful implementation of the climate change policy. Key elements of the climate change policy will include:

- Recognition of the fact that climate change is occurring and that it needs to be addressed;
- Resolution to address the issue in an integrated, holistic manner;
- An undertaking to develop plans and strategies through broad stakeholder participation;
- An undertaking to create the appropriate legal and institutional matrix for addressing climate change.

In formulating a national strategy/ action plan issues to be addressed will include:

- Institutional and legislative review;
- Determination of institutional and legal requirements;
- Institutional strengthening and capacity building;
- Incorporation of Climate change issues into the national planning matrix;
- Coordination;
- Monitoring, enforcement and evaluation;
- Public awareness and education;
- Stakeholder consultation, participation and involvement;
- Financial and other resources.
- The role of local government
- Sustainable energy policy

Some specific issues germane to the successful implementation of the strategy and action plan will now be further addressed:

Institutional Strengthening and Capacity Building/Linkages and Resource Allocation

In developing and formulating mechanisms to build capacity and strengthen institutions, it is important to take into consideration the resources that already exist in existing institutions. These resources would include studies that have already been undertaken, personnel that have been trained and their areas of skill and specialty, equipment and materials that are available in each institution. Through the National Development Policy, it should be mandated that close collaboration and networking among agencies be an integral aspect of work programs. The Integrated Development Planning process presently underway in the Ministry of Planning should take these suggestions into consideration to encourage agencies of Government to work much more closely together and thereby maximise and optimise the use of scarce resources.

Monitoring and Surveillance/Feeding Data Back into the Management Process

As the strategy indicates, much of the adaptation to climate change impacts will necessitate regular monitoring and surveillance activities. However these must not be seen as ends in themselves. The strategy further indicates that the records of data need to be analysed and the information fed back into the management and decision making process and the public domain, where necessary. Mechanisms must be established in the Climate Change Action Plan so that these ideas can be implemented for the smooth conveyance of information into the decision making process. The decision making process must always be current and up-to-date, cutting edge, in tune with the availability of information as soon as it becomes current. Again the Integrated Development Planning process of the Ministry of Planning should bear this point in mind when formulating its decision making procedures.

The Role of Local Government

Presently St. Lucia is in the process of developing and implementing a local government policy and management system. The participation of communities and the public will be critical to the successful implementation of the adaptation measures. The institution and activation of local government mechanisms should play an integral role in ensuring that the public and communities participate in the effective implementation of climate change adaptation measures. Hence the integrated development planning process should ensure that the climate change policy is taken into consideration into its development. An essential feature of the national action plan for climate change should be the role that local government should play in driving the successful implementation of adaptation measures.

Sustainable Energy Policy

St. Lucia has declared itself on the world stage as a Sustainable Energy Demonstration Country. When a country is able to utilize energy in a sustainable manner, many benefits may accrue to the environment and these will assist the country in adapting to the impacts of global climate change. Consequently, the island is currently in the process of finalising the development of a Sustainable Energy Plan. This Plan needs to be fed into the climate change and overall National Development process.

5.0 SUMMARY AND CONCLUSIONS

The effects of climate change will not be impacting an untouched pristine environment. They will be occurring in a situation where natural conditions have been significantly altered and where, in many respects, the resilience of natural systems have been greatly weakened, thus rendering these systems more susceptible. Policy responses to climate change will have to take these into consideration along with projected trends, such as population growth.

Depending on their level of severity, the effects of climate change could have significant impacts on the near-shore marine environment, coastal lands and infrastructure, agriculture, human settlements, water supply, tourism and health. In short, climate change could have a telling impact on all aspects of human existence on St. Lucia.

The response to climate change needs to be addressed in the immediate future, not when the signs have become overwhelmingly self-evident. This, *inter alia*, implies a need for convincing the general population and decision-makers that:

a. Climate change is happening;

b. It is in everyone's interest to do something about it;

c. The absence of absolutely conclusive data at the national level is no justification for inaction.

Any steps towards the formulation of a policy to address climate change must be broad-based and inter-sectoral. They must reflect the concerns of national and local government bodies, sectoral interests, resource users and civic groups. The policy must, in the end, be holistic and representative of all sectoral needs. It must address issues such as coordination and areas of responsibility. It is likely that some of the approaches to addressing climate change might involve doing what should have been done long ago, such as enforcement of setbacks and legislative review.

Critical issues to be addressed include:

- Review of legislation to ensure adequacy and to reduce overlap;
- Developing of effective mechanisms for coordination and collaboration between relevant entities;
- Monitoring, enforcement and evaluation;
- Mechanisms for feeding new data/information into the implementation/management process;
- Sensitisation and education of relevant interest groups;
- Incorporation of climate change issues into the planning process;
- Availability of financial resources;

- Human resource and institutional capacity considerations.

There will be economic and social costs to be incurred in addressing climate change. It is important to note however that many strategic developments presently underway in St. Lucia, like the Integrated Development Planning Process and the Disaster Mitigation Plan currently being undertaken and revised, in the Ministry of Planning and the National Emergency Management Organisation respectively, will lend themselves quite effectively to the adaptation plans and policy for Climate Change. Further, addressing climate change might not require the establishment of many, or any, new institutions. Rather, it might mean that existing entities have to place emphasis on the aspects of their work which feed into the climate change process.

A Climate Change Policy should not be seen as starting totally from a clean slate, but rather, building on existing systems and creating appropriate new linkages. As indicated earlier, there will be a cost to addressing climate change and this may require the diversion of resources away from “productive” economic activity. Government and other relevant entities may consider the opportunity cost too high in the short term. However, it must be remembered that any action taken towards adapting to climate change will be in an effort to safeguard the economic and well-being, and the ultimate survival of St. Lucia as a nation. On the other hand, failure to take the concrete actions necessary to address climate change is likely to prove far more costly in the long run.

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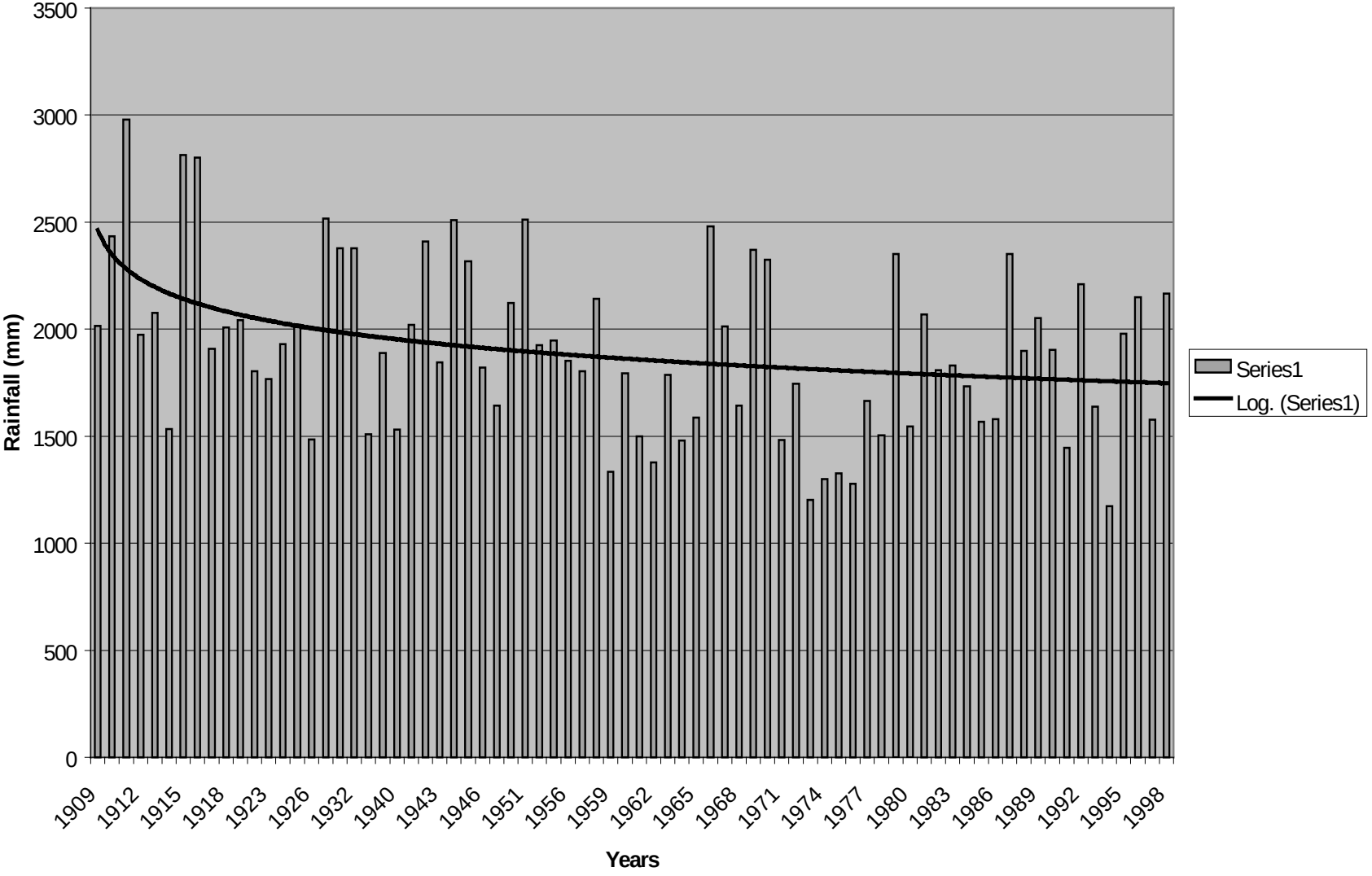
APPENDICES

RAINFALL RECORDS FOR SELECTED STATIONS

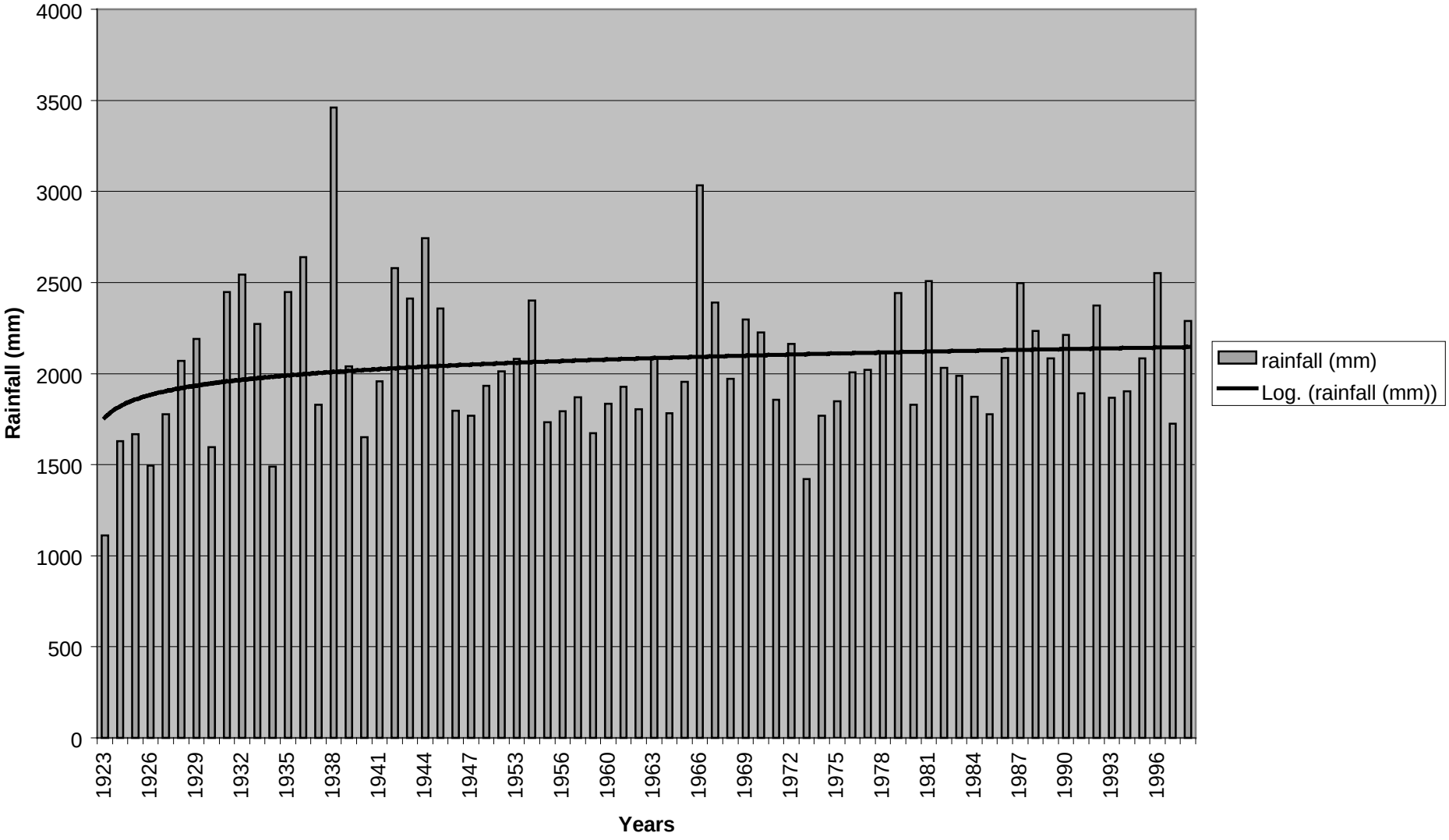
Source:

Mr. Lyndon John, Research Officer
Ministry of Agriculture

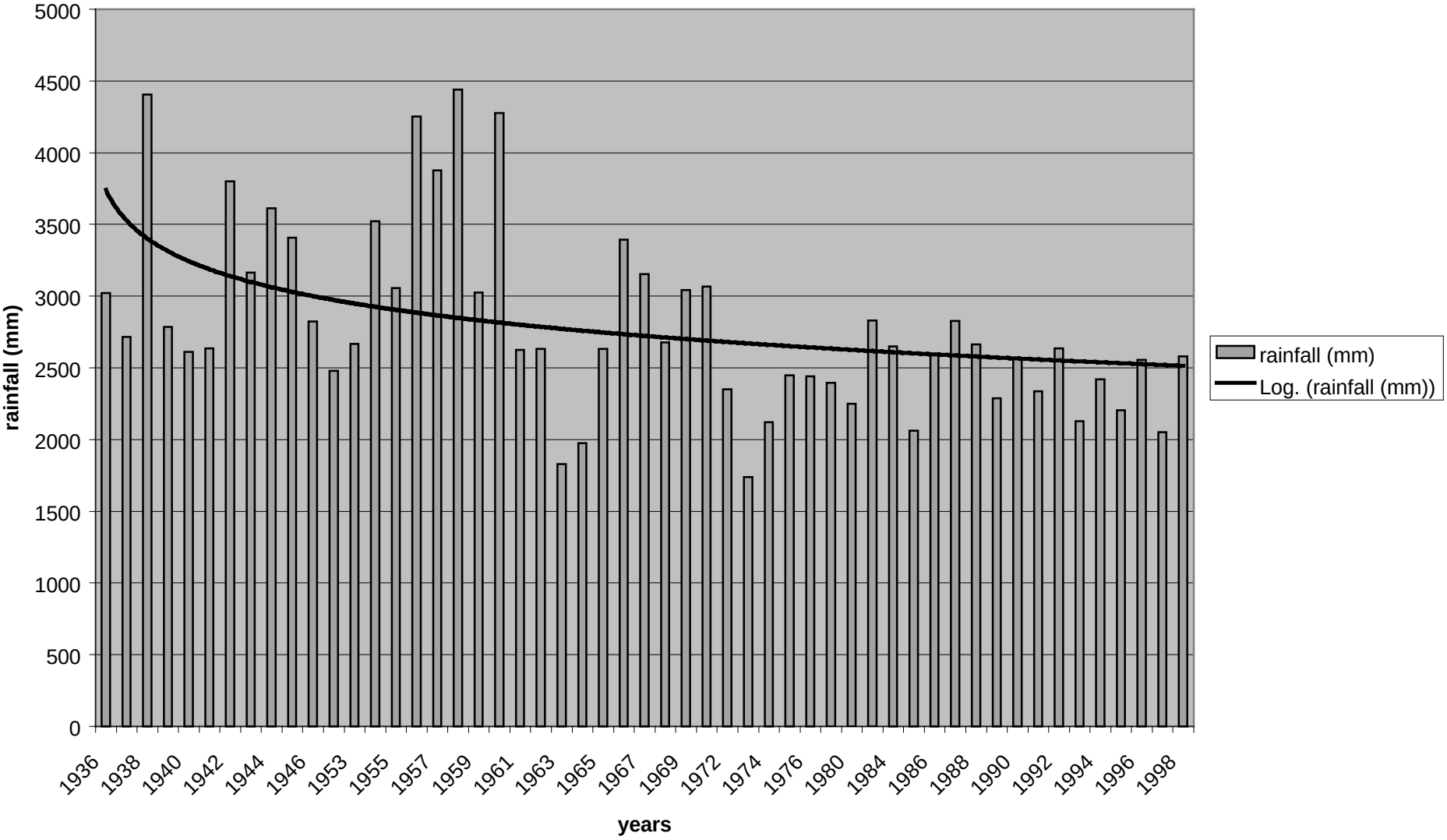
Marquis Rainfall records (1909-1998)



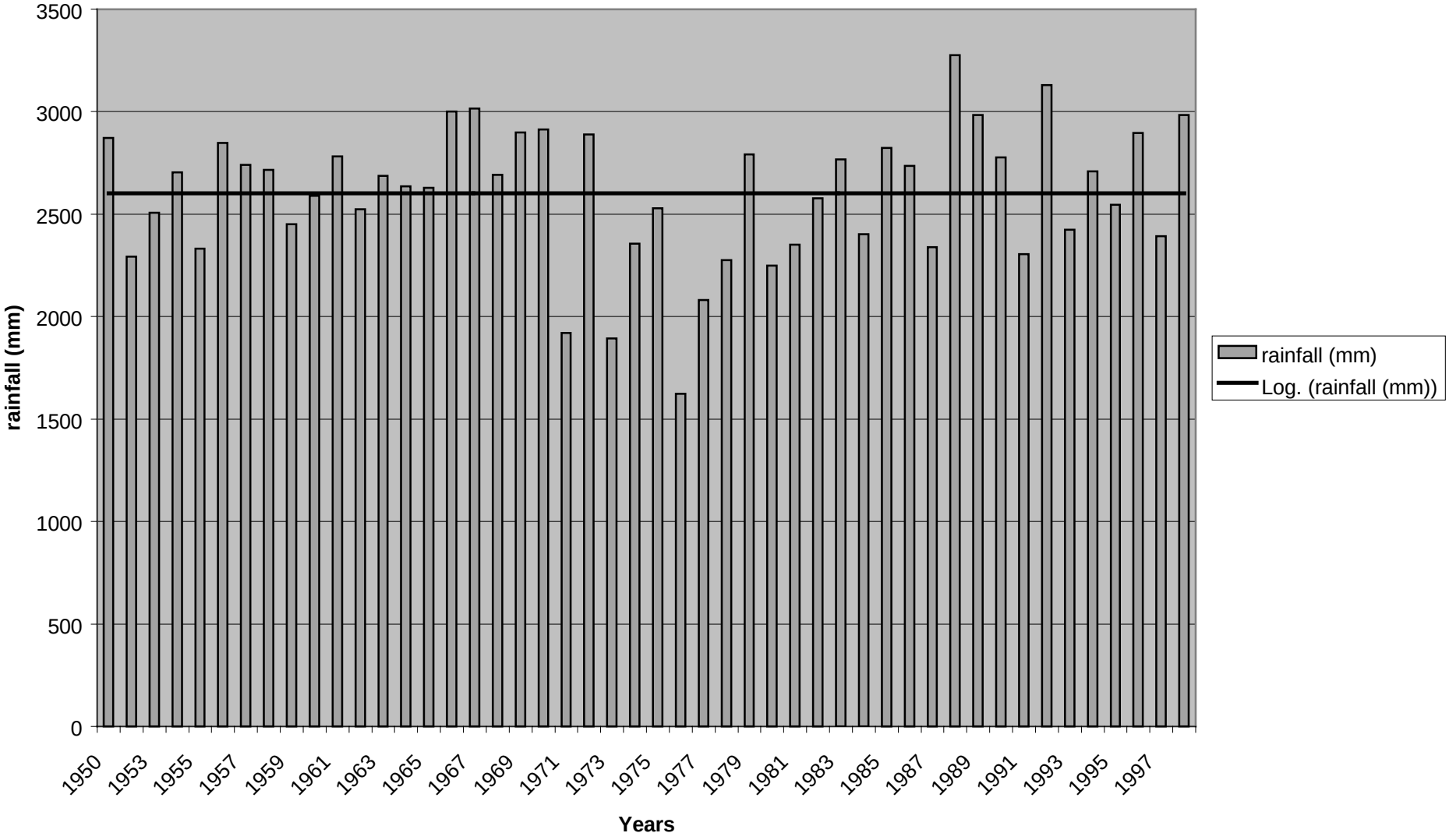
Union Agric. Station Rainfall (1923-1998)



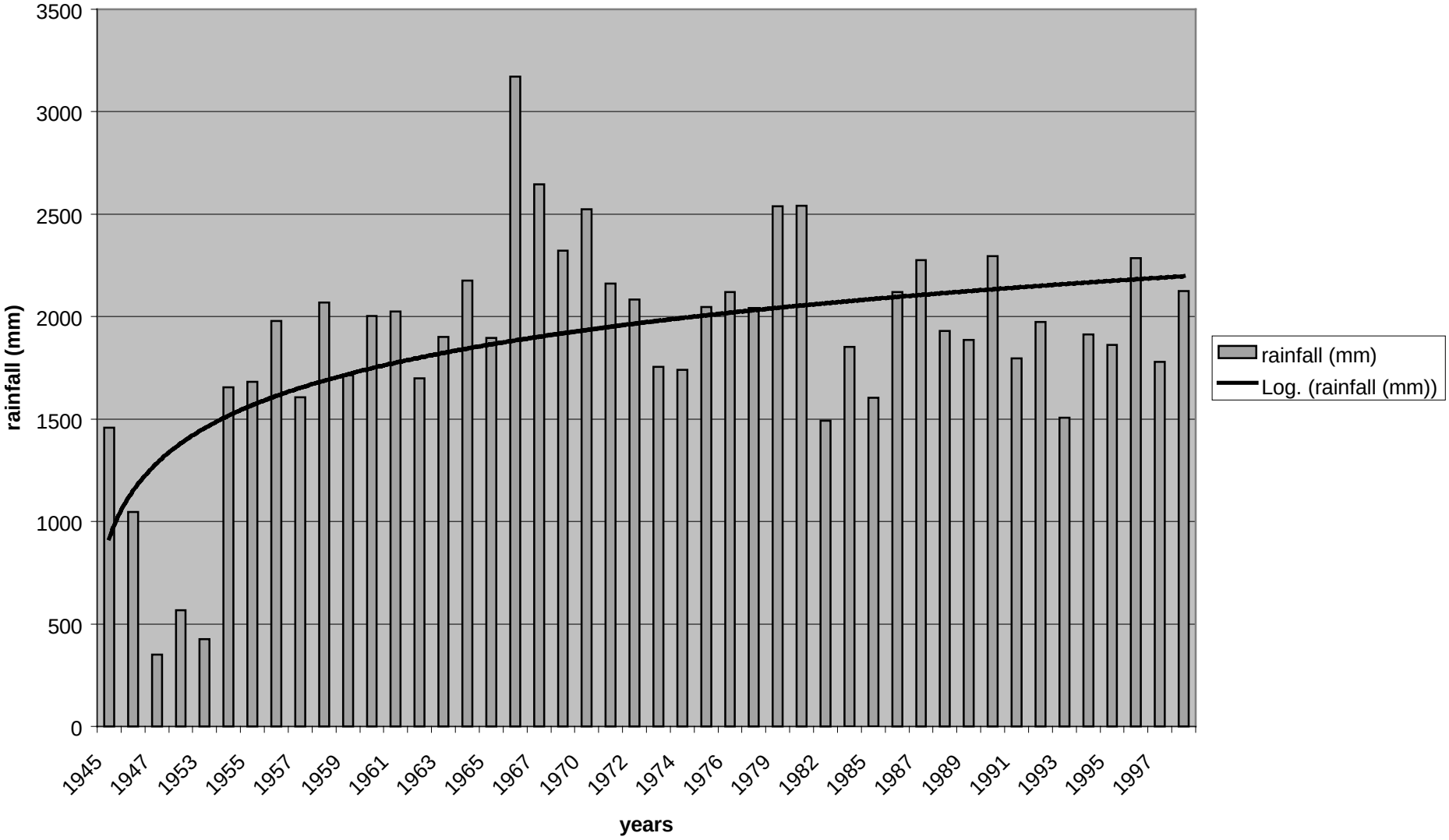
Barre de L’isle rainfall (1936-1998)

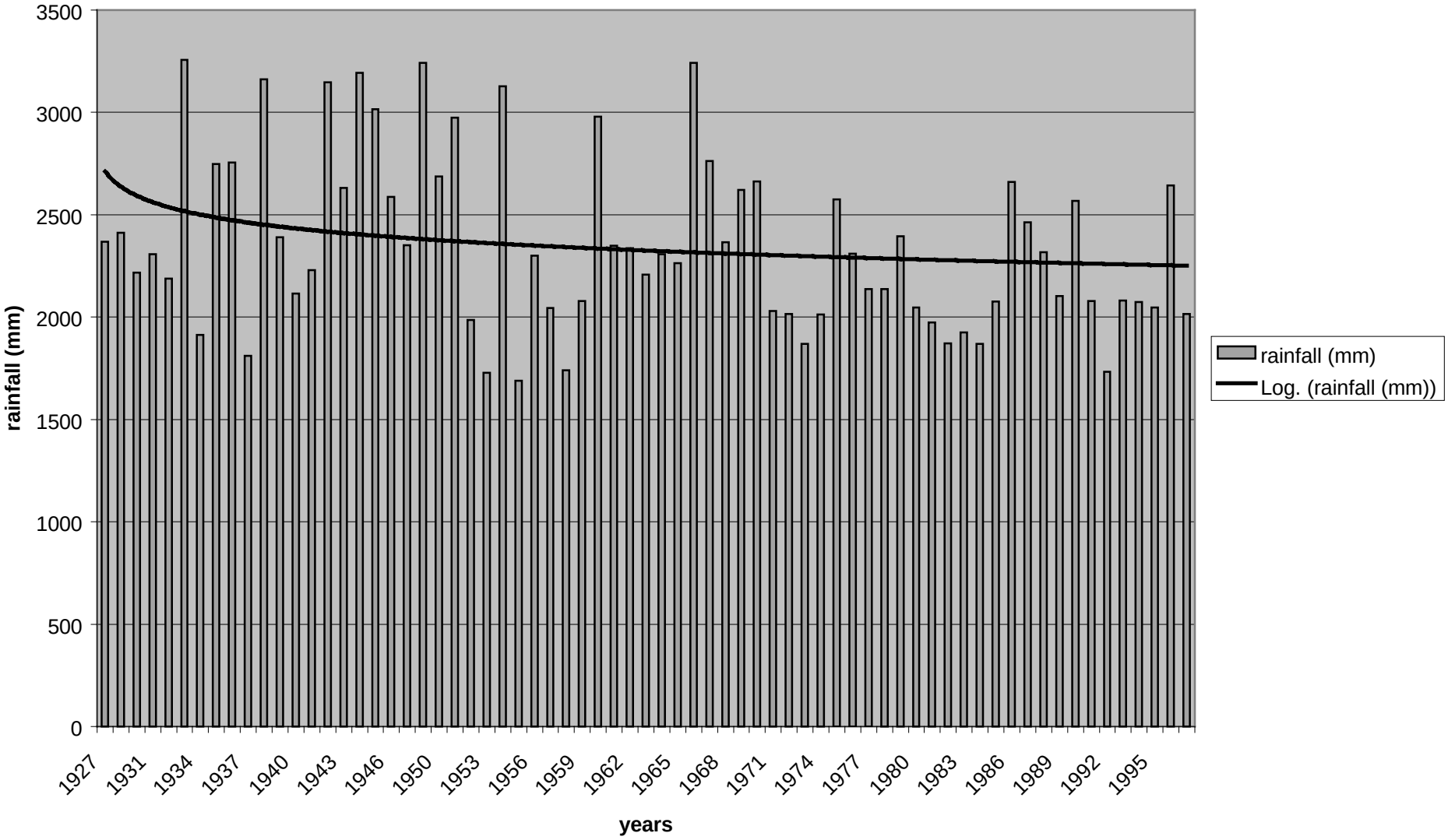


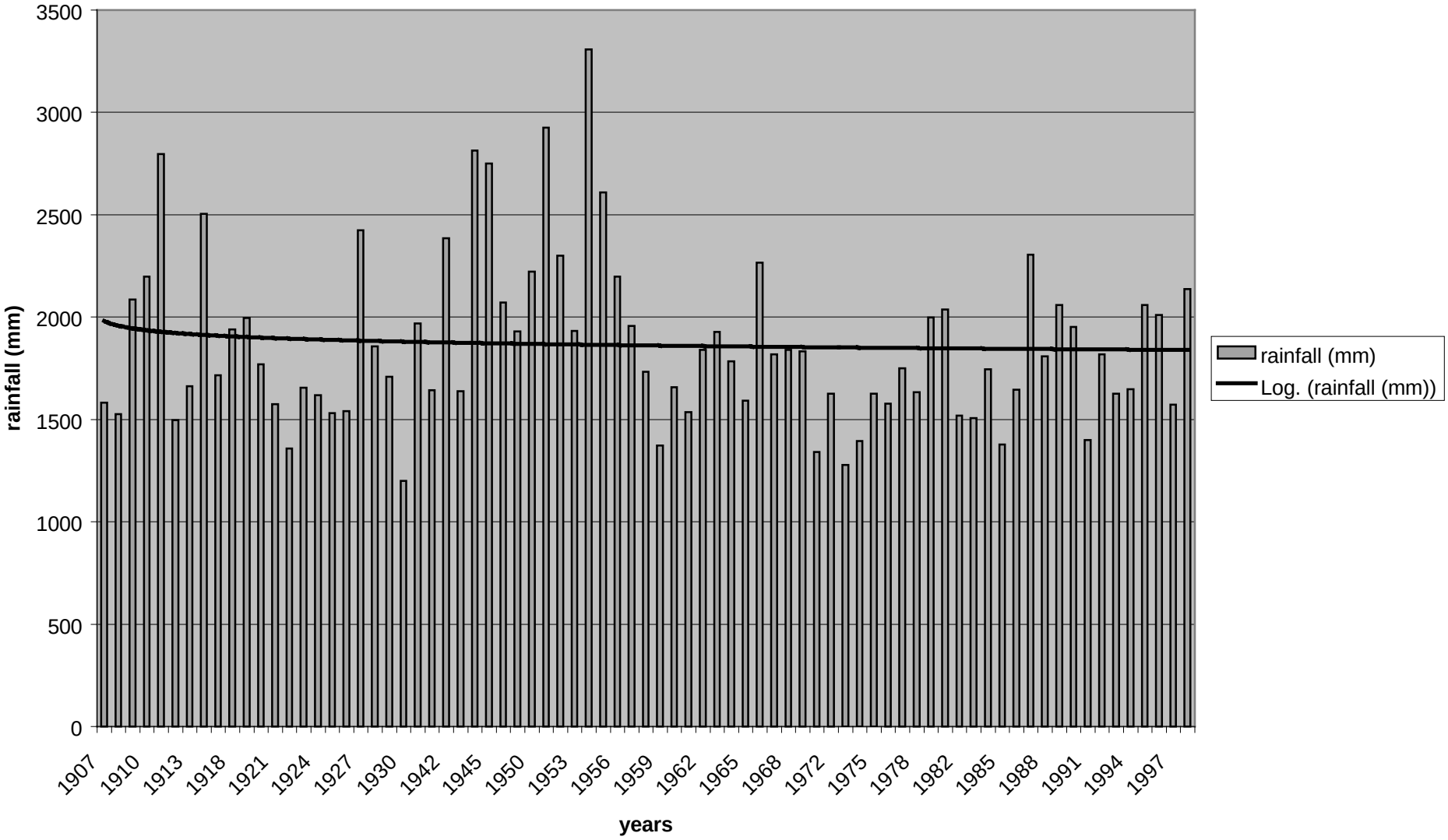
Barthe Nursery rainfall (1949-1998)

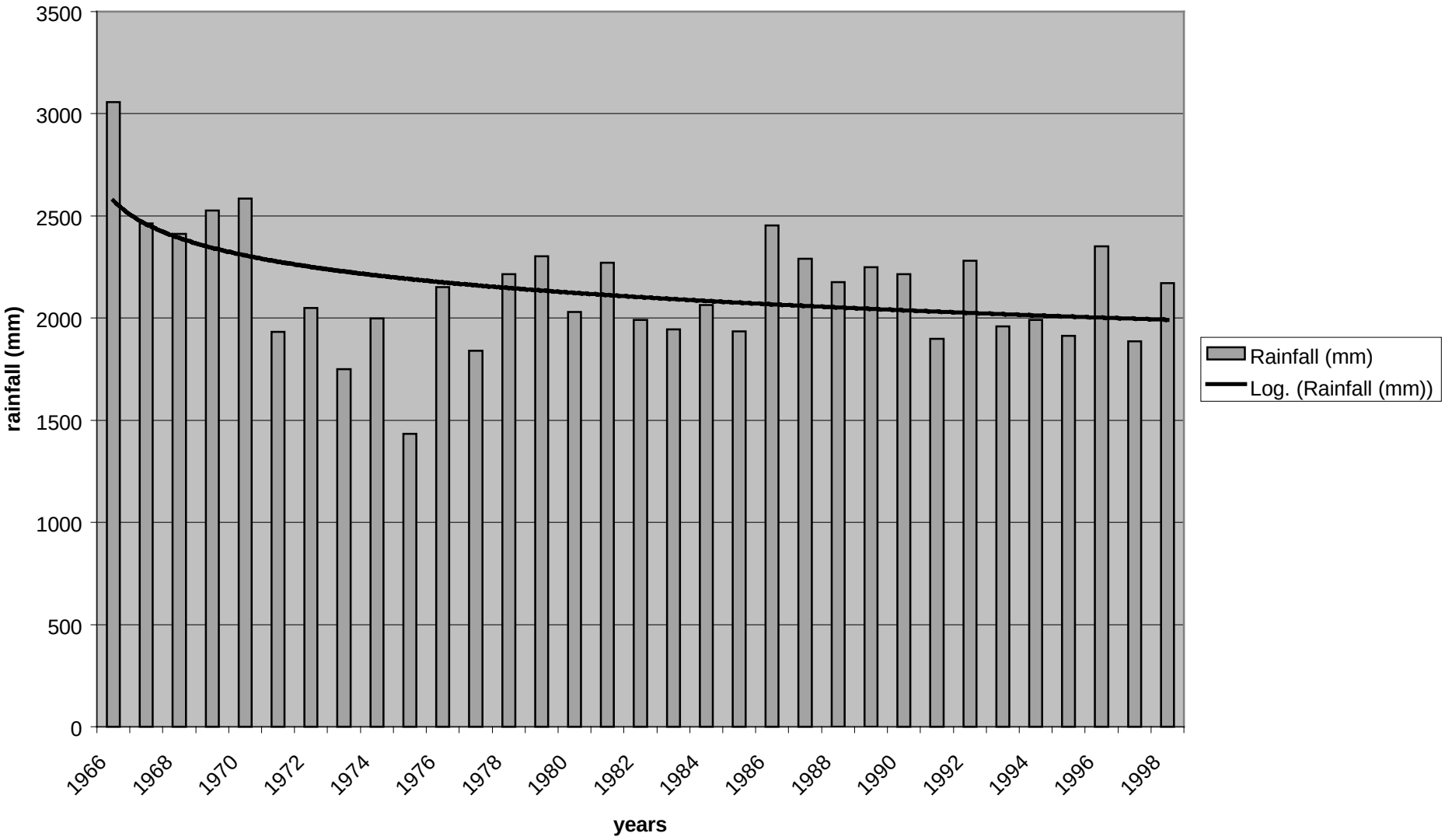


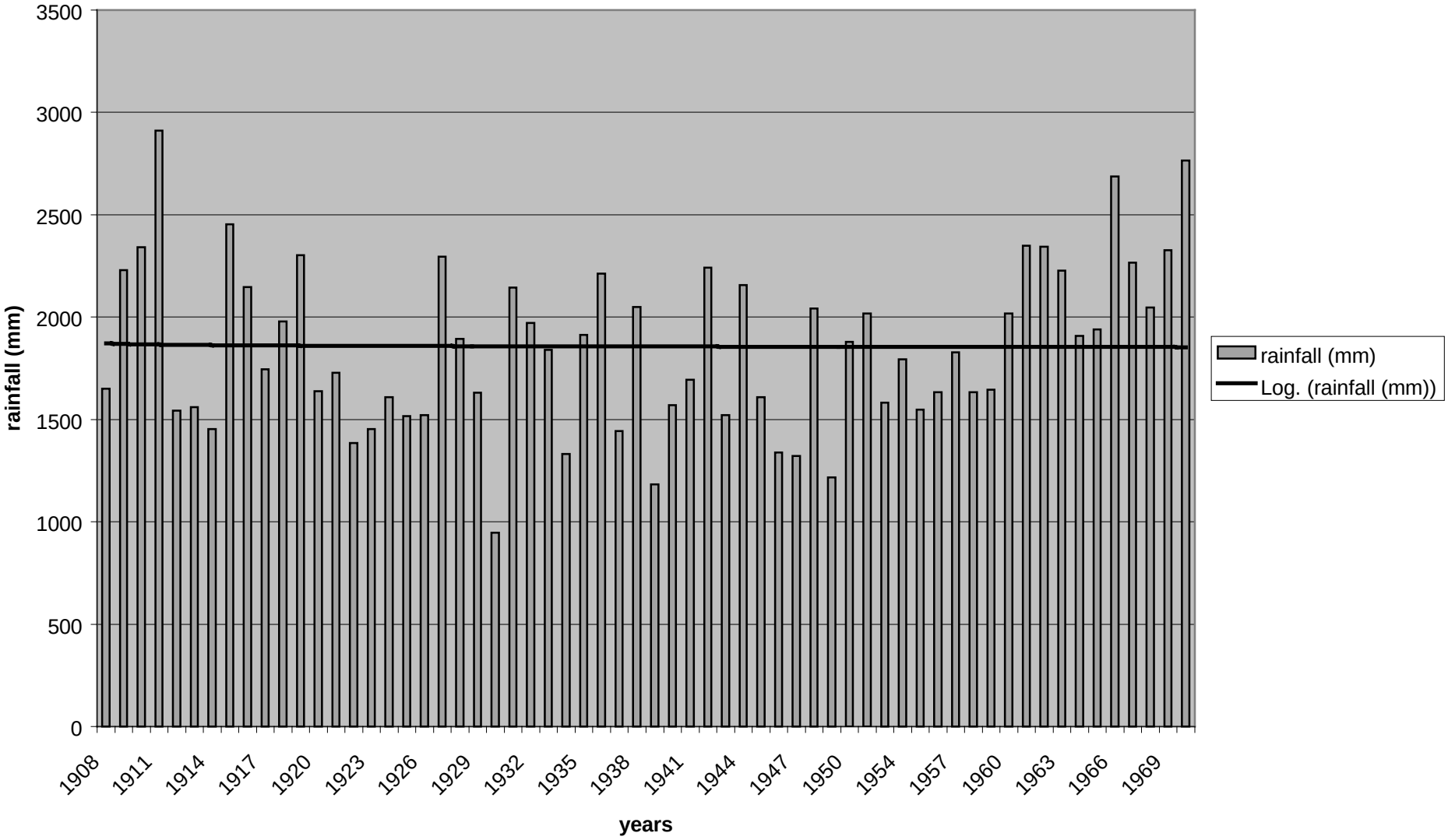
Government House rainfall (1945-1998)




Soucis rainfall (1927-1997)
rainfall (mm)
3500
3000
2500
2000
1500
1000
500
0
1927
1931
1934
1937
1940
1943
1946
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
years
rainfall (mm)
Log. (rainfall (mm))


La Caye rainfall (1907-1998)
rainfall (mm)
3500
3000
2500
2000
1500
1000
500
0
1907
1910
1913
1918
1921
1924
1927
1930
1942
1945
1950
1953
1956
1959
1962
1965
1968
1972
1975
1978
1982
1985
1988
1991
1994
1997
years
rainfall (mm)
Log. (rainfall (mm))


WINBAN rainfall (1966-1998)
3500
3000
2500
2000
1500
1000
500
0
rainfall (mm)
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
years
Rainfall (mm)
Log. (Rainfall (mm))


Mamiku Estate rainfall (1908-1970)(1970-1980 missing)
3500
3000
2500
2000
1500
1000
500
0
rainfall (mm)
1908
1911
1914
1917
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
1954
1957
1960
1963
1966
1969
years
rainfall (mm)
Log. (rainfall (mm))