Caribbean Community
Climate Change Centre

IMPACT ASSESSMENT REPORT AND NATIONAL ADAPTATION STRATEGY AND ACTION PLAN TO ADDRESS CLIMATE CHANGE IN THE TOURISM SECTOR OF SAINT LUCIA
VOLUME I

Prepared for the
Caribbean Community Climate Change Centre
Belmopan, Belize
and the
Government of Saint Lucia

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Impact Assessment Report and National Adaptation Strategy and Action Plan to Address Climate Change in the Tourism Sector of Saint Lucia Volume I

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For more information visit:

- The Global Climate Change Alliance website: http://www.gcca.eu/
- The African, Caribbean and Pacific Secretariat website: http://www.acp.int/
- The Caribbean Community Climate Change Centre website: http://www.caribbeanclimate.bz
- Ministry of Sustainable Development Energy, Science and Technology: Sustainable Department Environment Division website: http://sustainabledevelopment.govt.lc/

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List of Acronyms

CARIFORUM	The Caribbean Forum
CCCCC	Caribbean Community Climate Change Centre
CCCRA	CARIBSAVE Climate Change Risk Atlas
CDB	Caribbean Development Bank
CIMH	Caribbean Institute for Meteorology and Hydrology
CTA	Technical Centre for Agricultural and Rural Cooperation
CZMU	Coastal Zone Management Unit
DCA	Development Control Authority
DGIS	Netherlands Directorate-General for International Cooperation
DFID	UK's Department for International Development
DVRP	Disaster Vulnerability Reduction Project
EC	Eastern Caribbean
ECCB	Eastern Caribbean Central Bank
ECCU	Eastern Caribbean Currency Union
EIA	Environmental Impact Assessment
ESL	Environmental Solutions Limited
EU	European Union
EU GCCA	European Union Global Climate Change Alliance
FAO	Food and Agriculture Organisation
GEF	Global Environment Facility
GOSL	Government of Saint Lucia
GWP	Global Water Partnership
HDI	Human Development Index
IDB	Inter-American Development Bank
IFAD	International Fund for Agricultural Development

IPCC	Intergovernmental Panel on Climate Change
MAFPFCRD	Ministry of Agriculture, Food Production, Fisheries, Co-operatives & Rural Development
MEHRDL	Ministry of Education, Human Resource Development and Labour
MFEASS	Ministry of Finance, Economic Affairs and Social Security
MHWHSGR	Ministry of Health, Wellness, Human Services and Gender Relations
MIPST	Ministry of Infrastructure, Port Services and Transport
MPDHUR	Ministry of Physical Development, Housing and Urban Renewal
MSDEST	Ministry of Sustainable Development Energy Science and Technology
MTHCT	Ministry of Tourism Heritage and Creative Industries
NASAP	National Adaptation Strategy and Action Plan
NCA	National Conservation Authority
OECS	Organisation of Eastern Caribbean States
OECS	Organisation of Eastern Caribbean States
PAHO	Pan American Health Organisation
PPCR	Pilot Program for Climate Resilience
RCP	Representative Concentration Pathways
SIDS	Small Island Developing States
SLASPA	Saint Lucia Air and Sea Ports Authority
SLNT	Saint Lucia National Trust
SLR	Sea Level Rise
SLTEPA	Saint Lucia Trade Export Promotion Agency
SMMA	Soufrière Marine Management Area
SMMA	Soufriere Marine Management Association
SRDF	Southern Regional Development Foundation
STDC	Southern Tourism Development Corporation
SST	Sea Surface Temperatures
UKAid	United Kingdom Aid

UNDP	United Nations Development Programme
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
UWI	University of the West Indies
WASCO	Water and Sewerage Company Inc.
WHO	World Health organisation
WRMA	Water Resources Management Agency

Executive Summary

Saint Lucia experiences several stresses with the onset of climate change, issues related to droughts during unusually extended dry periods and significant flooding and subsequent damage from tropical systems have been high on the agenda.

These challenges along with the significance of the tourism sector to the Saint Lucian economy and its exposure to climatic threats, the country is vulnerable to large-scale global economic and environmental shocks and stresses. Given the challenges faced, the Government of Saint Lucia sought funding to address climate change impacts on the tourism sector and mainstream climate change adaptation measures into national development through this project.

Funding was received through the Caribbean Community Climate Change Centre (CCCCCs) from the European Union under the Global Climate Change Alliance (EU GCCA) Caribbean Project. The EU GCCA Project aims to assist participating countries to develop the capacity to design and implement climate change adaptation policies and measures. The following analyses were completed for Saint Lucia in order to inform both Volumes of this Final Report: 1. Final Impact Assessment and 2. National Adaptation Strategy and Action Plan (NASAP) report. The Impact Assessment involved several assessments, these included:

1. Climate Analysis and Projections
2. Tourism Sector Assessment
3. Economic Assessment
4. Policy and Legislative Assessment

These assessments were informed by stakeholder consultations, a literature review and historical climate and tourism data. Limitations for these assessments were largely associated with the inadequacy or absence of data sets that would improve the analyses conducted.

The results of the assessments helped to inform the development of the National Adaptation Strategy and Action Plan (NASAP) recommended for the tourism sector in Saint Lucia. This was developed in consultations with the Stakeholders in May and July 2015.

Impact Assessment

The results of the climate analysis indicated that the annual mean temperature of Saint Lucia is projected to increase irrespective of scenario, model or methodology used. GCMs suggest that the mean annual temperature over Saint Lucia will increase by 0.3 to 1.2˚C by the 2030s and 0.5 to 2.1˚C by the 2060s, relative to 1970-99 with warming occurring at a faster rate in the north of the island than in the south by the 2030s (1.313 versus 1.231°C).

Through the 2030s median changes in rainfall projections deduced from GCMs are all negative, which may suggest drier conditions. RCM ensemble mean suggests decreases in annual rainfall by greater than 5%. Consistent with the GCM projections, the PRECIS RCM suggests a decrease in rainfall intensity towards the end of the century. The RCM, however, suggests that this decrease in rainfall intensity may be accompanied by a decrease in mean dry spell length.

RCM ensemble means suggest an increase in wind speeds annually by up to 0.06 m/s. Hurricane intensity over the north tropical Atlantic is likely to increase (as indicated by stronger peak winds and more rainfall), but not necessarily hurricane frequency. Caribbean sea levels are projected to rise by up to 0.24 m by mid-century under the A1B scenario.

Global warming describes the steady increase in average atmospheric and ocean temperatures. This basic change has far reaching consequences as the climate system is extremely complex and interlinked.

Increasing temperatures, sea level rise, more intense hurricane events, and rainfall extremes translate to a greater chance of drought and flood events. These physical changes then create a full spectrum of impacts for the ecosystems that support human life, the built environment, health and way of life.

Saint Lucia's tourism sector has a number of inherent characteristics that make it very vulnerable to these threats, including fragile natural systems, existing high environmental impacts and development pressures of the built tourism structures, focused coastal tourism development, limited human and financial resources, limited access to technology, an open economy, and propensity to extreme weather events.

It cannot be overemphasized that climate change is not just an environmental issue, it is equally an economic issue, a disaster management issue, a food security, a human health issue, and a quality of life issue – this makes climate change everyone's business and a cause for concern and action at the individual, community, organizational, and country level. In some areas the tourism community is taking steps to implement sound environmental practices within the operations of their tourism facilities. Although this is a most welcoming move, the entire tourism community needs to follow suit.

While the impacts of climate change are diverse and costly, they can also be manageable, in most cases, through implementation of well-established best management practices and strengthening of existing legislation, policies, institutions, and programmes.

The main legislation guiding the tourism sector (primarily dealing with incentives) are the Tourism Incentives Act, 1996 and the Tourism Stimulus and Investment Act, 2014. However, tourism is affected by a vast array of legislative instruments including the Physical Planning Act, which governs the siting of hotels. However, whilst provision for EIA is contained in this Act, no EIA regulations have been promulgated to effectively deal with this issue (through draft EIA regulations have been proposed but not approved by Cabinet). The Public Health Act and its regulations also affect sanitation, public health measures, etc. However, they are not adequate or comprehensive regulations to address pollution issues in the county – this gap would also affect the tourist sector. Ecotourism and related activities would also relate to the legal and institutional aspects in other sector e.g. Forest, Soil and Water Conservation Ordinance and the Rules. The Wildlife Protection Act and Saint Lucia National Trust Act are also relevant. The Beach Protection Act affects the issue of beaches, which is highly relevant to the tourism sector. Any improvement in the legislative structure affecting national resource management will be directly relevant to the tourism sector. So draft legislation such as the draft Forest Act, the draft Environmental Management Act, the draft EIA

regulations will enhance the regulatory framework for the tourism sector if they are approved by Cabinet and enacted or in the care of the legislation promulgated by the appropriate Minster.

Despite the existence of some legislation, misuse of land, water, mangrove, swamps and other natural resources has proceeded loyally unchecked in Saint Lucia for years. There are still significant gaps in the policy and legislative framework. In addition, there exist a comprehensive number of institutions. Some of the key agencies include Forestry Department, NEMO, CZMU, Solid Waste Management Authority, Physical Planning Department, the Environment Health Unit etc. Many of these key institutions need to be strengthened both in terms of staffing and technical capacity.

The urgency for the tourism sector to address the issues faced, is related to the threat to the facilities, the environmental services, and the natural resource based attractions for visitors. This is in addition to the impact of climate change in the source countries on people's desire and affordability for vacations in Saint Lucia. Warmer winters, anxiety and fears of violence and disease, loss of the appeal of natural attractions, such as the marine environment, and weak incomes will further discourage demand for vacations in Saint Lucia.

National Adaptation Strategy and Action Plan

The aim of the NASAP is to address the anticipated adverse effects of climate change on the tourism sector discussed in the findings. The strategy covers a 5 year period 2016-2021 and outlines three national outcomes for the tourism sector.

1. Improved, policy, legal, regulatory, and institutional framework for the tourism sector
2. Improved technical and institutional capacity for the tourism sector
3. Enhanced and improved training and awareness in relation to climate change and the tourism sector

Expected results (output) are presented along with the actions to meet the defined objectives. The timeline for each activity is given, along with an indicative cost, where possible, and the responsible agencies (lead and partner). The table below outlines a summary budget for the three strategic outcomes. The objectives within each outcome have multiple activities, some of which have only been costed for partially.

OUTCOMES	NO. OF OBJECTIVES	INDICATIVE COSTS US$
Outcome 1 Improved, policy, legal, regulatory, and institutional framework for the tourism sector	10	535,000
Outcome 2 Improved technical and institutional capacity for the tourism sector	28	2,476,000

OUTCOMES	NO. OF OBJECTIVES	INDICATIVE COSTS US$
Outcome 3 Enhanced and improved training and awareness in relation to climate change and the tourism sector	3	415,000
TOTAL	**42**	**3,421,000**

The implementation of the NASAP for the tourism sector has to be monitored and evaluated will be done on an annual basis in conjunction with all lead and partner agencies referred to in the NASAP. This is important for transparency and accountability. The Ministry with responsibility for Tourism is expected to take the lead, in collaboration with partner agencies, as necessary.

Recommendations were also made for changes in Tourism and other supporting sectors to be monitored. A monitoring programme should be developed and it is expected that the Ministry with responsibility for Tourism will prepare evaluation reports for submission to the relevant authority.

Report Layout

This document presents the Draft Impact Assessment and National Adaptation Strategy and Action Plan (NASAP) for the project. The report has been divided into two volumes: Volume I, which presents the Impact Assessment and Volume II, which presents the NASAP.

Under Volume I: Chapter 1 outlines the contextual background, methodology and limitations for the study; Chapter 2 and 3 present the climate variability and change assessment; the tourism sector vulnerability issues and threats are presented in Chapter 4; the economic analysis is in Chapter 5; and the policy, legislative and institutional review is in Chapter 6;. Volume II presents the strategic objectives, outcomes and recommended activities in Chapter 7.

VOLUME I

1 Introduction

1.1 Purpose

Environmental Solutions Limited (ESL) has been contracted by the Caribbean Community Climate Change Centre (CCCCC) to execute the project: ***National Adaptation Strategy and Action Plan to address Climate Change in the Tourism Sector, Saint Lucia.*** This project is a part of the overall European Union Global Climate Change Alliance (EU GCCA) Caribbean Support Project, which is being executed by the CCCCC. The EU GCCA Project aims to assist participating countries to develop the capacity to design and implement climate change adaptation policies and measures. It seeks, among other things, to incorporate and mainstream climate change adaptation issues into the national development and planning processes and mechanisms in order to enhance the economic and social development of the individual participating countries in particular, and the Caribbean as a whole.

The Project has two main objectives:

a. To conduct an Impact Assessment of climate change and climate variability on the tourism sector in Saint Lucia and using the report generated to prepare a National Adaptation Strategy and Action Plan (NASAP) for the sector; and

b. To facilitate buy-in and foster ownership of the NASAP by key stakeholders, through a collaborative and consultative process.

The impact assessment examines a way forward for the tourism sector, in light of climate change impacts and will provide critical inputs for the development of the National Adaptation Strategy and Action Plan. The NASAP is expected to build on past and current initiatives and chart the way forward for the tourism sector viz-a-viz climate change, in key areas, including water, coastal/marine, physical planning, health, food security, etc.

1.2 Contextual Background

1.2.1 Country Profile

1.2.1.1 Location

Saint Lucia is located in the Eastern Caribbean section of the Caribbean archipelago. It is one of the larger islands in the Lesser Antilles with an area of 616 square kilometres (238 square miles). Saint Lucia is part of the Windward Island group of nations, which extend from Grenada in the south to Dominica in the north. Its nearest neighbours are Martinique, at 34 kilometres (21 miles) to the north and Saint Vincent, at 42 kilometres (26 miles) to the southwest. Saint Lucia is sub-divided into eleven districts and its capital is Castries (Figure 1.1).

Figure 1.1: Saint Lucia: Districts

1.2.1.2 Physical Environment

The island is made up of a central ridge running from north to south, which is dissected by rivers that form broad valleys in some areas. Its highest peak is Mount Gimie, which rises to 958.6 metres (3145 feet). As a result of its volcanic origin, the country consists of fertile volcanic soils. Other evidence of its volcanic history includes The Pitons volcanic plugs in Soufrière and the world's only "drive-in volcano", which are located in the south-western portion of the island (Figure 1.2).

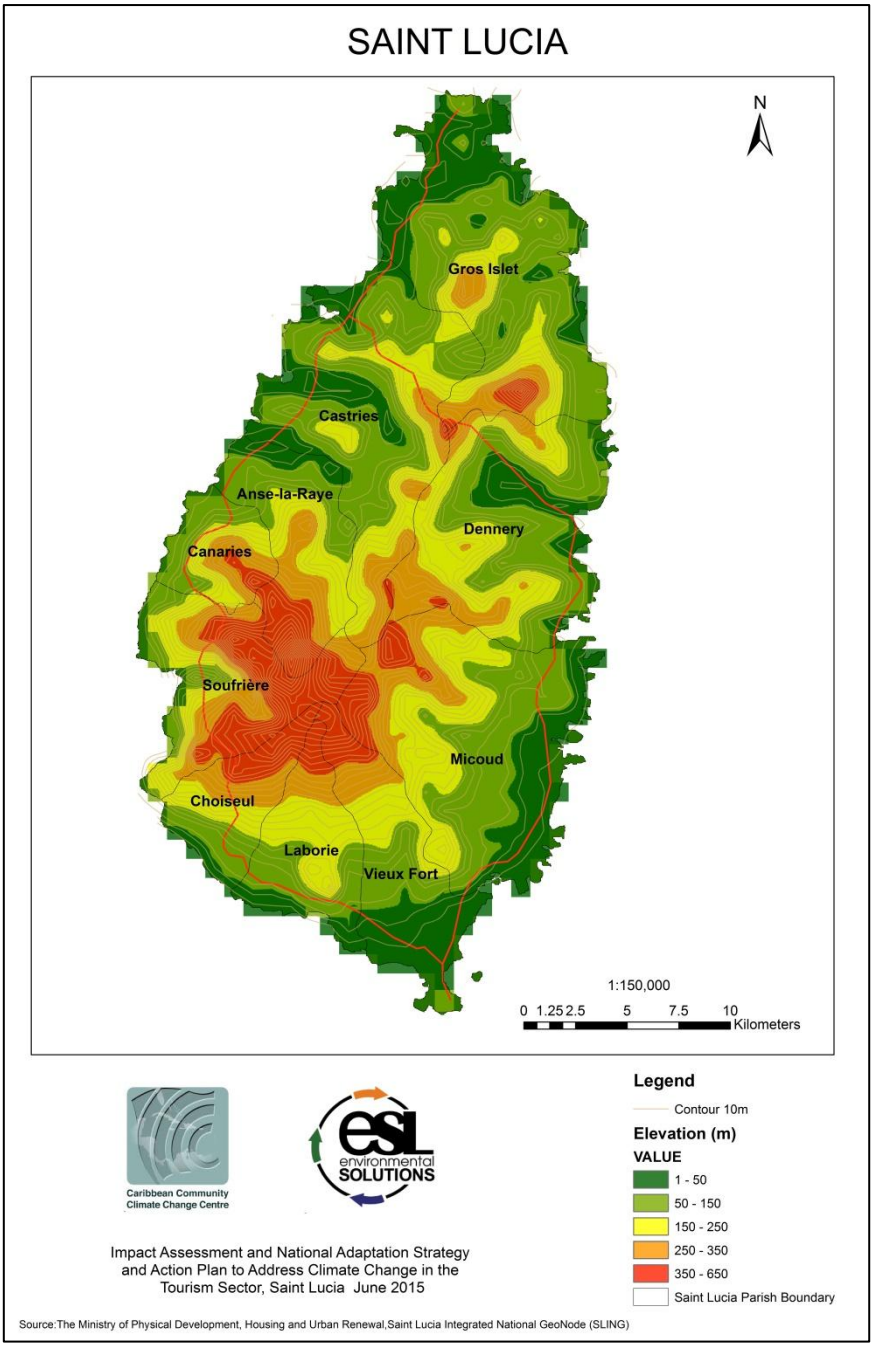


Figure 1.2: Saint Lucia: Topography

Saint Lucia has a tropical maritime climate, moderated by the north east trade winds, with two seasons. The dry season extends from December to April and the rainy season from May to November. The latter coincides with the Atlantic hurricane season. The average temperature in Saint Lucia is 27°C (80°F), while average rainfall ranges from 1295 millimetres (51 inches) per year along the coast to 3810 millimetres (150 inches) per year in the mountainous interior (Figure 1.3).

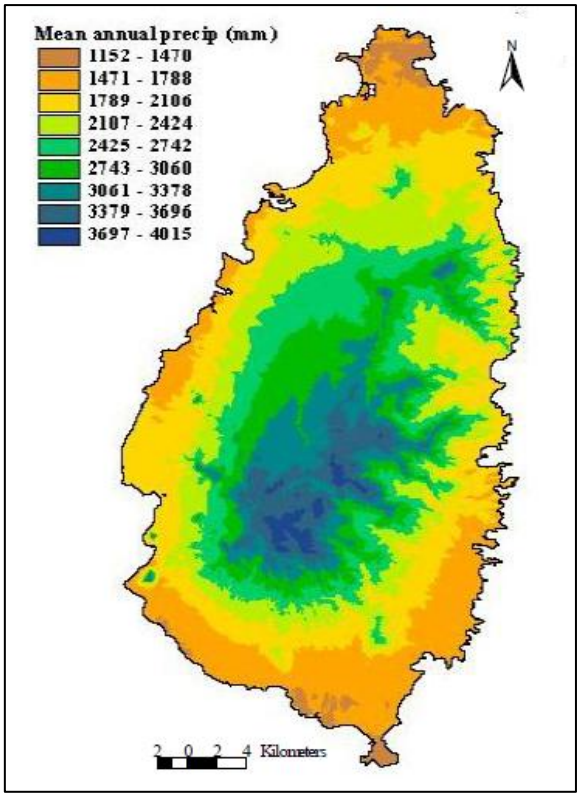


Figure 1.3: Distribution of Saint Lucia's Mean Annual Rainfall (Source: Isaac and Bourque, 2001)

Additionally, Saint Lucia has a rich ecology. The island has various ecosystems, which range from dry cactus scrubs, to rainforests, to mangroves and coral reefs. Its forest habitat is diverse and supports a wide variety of species. In fact, the island is home to over 200 endemic species of plants and animals. The country's natural resources include forests, beaches, minerals (pumice) and mineral springs.

Saint Lucia has over 20 protected areas, including Pigeon Island National Landmark, Maria Island Nature Reserve and the Soufrière Marine Management Area (SMMA). Furthermore, Mankoté Mangrove and Savannes Bay are Ramsar wetland sites, while the Pitons Management Area (PMA), in addition to being a local Environmental Protection Area, was designated as a UNESCO World Heritage Site in 2004.

Land use, as indicated in Figure 1.4 below, shows the location of urban settlements and much of the tourism development as largely coastal. Much of the farming activities in Saint Lucia is evident on slopes and in the interior, just below the areas demarcated as natural forests.

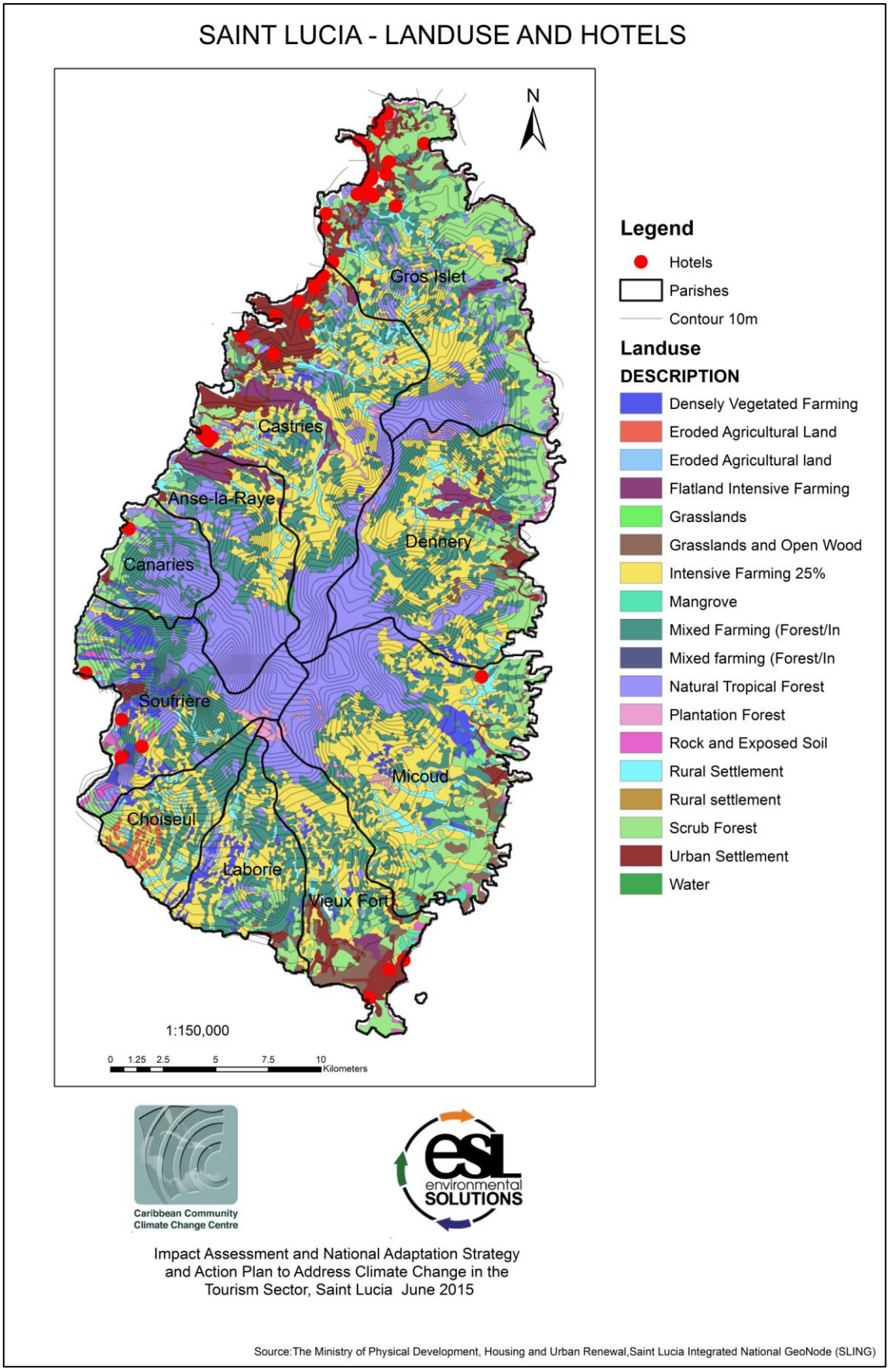


Figure 1.4: Land Use in Saint Lucia

1.2.1.3 Socio-demographic Profile

In 2014, the Government's Economic and Social Review of Saint Lucia estimated that the country had a population of 172,623. About a third of this figure lives in the capital, Castries. A large proportion of the population also resides in the narrow coastal zone of the island.

Although the population continues to grow, Saint Lucia's population growth rate has declined from 1.2% in 2010 to 0.7% in 2014[1]. Saint Lucia has a fairly young population, with approximately 78% of persons being under the age of 50. Additionally, the country's youth (persons 15-29 years old) makes up about 26% of its population[2].

The 2010 Census reported the country's population density as 796 persons per square mile (305 persons per square kilometre). However, densities in the different districts of Saint Lucia ranged from a high of 2,139 persons per square mile (822 persons per square kilometre) in Castries to a low of 434 persons per square mile (167 persons per square kilometre) in Soufrière[3].

Over the years, the standard of living in Saint Lucia has increased, with many households now having access to basic amenities. Many demographic indicators have also improved. For instance, life expectancy has increased, while fertility rates have decreased. Adult literacy is also quite high at 94.5 percent. Education is free up to secondary level for Saint Lucians since 2006. In 2013, Saint Lucia scored 0.714 on the Human Development Index (HDI), making it fall into the high human development category.

Poverty and inequality remain a concern for Saint Lucia. The most recent poverty assessment (2005/2006) estimated that about 28.8 percent of the population was poor (living on under EC $13.93 or US $5.22 per day). This represented an increase of the 25.1 percent of population described as poor in 1995. On the other hand, the proportion of the population described as indigent (living on EC $3.40 or US $1.27 per day) fell from 7.1 percent in 1995 to 1.2 percent in 2005/2006. In addition, about 40% of the population consumes at a level, which is below the vulnerability line[4]. Over 50 percent of the poor are under age 20. The incidence of poverty is also slightly higher among men than women (29 percent and 25 percent respectively).

[1] http://data.worldbank.org/indicator/SP.POP.GROW/countries/LC?display=default
[2] http://204.188.173.139:9090/stats/index.php/statistics/population
[3] Saint Lucia's Housing and Population Census 2010
[4] Vulnerability line is 125% of the poverty line. It measures the number of persons who are susceptible to becoming poor due to unanticipated events such as a natural disaster or other economic shocks. See St Lucia Joint Rapid Damage Needs Assessment- Flood Event December 24 – 25, 2013

Figure 1.5 shows the Regional differences in Saint Lucia's poverty rate.

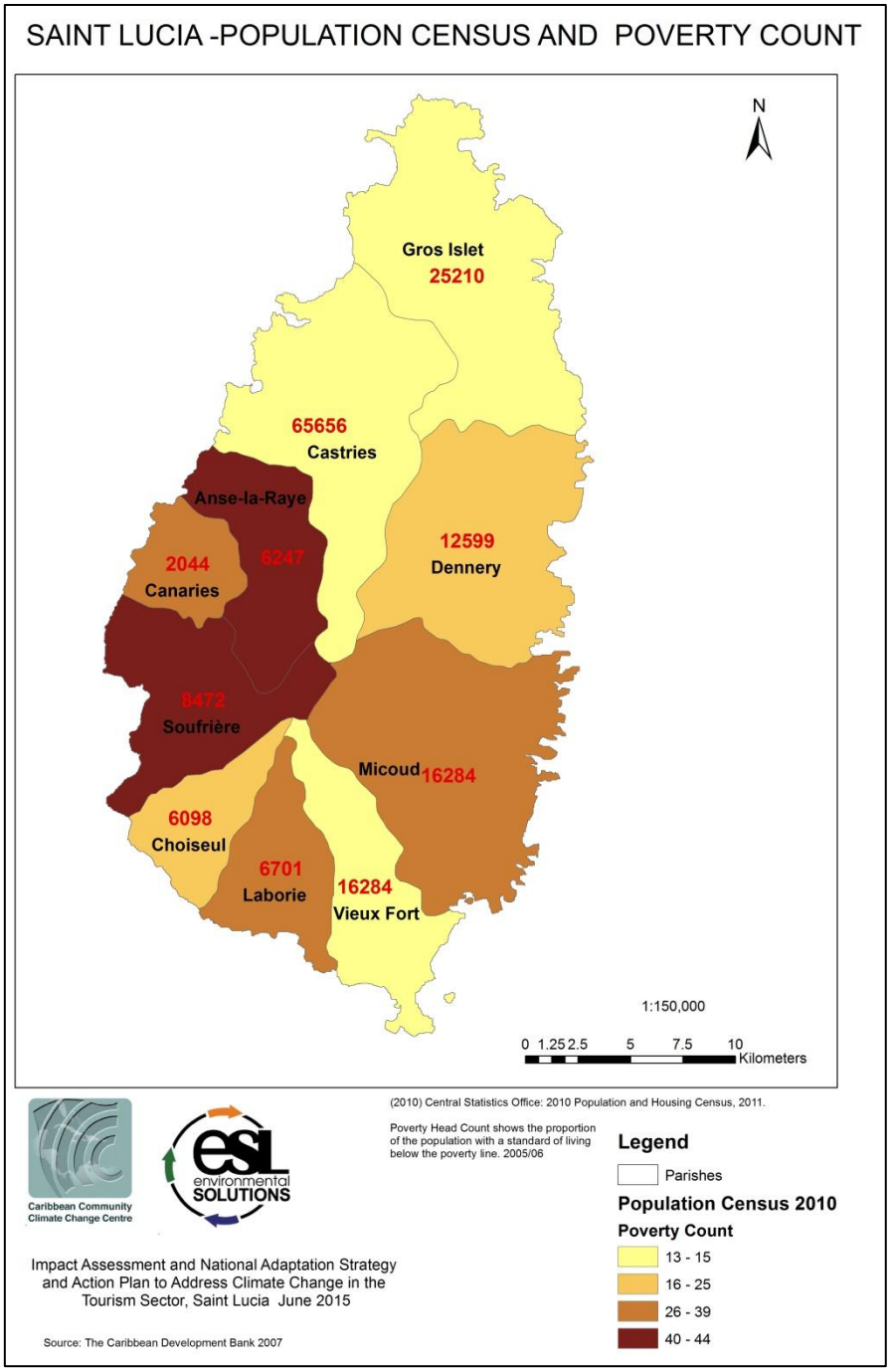


Figure 1.5: Regional Differences in Saint Lucia's Poverty

Anse La Raye has the highest poverty rate at 44.9 percent, while Castries has the lowest rate at 13.1 percent. The Laborie, Soufrière and Micoud areas also all have poverty rates which are over 40 percent. This disparity causes emigration from rural areas to Castries, which results in the loss of social networks in the rural regions. Furthermore, recent data have shown that areas with high poverty rates are more negatively impacted by natural disasters, such as flooding.

Unemployment in Saint Lucia is quite high, estimated at 23.3 percent[5]. The high unemployment rate has had several negative effects on Saint Lucia, including the usage and trafficking of illegal drugs. Unemployment also increases poverty and thus contributes to the emigration of persons to Castries.

1.2.1.4 Economy

Saint Lucia is one of the ten members of the Organisation of Eastern Caribbean States (OECS), an institution that promotes and contributes to the development of the nations of the Eastern Caribbean. The country is also a member of the Eastern Caribbean Currency Union (ECCU), which is a development of the OECS. The ECCU falls under the supervision of the Eastern Caribbean Central Bank (ECCB), which issues one single currency (East Caribbean (EC) dollars) to all its members.

It is a small island economy (Bellong and Reilly, 2009) and is categorised in the group, upper-middle income countries. Saint Lucia's GDP in 2013 was US $1.336 billion, while its per capita GDP (PPP) was US $11,141 for the same year. Saint Lucia's economy has shifted from being predominantly agriculture-based to one that concentrates on services**Error! Reference source not found.**; pecifically tourism and off-shore banking. Some estimates indicate that tourism directly and indirectly accounts for about 65 percent of GDP[6]. The sector also employs a large proportion of the country's labour force.

Saint Lucia's economy grew annually by 4.5 percent from 2003-2006, however, this growth abruptly slowed in recent years because the island experienced a variety of shocks including hurricanes, earthquakes, change in food and energy prices and the global financial crisis.

1.2.1.5 Vulnerabilities

Saint Lucia is vulnerable to a variety of natural and man-made hazards, which can cause the loss of life and property, as well as significant damage to the economy and environment. Key sectors, such as tourism, can potentially be severely affected. Globalization and increased interdependence also cause the nation to be vulnerable to hazards that occur abroad.

1.2.1.5.1 Epidemiological

Saint Lucia has fairly good health indicators. Recently, the nation has had to deal with Influenza Pandemic (Table 1.1). Dengue fever is a potential risk linked to a virus carried by mosquitoes, which breed rapidly in the rainy and hurricane season. Consequently, an increase in storm activity as a result of climate change would result in increased dengue fever cases, which in turn will place greater demand on the health care system.

[5] http://204.188.173.139:9090/stats/index.php/ticker/109-unemployment-rate
[6] St Lucia Joint Rapid Damage Needs Assessment- Flood Event December 24 – 25, 2013

Table 1.1: Epidemiological events 2001 to 2009

Date	Event	Number of Deaths	Comments
2001	Ringworm Alert	0	
2002	Conjunctivitis (aka Red Eye)	0	Back to school event
2003	Dengue Alert	0	
2003	SARS Alert	0	No Cases Reported, the possibility exists for a repeat of the alert
2008	Dengue Alert	0	Type 2 & 3
2009	Influenza Pandemic	1	WHO Declared a Global Phase 6 pandemic

Source: Adapted from St Lucia SNC, Disaster Chapter

1.2.1.5.2 Fires

The Wildlife Management Plan (2008) indicates that wildfires in Saint Lucia mostly occur in the dry season (January to June) in the coastal northern region of the country, near to towns and villages. Some of these fires may have been caused by the actions of humans, whether purposefully or by mistake. A global increase in temperature, along with less rainfall, will result in an increase the occurrence of fires. This could potentially severely affect housing, agriculture, biodiversity and tourism in the country.

1.2.1.5.3 Flooding

Flooding is a frequent occurrence in Saint Lucia and the Caribbean (Table 1.2).

Table 1.2: Summary of some of Saint Lucia's flood events

YEAR	FLOOD EVENT
1994	Floods during Tropical Storm Debbie
1996	October 26; resulting in severe damage in Sourfrière, Anse la Raye, Castries and Vieux Fort
2006	October flooding in Cul de Sac cut Castries off from rest of island
2006	Flood waters cut north Castries off from south Castries
2007	Hurricane Dean flooding in Castries
2008	October 6-16; significant flooding in the north of island
2010	Flooding from Hurricane Tomas in several areas, notably the Hewanorra International Airport
2013	December 24-25, 2013; major flash floods across the island

Source: Modified from St Lucia SNC, Disaster Chapter; St Lucia Joint Rapid Damage Needs Assessment - Flood Event December 24 – 25, 2013

In Saint Lucia, flooding is facilitated by the island's rugged topography, rock structure, thin soils and the continuous development of roads and other impermeable surfaces, all of which encourage run-off. Flooding in Saint Lucia takes a variety of forms including:

- Flash Floods- result when heavy rainfall occurs in a small drainage basin. They are difficult to forecast and are highly destructive

- Riverine Floods- occur when a large amount of rain falls over a river system with tributaries that drain a large area. They may last anywhere from a few hours to a few days
- Land-based flooding- occurs when a large amount of rain falls over a short period of time. The land characteristics, high deforestation and the presence of obstacles to drainage cause these floods
- Coastal/ Tidal Flooding- occur when large bodies of water overflow onto bordering lands. They may result from high tides, heavy rains that accompany hurricanes, waves created by high wind surges, and earthquake or volcanic eruptions at sea
- Ponding- refers to the slow build-up of water in depressions, sinks and areas with clay soils and slow percolation rates. These floods last many days because of poor drainage

Human activity, such as deforestation, reduces infiltration and increases runoff, thereby increasing the potential for flooding. In Saint Lucia and the wider Caribbean, flooding is also closely associated with hurricanes and tropical storms. Consequently, an increase in storm activity or intensity with climate change, will also likely increase flooding. Flooding has resulted in millions of US dollars in losses annually and leads to the destruction of infrastructure and the displacement of people in Saint Lucia.

1.2.1.5.4 Hurricanes

By virtue of its location in the Atlantic hurricane belt, Saint Lucia is extremely vulnerable to this type of hazard. Hurricanes tend to deposit large amounts of rainfall, which causes excess runoff and overland flow resulting in flooding. Additional flooding during storms is caused by land inundation by storm surges. Furthermore, hurricanes carry high winds, which can put stress on buildings, as well as, certain agricultural crops such as fragile banana trees.

Saint Lucia has been hit by many tropical storms ranging in magnitude from depressions to category 5 hurricanes. Despite their magnitude, all the storms have caused some level of damage to the island. Hurricane Allen in 1980, for example, resulted in losses of 69 percent of GDP, while in 2010 Hurricane Tomas (Figure 1.6) caused damages and losses of 43.4 percent of GDP. For tourism, loss from Tomas was estimated at three times the sector's GDP share. Table 1.3 summarises the losses incurred due to a select number of storms that hit Saint Lucia.

Table 1.3 Economic Impact of a Selection of Hurricanes that Hit Saint Lucia

Hurricane	Year	Economic Impact (US $ millions)
Hurricane Tomas	2010	336.00
Hurricane Dean	2007	18.80
Hurricane Ivan	2004	2.60
Tropical Storm Lili	2002	20.00

Source: Caribbean Development Bank

Figure 1.6: Destruction caused by Hurricane Tomas (2010) (Source: SLU DRR)

Whether the magnitude or frequency of storms increases with climate change, the end result will be significant economic losses for Saint Lucia once landfall is made.

1.2.1.5.5 Landslides

Saint Lucia's high, steep slopes are particularly vulnerable to landslides (Figure 1.7).

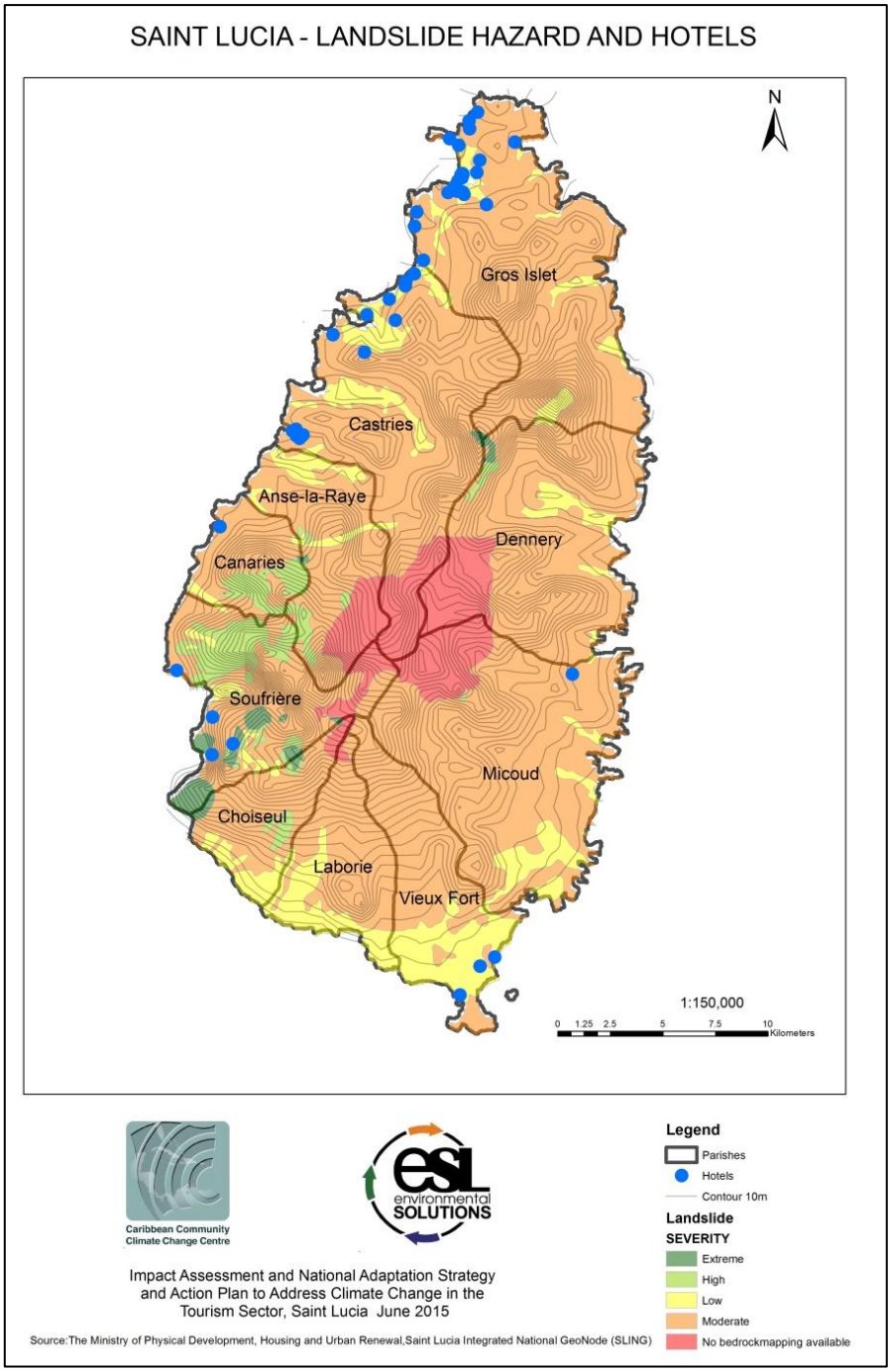


Figure 1.7: Saint Lucia - Landslide Risk

Saint Lucia has in fact experienced a number of landslides ranging from debris flows to rockslides (Figure 1.8). Eight major slippages, including the 1938 Ravine Poisson Landslide during the period 2002 – 2007, resulted in significant loss of lives, the destruction of property and the loss of biodiversity. Approximately 145 families have also been dislocated because of landslides in Saint Lucia over the same period.

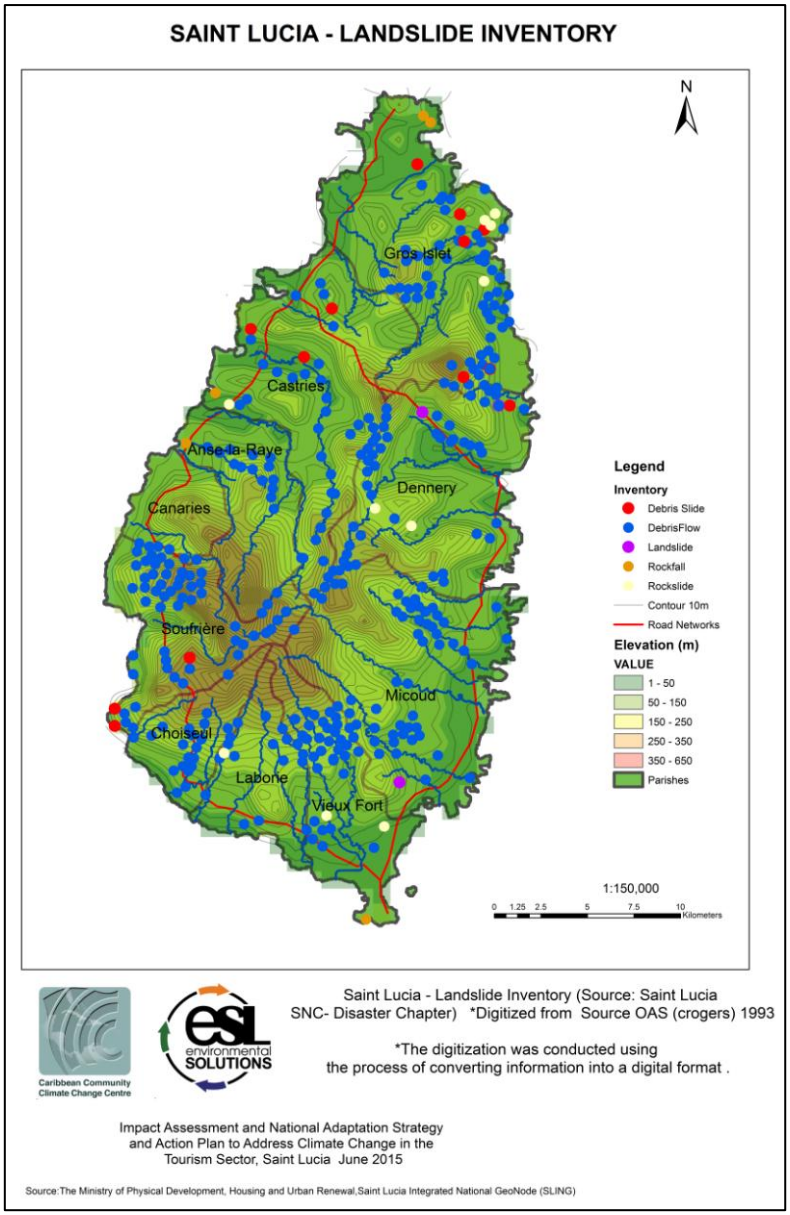


Figure 1.8 Saint Lucia - Landslide Inventory (Source: Saint Lucia SNC- Disaster Chapter)

Landslides here are mainly triggered because of rainfall, hence the greater the rainfall, in terms of intensity, frequency and duration, the more likely it is that landslides will occur. In addition, the volcanic nature of Saint Lucia also makes it potentially prone to the occurrence of landslides as a result of earthquakes and other forms of volcanic activity.

1.2.1.5.6 Droughts

Water Management Plan for Drought Conditions, approved by the Cabinet in 2009, indicated that Saint Lucia is generally regarded as a water-rich island. However, in 2001 and 2009/2010, the island experienced severe drought periods. Currently, the island and the wider Caribbean are also experiencing a drought. Drought can have severe negative impacts on various sectors of the economy, including tourism, which depends heavily on water to maintain many aspects of its product, such as pools and golf courses. Prolonged drought can also lead to other hazards, such as wildfires, due to the drying up of plants (Figure 1.9). With climate change, it is expected that rainfall patterns will change and there will be longer periods of drought for Saint Lucia.

Figure 1.9: Drying of up of plants as a result of drought conditions (Source: Saint Lucia SNC- Disaster Chapter)

1.2.2 The Tourism Sector

Globally, Saint Lucia has a very positive image. It is perceived as a beautiful and romantic destination within the Caribbean. As a result, Saint Lucia has made a name for itself as one of the premier wedding and honeymoon destinations in the world. In fact, the country has won the World Travel Awards "World's Leading Honeymoon Destination" on various occasions[7].

The tourist product in Saint Lucia is quite diverse. There are a variety of attractions on the island including: beaches, forest tours, waterfalls, and the world famous Pitons. Accommodations are equally as varied, ranging from internationally renowned high-end hotels to more intimate and homely guesthouses.

The Caribbean is tourism-dependent, as it provides the baseline for their social and economic development, being the largest employer and earner of foreign exchange for most Caribbean destinations. The Caribbean is blessed with a wide variety of non-tradable commodities, such as its natural beauty and its cultural and historical characteristics that can be "traded" at a premium price. As a result of these characteristics, the industry accounts for one-third of all trade, a quarter of foreign exchange receipts and one-fifth of total employment in the Caribbean[8]. Numerous authors have also attributed most of the region's growth to the industry (Latimer, 1985; Modeste, 1995). Bishop (2010), however, argues that the shift to tourism as a key plank of the region's development strategy was not a strategic decision, but one pressed upon the region given dwindling alternatives[9]. This situation reflected the deteriorating options available due to the decline in preferential access to traditional metropolitan markets for agricultural goods.

Saint Lucia, in particular had been significantly affected. In January 2006, the Banana Trade War between the United States of America and the European Union was brought to an end with the elimination of preferential access to the European Union banana market. The economic cost for the island was significant: banana exports fell from US$68.4 million in 1992 to US$15.5 million in 2001.

[7] 1998, 2002-2004, 2006-2010

[8] Economic Commission for Latin America and the Caribbean Sub-regional Headquarters for the Caribbean, de Albuquerque, K., & McElroy, J. (1995). Planning for Effective Management and Sustainable Development of Coastal Resources in Caribbean Small Island States; Caribbean Dialogue,

[9] "AN ASSESSMENT OF THE ECONOMIC IMPACT OF CLIMATE CHANGE ON THE TOURISM SECTOR IN SAINT LUCIA" Economic Commission for Latin America and the Caribbean Sub-regional Headquarters for the Caribbean,

This also affected other Caribbean destinations, such as Jamaica and Dominica. As a result, the drive to intensify the development of the tourism sector was pushed to the forefront.

Most Caribbean countries today have embraced tourism as one of the key components of their development strategy. The main motivations behind this approach relate to the advantages the industry provides relative to other exports of goods and services. First, it allows the destination to obtain economic benefits from characteristics that normally could not be traded, for example natural and other cultural attractions. Second, locally produced goods can be sold at a premium to visitors. Finally, goods that could not be exported due to insufficient export capability can be sold to tourists (Mihalic, 2002).

Saint Lucia's rich history and cultural heritage present a unique and authentic cultural experience that cannot be replicated anywhere else. The island's French heritage remains very present in the creole language, which is widely spoken; the mouth-watering cuisine; music; dance and architecture. The island's first European colonizers, the French, named her "Sainte Lucie' (Saint Lucia) and she is distinguished for having changed hands between the English and French 14 times, earning her the name "*Helen of the West Indies".*

Saint Lucia has a diverse tourism product, from small and intimate inns situated in scenic, remote and private locations, to major hotels on tranquil beachfronts, which are rapidly becoming threatened by the effects of climate change. The northernmost part of the island is renowned as the entertainment hot spot, with exquisite internationally acclaimed restaurants that cater to a wide range of tastes and offer a variety of cuisine. Conversely, the south and surrounding coastal villages cater to the spontaneous excursionist and adventure-seeker with an array of soft adventure activities, including hiking, biking, mountain climbing and eco-tours to waterfalls, and rainforests.

Economic Significance

The tourist industry directly and indirectly contributes 38.8 per cent of the country's GDP. Further, travel and tourism supports 31,000 jobs or 42.1% of employment in Saint Lucia. Of this figure, 14,000 represents direct employment, while 17,000 is indirect employment in offshoots from the tourism sector.

The tourism industry has been and continues to expand in Saint Lucia. In 2014, the island received 1.034 million visitors, the highest in its history. This record can be attributed to an increase in the number of stay-over visitors, cruise ship and yacht arrivals. The number of stay-over visitors improved by 6.1 per cent to 338,158, compared to the previous year, mainly because of the increase in visitors from the United States and Canada. Cruise ship visitors rose by 8.0 per cent to 641,452 because forty five additional calls were made to Saint Lucia in 2014. Yacht arrivals also rose to 47,196 (Figure 1.10).

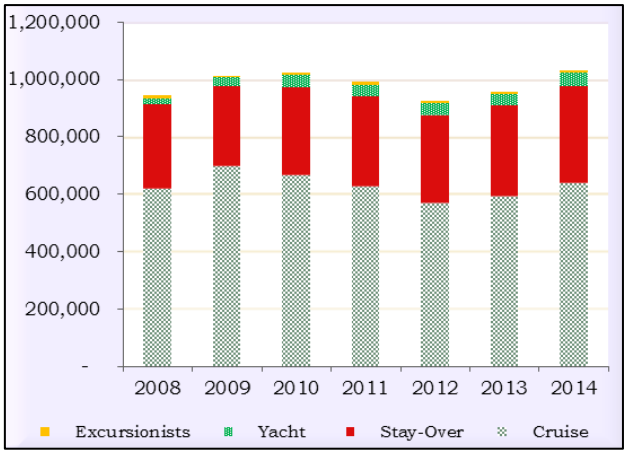


Figure 1.10: Visitor arrivals by category 2008-2014 (Source: Government of Saint Lucia- Review of the Economy 2014, 2015)

The aforementioned had positive impacts on average daily rates, length of stay, occupancy and total visitor expenditure. Tourist expenditure in 2014 was about EC $2.0 billion (US $741 million), which represented a 14.3% increase over the previous year's figure (Figure 1.11). Further evidence of the industry's expansion is the fact that 451 more persons were employed in the sector compared to the previous year.

Figure 1.11: Saint Lucia- Visitor arrivals and expenditure 2000-2014 (Source: Government of Saint Lucia- Review of the Economy 2014, 2015)

1.2.2.1 The Tourism Subsectors

Figure 1.12 below outlines some of the main economic sub-sectors within the Saint Lucian tourism environment.[10] All tourism subsectors without exception are threatened by the effects of climate change. If immediate actions are not implemented and sound environmental best practices not adopted, the Saint Lucian economy will see major declines in visitor arrivals, revenues, investments and development within the tourism sector.

The primary subsectors of the tourism sector are accommodations, food and beverage services, attractions, transportation (airlift, cruise and ground transportation) and the arts and craft industry. The tourism sector also relies on the agriculture sector for produce and so it is important to

[10] Tourism Sector Snapshot

consider. Secondary sectors, equally as important to the development of tourism, include the utility services (electricity and water), construction, manufacturing, banking and communications.

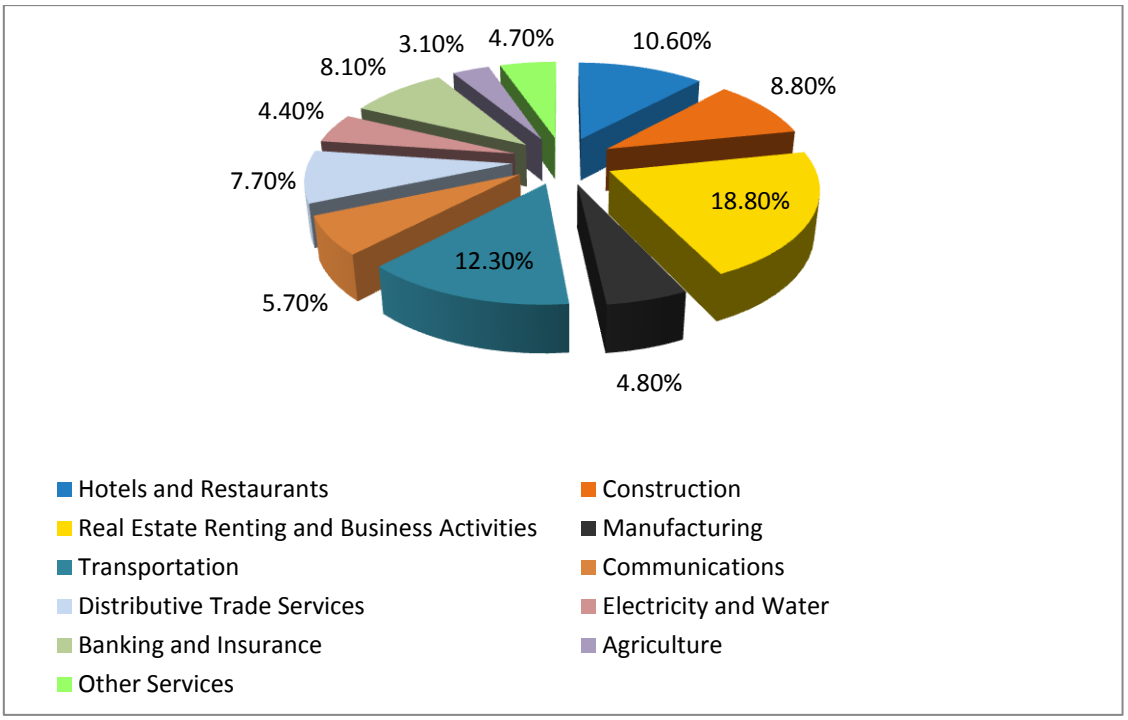


Figure 1.12: Tourism Subsectors and other Related Key Sectors

1.2.3 Climate Change

1.2.3.1 Global climate change

The Earth's climatic system has been warming at record rates since the 1950s. Empirical evidence has shown that both the atmosphere and ocean have warmed and this has been accompanied by a decline in the amount of snow and ice. Additionally, sea level has risen and the concentration of greenhouse gases in the atmosphere has increased (IPCC, 2013). The IPCC 5th Assessment Report has also shown that:

- Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850 (Figure 1.13). Global surface temperature change for the end of the 21st Century is likely to exceed 1.5°C, relative to 1850 to 1900, for all Representative Concentration Pathways (RCP) scenarios except RCP2.6. Warming will continue to exhibit inter annual-to-decadal variability and will not be regionally uniform.

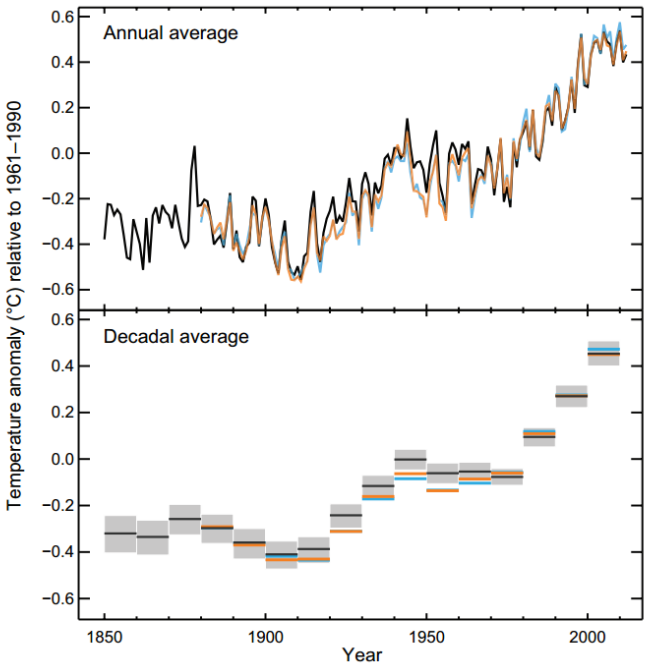


Figure 1.13: Observed globally averaged combined land and ocean surface temperature anomaly 1850 – 2012 (IPCC, 2013)

- Changes in the global water cycle, in response to the warming over the 21st Century, will not be uniform. The contrast in precipitation between wet and dry regions and between wet and dry seasons will increase, although there may be regional exceptions.
- Changes in many extreme weather and climate events have been observed since about 1950. In general, there are more land regions where the number of heavy precipitation events has increased than where it has decreased. The frequency or intensity of heavy precipitation events has generally increased in North America and Europe.
- The rate of sea level rise, since the mid-19th Century, has been larger than the mean rate during the previous two millennia (high confidence). Over the period 1901 to 2010, global mean sea level rose by an average of 0.19m [0.17m to 0.21m].

1.2.3.2 Regional climate change

For the Caribbean, the IPCC (2013) report has projected that temperature rise will range between 0.7°C to 2.4°C by the end of the 21st Century. Similarly, models have projected that changes in annual precipitation will range anywhere from -29 per cent to +14 per cent by the end of the 21st century. It has also been projected that there will be a reduction in the length of the rainy season with a corresponding increase in the length of the dry season. Models also predict that there will be more intense flooding events and also increases in the intensity of hurricanes (although some also predict that the frequency of hurricanes will be reduced).

The Caribbean region, consisting of Small Island Developing States (SIDS) is expected to be among the first and the most severely impacted by changes in climate (Pulwarty et al. 2010; Simpson et al. 2009) because of its prevailing local conditions. The majority of Caribbean nations have relatively small geographic size, high concentration of infrastructure along the coast, which leads to high coastal populations, limited natural and human resource bases and open economies. Most countries are also located in areas that are highly prone to extreme weather events hurricanes and droughts

(Gamble et al., 2010; Mimura et al., 2007; Nurse et al., 2001; Nurse and Moore, 2005; Pelling and Uitto, 2001). These conditions make the Caribbean more susceptible to climatic risk, because their coping mechanisms are significantly lower than bigger nations, where the cost of climatic fallouts can be spread over larger areas and especially over those portions of the economy which would remain unaffected (Melville, 2003).

1.2.3.3 Climate change in Saint Lucia

General climate model projections for Saint Lucia (Simpson et. al, 2012) indicate that there will be:

- An increase in sea level;
- An increase in average atmospheric temperature;
- Reduced average annual rainfall;
- Increased sea surface temperatures (sst); and
- The potential for an increase in the intensity of tropical storms.

Sea level rise (SLR) is one of the greatest concerns for Saint Lucia. A 1m rise in sea level would place 7 per cent of the major tourism properties at risk, along with one of the country's two airports and 100 per cent of the ports (Simpson et. al, 2012). Pigeon Island, Pigeon Causeway, Rodney Bay and Soufrière have been identified as extremely vulnerable to sea level rise (SLR), putting many key critical facilities (hospital, police offices, post offices etc.) and tourism facilities (hotels, restaurants etc.) at great risk (Simpson et. al, 2012). Incremental SLR and erosion impacts on the changes to the beachscape will reduce aesthetic appeal and affect recreation activities, as well as, the livelihoods of those employed in fisheries, water-sports and other related activities (ibid).

Given the historical losses within the tourism sector and projected climate variability outlined above, a number of key initiatives were undertaken to address the challenges. Of note, is the *Assessment of the Economic Impact of Climate Change on the Tourism Sector in Saint Lucia*, completed in 2011 by the United Nations Economic Commission for Latin America and the Caribbean (UNECLAC) and United Kingdom Aid (UKAid). The *Assessment of the Economic and Social Impact of Climate Change on the Tourism Sector in the Caribbean* was completed in 2013. A *Vulnerability and Adaptation Assessment of the Tourism Sector* was also completed in 2010.

1.2.4 The Project

The CCCCC received funding from the European Union (EU) under Grant Contract **FED/2011/267-392** to implement support to the Global Climate Change Alliance (GCCA) as part of the 10th EDF Intra-ACP framework for the Caribbean. The European Union Global Climate Change Alliance (EU GCCA) is a Caribbean Forum (CARIFORUM) project aimed at assisting the sixteen (16) participating countries to develop their capacity to design and implement climate change adaptation policies and practices.

The overall goal of this Project is to support the sustainable development of the Caribbean in their effort to achieve the Millennium Development Goals (MDGs) and the Sustainable Development Goals which are to be adopted in September 2015. The Project's specific aims include:

1. To enhance national and regional institutional capacity in areas such as climate monitoring, data retrieval and the application of space-based tools for disaster risk reduction;

2. To develop climate scenarios and conduct climate impact studies using Ensemble modelling techniques;
3. To conduct further vulnerability assessments that can assist with the identification of local/national adaptation and mitigation interventions;
4. Building regional and national capacity to access carbon financing; and
5. To implement adaptation pilot projects that may be subsequently replicated.

Tourism in Saint Lucia is particularly vulnerable to the effects of climate change (Morales, 2011) especially in the form of sea level rise and the increase in the frequency and intensity of extreme weather events. As a result of the importance of tourism to the country's economy, the Ministry of Tourism, Heritage and Creative Industries (MTHCI), in collaboration with the Ministry of Sustainable Development, Energy, Science and Technology (MSDEST), solicited consultancy services through the Caribbean Community Climate Change Centre (CCCCC) to assess Saint Lucia's tourism sector with respect to climate change. The Project has two main objectives:

a. To conduct an Impact Assessment of climate change and climate variability on the tourism sector in Saint Lucia, using the report generated to prepare a National Adaptation Strategy and Action Plan (NASAP) for the sector; and

b. To facilitate buy-in and foster ownership of the NASAP by key stakeholders, through a collaborative and consultative process.

Both are aimed at addressing the threat that climate change poses to tourism. Through this initiative, recommendations on the available climate adaptation response options, will be presented to the Government of Saint Lucia (GOSL), in an attempt to develop Saint Lucia's capacity to deal with the potential negative effects of climate change on the tourism sector.

1.3 Scope and Approach

A participatory approach was used to gather the data, which informed this report. Consultations with key stakeholders were completed along with scientific data analysis. Great emphasis was placed on ensuring that the data gathering process addressed crosscutting issues and that a full understanding among stakeholders involved was achieved.

The specific methods employed are discussed in the following sections. Limitations for these assessments were largely associated with the inadequacy or absence of data sets that would improve the analyses conducted. The results of the analyses were used to develop a National Adaptation Strategy and Action Plan for the Tourism Sector to address the issues being faced.

1.3.1 Literature Review

A comprehensive review was undertaken of various reports related to tourism and climate change in Saint Lucia. These documents included but were not limited to:

- Saint Lucia Climate Change Adaptation Policy, 2002 and 2015
- Saint Lucia Initial National Communication to the UNFCCC

- Saint Lucia Second National Communication to the UNFCCC, 2010
- Vulnerability and Adaptation Assessment, 2010
- An Assessment of the Economic Impact of Climate Change on the Tourism Sector, UNECLAC, 2011
- An Assessment of the Economic and Social Impacts of Climate Change on the Tourism Sector in the Caribbean, UNECLAC/AUSAID, 2013
- THE CARIBSAVE Climate Change Risk Atlas (CCCRA) Climate Change Risk Profile for Saint Lucia, 2012
- Revised National Environment Policy (NEP) and National Environmental Management Strategy (NEMS), 2014
- Saint Lucia Tourism Benchmarking and Competitiveness Assessment Report, 2013

Given the need to ensure that tourism is addressed in relation to water, health, natural and built environment, food security, etc., a large number of other documents, not listed here, were reviewed, as per the electronic data base established by the Project proponents.

Existing climate change and tourism-related initiatives provided a good foundation upon which to build a Tourism Adaptation Strategy. As a result, on-going projects, such as the Saint Lucia Third National Communication to the UNFCCC and the Revised Tourism Incentives Act were reviewed in order to analyse the potential impact they would have on this assessment. Additionally, all tourism related policies, legislations and regulations were gathered and reviewed.

During the inception mission, additional documents were collected from the client and key stakeholders. These documents were also reviewed and were used to inform:

- the identification of relevant stakeholders;
- the analysis of the status of the tourism sector and resources;
- the preparation of the impact assessment report;
- the National Adaptation Strategy and Action Plan.

1.3.2 Stakeholder Consultation

In order to ensure that the tourism sector continues to expand, Saint Lucia has to pay keen attention to sustainability, especially as it relates to the impacts of climate change. To this end, meetings were held with key stakeholders in the tourist industry, who were identified during the Inception Meeting, in an effort to fully understand the current state of the country's tourism sector. These consultations were used to inform the gap and needs assessments, as well as to develop recommendations and the NASAP. Stakeholder consultations included structured interviews that were completed either face to face or via conference calls, focus groups, visioning workshops, community meetings and print and electronic surveys.

The Consultants liaised with stakeholders from several organisations both government and private. Appendix I presents a complete list of all the stakeholders consulted during the Inception and Data Collection Phases, i.e. May-June, 2015 and at the National Consultations held in July 2015.

In assessing the current state of the sector, the following information was gathered from stakeholders:

1. Country specific tourism data, for example: visitor arrivals and mode of arrival, number of tourism facilities (accommodations, attractions services), tourism water usage, tourism water supply, forest cover, rainfall and other meteorological data, among others.
2. Exposure and impacts of climate hazards on all aspects relating to the tourism sector – accommodations, attractions, craft development, cruise shipping, food production and supply etc.
3. Tourism sector characteristics - water availability and supply to tourism entities, tourism resources and management (beaches, waterfalls, rivers, forests etc.), sanitation, finance, including government spending and donor funding, government supply and capacity, sector coordination, equity, sustainability, private sector and civil society.
4. Current national activities and programmes relevant to the tourism sector.
5. Challenges faced and priority areas for improving the sector.

1.3.3 Climate Change Analysis

To establish a baseline and a future climatic scenario, a comprehensive literature review was undertaken for the Caribbean and, specifically for Saint Lucia (where available). For the baseline analysis, emphasis was placed on precipitation, drought, maximum and minimum temperature, hurricane frequency and intensity (both direct – landfall; and indirect – storms passing within a specified distance that affected Saint Lucia) and sea level rise. For the future climatic scenario, analyses were conducted on the same variables, minus hurricane intensity and frequency, but including wind speeds, sunshine hours and relative humidity.

1.3.3.1 Statistical and Dynamic Downscaling

This component seeks to use one or two approaches, dependent on data availability. The first involves the use of the regression based downscaling methodology, which relies on empirical relationships between local scale predictands and regional scale predictors[11] - Statistical DownScaling Model (SDSM) techniques. This approach is heavily dependent on the availability of sufficient historical meteorological data - daily precipitation, maximum and minimum temperature data (particularly over the 1961-2010 period). If sufficient historical meteorological data is available, then future mean change can be deduced using this approach.

The second approach involves the use of regional climate model simulations, otherwise known as Dynamical Downscaling. Regional climate model simulations involves the nesting of the higher resolution regional climate model within a coarser resolution global climate model, and the results provided are at scales more representative of the small size of islands such as Saint Lucia. This approach was also used to determine future changes in rainfall, mean temperature, wind and relative humidity. Tables were produced to suggest maximum, minimum and median value changes.

Both approaches utilized the SRES scenarios and where possible or available, the IPCC's RCP4.5 for 2031-2040 and 2051-2100 relative to a model baseline period (e.g.1961-1990). Projections from

[11] Predictands and predictors refer to climate variables

regional climate modeling output were provided at a minimum resolution of 25km, or where possible and data is available, to a maximum or 10km horizontally.

1.3.4 Institutional, Policy and Legislative Framework

A thorough evaluation was conducted of all the GOSL Ministries and other relevant agencies and organizations that are involved in research, regulations, provision or enforcement within the tourism sector, especially as related to climate change.

The analysis included the following categories:

- Policies specific to or related to the tourism sector and climate change adaptation;
- Legislation and regulations governing or related to the tourism sector;
- Institutional arrangements governing the tourism sector and managing resources.

Gaps, needs and recommendations for capacity building measures and other interventions were identified based on the results of the institutional assessment. Table 1.4 below, is an example of one of the tools used to identify the capacity of the various players and decision-makers in the sector. These stakeholders are largely government agencies and ministries.

Table 1.4: Example of Tool Used in Institutional Review

Government Agency/ Ministry	Mandate	Vision Statement	Legislation	Policy/Plan	Capacity	Current Roles
Ministry of Tourism, Heritage and Creative Industries						
Ministry of Agriculture, Food Production, Fisheries, Cooperatives and Rural Development						
Ministry of Sustainable Development, Energy, Science and Technology.						
National Emergency Management Organisation						
Saint Lucia National Trust						
National Conservation Authority						
Saint Lucia Meteorological Services						

1.3.5 Economic Review

Due to the importance of tourism as an employer and earner of foreign exchange, the impact of climate change on tourism is transmitted to the economy as a whole. In particular, it affects the economy's potential for the growth of output, exports, and employment, which in turn brings

pressure on the living standards of the population. In this regard, securing the availability of, and accessibility to the local food supply should be a matter of priority. On the other hand, the changes can also bring opportunities for creative entrepreneurship. Again, with regard to food, some analysts are projecting a tightening of international food supplies as agricultural production around the world suffers from higher temperatures and problems of too much or too little water. This will afford market opportunities for the expansion of local food production.

This NASAP assessed the evolving structure of the Saint Lucian economy and determined its resilience to climate change, as well as, what types of climatic adaptations are necessary and feasible, with emphasis placed on the tourism sector. Against the background of the historical evolution of the sectoral composition of output of goods and services, especially exports, and the principal markets for capital, labour, exports, imports, food, energy, and tourism, particular attention was given to the likely impact on the respective historical trends. Saint Lucia's economic and environmental vulnerabilities arose from its position within the international economy and on the globe, respectively. The assessment began with the changes in Saint Lucia's international and regional relations, and then took into account the additional pressures from climate change.

Like many other Caribbean states, Saint Lucia has a predominantly service-based economy. Yet, its two most important earners of foreign exchange, Agriculture and Tourism, are both dependent on natural resources. Traditionally, the Saint Lucian economy has been dependent on land and climatic resources, and with the development of the tourism sector, the resources of the coastal zone are also assuming greater economic importance. Climate change will likely amplify the variability of climatic conditions, and most definitely threaten the coastal zone where a large segment of the tourism sector is based.

Saint Lucia competes in a narrow range of international markets for both its agricultural products and tourism services. The rapid liberalization of the global economy has eroded the country's share of its traditional market for bananas, and with the gradual normalization of relations between Cuba and the USA, the tourism market is even more competitive.

With respect to imports, Saint Lucia is heavily dependent on imported energy and food. The recent collapse of energy prices offers import-dependent countries a chance to re-engineer their energy sources and use, but does not change the long-run trajectory of rising petroleum prices. The trend of rising food prices on international markets is also expected to continue with the growing demand for food, and the climate change-induced productivity declines in many countries and regions.

The NASAP developed in this project addresses the country's economic vulnerabilities to international markets. The two critical export markets are also environmentally vulnerable to unfavourable weather conditions, which are expected to become more frequent and intense with climate change. Building resilience to manage these interrelated vulnerabilities will be an essential economic strategy in the NASAP.

Two pressing social problems for Saint Lucia are poverty and crime, both of which have their immediate roots in the recent difficulties in providing employment and incomes for the population. Specifically, the rapid decline of the banana industry, following the loss of preferential access to the UK market, and the impact of the global financial crisis of 2008, account for much of the economic

difficulties in the country. These are social vulnerabilities that are subtended by the weak market for labour.

Adaptation to climate change requires investing in both high and low risk activities to manage vulnerabilities and build resilience. Like other Caribbean economies, public policy must seek to attract some of the very limited capital available for green investments. This applies as well to resources allocated to public policy and administration: adaptation competes with business-as-usual strategies for all kinds of resources. The government's fiscal space has been even more limited by the inescapable servicing of the external debt. The NASAP therefore competes with the debt strategy for fiscal resources.

Projecting the main macroeconomic variables is all the more challenging when econometric models have to incorporate even more uncertain climate scenarios. The economic assessment included forecasting models that have been used to guide public policy in Saint Lucia, and proposed modifications and adjustment where deemed necessary.

In summary, the economic assessment informed the components of the NASAP that compete for resources.

2 Existing Climate Setting

2.1 General Climate

The island of Saint Lucia is located within the insular Caribbean at approximately 14°N and 61°W. The land mass spans 616 km^2 and is among the most mountainous of the Caribbean islands, rising to 958.6 metres at its highest point. The climate of Saint Lucia is typical of a small tropical island. Location, topography and limited coastal area contribute to the influence of many large scale climatic systems of the north tropical Atlantic on the island's weather.

In the course of a year, the country's climate is strongly modulated by the migration of the north Atlantic subtropical high, the eastward spread of the tropical Atlantic warm pool, the fairly steady easterly trade winds, and the passage of tropical waves, depressions, storms and hurricanes. The resulting climate regime is characterized by a dry winter-wet summer pattern and high and fairly uniform temperatures year-round. Inter-annual variability in the climate of the islands is also influenced strongly by the El Niño Southern Oscillation. El Niño events bring warmer and drier than average conditions during the late wet-season and La Niña events bring colder and wetter conditions at this time.

2.2 Rainfall

2.2.1 Climatology

The precipitation climatology of Saint Lucia, which is the average monthly rainfall over a number of years, is characterized by a unimodal pattern of monthly variation (Figure 1.1 below), with one rainy season from July to November and one dry season from January to May. Though there is a slight decrease in rainfall in September, the main rainy season delivers approximately 60% of total annual rainfall, while approximately 25% of rainfall is received during the dry period at the start of the year. Rainfall observations at the two major airports indicate that the island receives a total of 145cm to 190cm of rainfall per year (Table 2.1).

As is the case for the rest of the insular Caribbean, peak rainfall occurs during the Atlantic Hurricane season and seasonality is strongly influenced by large-scale atmospheric and oceanic systems. The rainfall pattern over Saint Lucia is largely conditioned by the North Atlantic High (NAH) pressure system, which is a large subtropical semi-permanent centre of high atmospheric pressure typically found south of the Azores in the Atlantic Ocean between 30˚ N and 35˚ N. During the northern hemisphere winter, the NAH is southernmost with strong easterly trades on the equator side of the system. Coupled with strong trade inversion, cold sea surface temperatures (SSTs) and reduced atmospheric humidity, the Caribbean generally is at its driest (lowest rainfall) during winter months. Precipitation during this period is generally due to the passage of mid-latitude cold fronts and moisture advection (weak low level convergence). By May, the NAH moves northward, the trade wind intensity decreases and the Caribbean Sea becomes warmer and the southern flank of the NAH becomes convergent (Taylor and Alfaro, 2005). The primary source of rainfall from June to November is the passage of easterly waves, which traverse the Atlantic Ocean from the west coast of Africa to the Caribbean. The waves are themselves a source of convection and can develop into depressions, storms, and tropical cyclones under conducive conditions. Near July, a temporary southward movement of the NAH is associated with diminished rainfall and the occurrence of a mid-summer drying in much of the region. Enhanced rainfall occurs with the return of the NAH to the

north and the passage of the Inter Tropical Convergence zone (ITCZ) northward. When the NAH treks south again at the end of the year, it marks the onset of the dry season. Another atmospheric feature important to rainfall variations during the rainfall season(s) is the Tropical Upper-level Tropospheric Trough (TUTT), a trough situated in the upper level (200 hPa) tropics.

2.2.2 Trends

Over the years, there has been an increase in the amount of rainfall observed throughout the year, particularly during the dry season in the early part of the year. The result has been a shift in the rainfall climatology of Saint Lucia across decades (Table 2.2). Since the 1970s, the wet season has begun earlier in the year and has displayed an increase in the number of peaks in rainfall. This observation is supported by the number of rain days over the period (Figure 2.3), which was lowest in the 1970s and highest since the 2000s. Late season rainfall peaked in September during the 1980s and 1990s, but shifted back to October in the 2000s, as it was in the 1970s. Overall, the climatology of the island has become decreasingly unimodal, but the general pattern of dry early months and wet late months of the year has been retained.

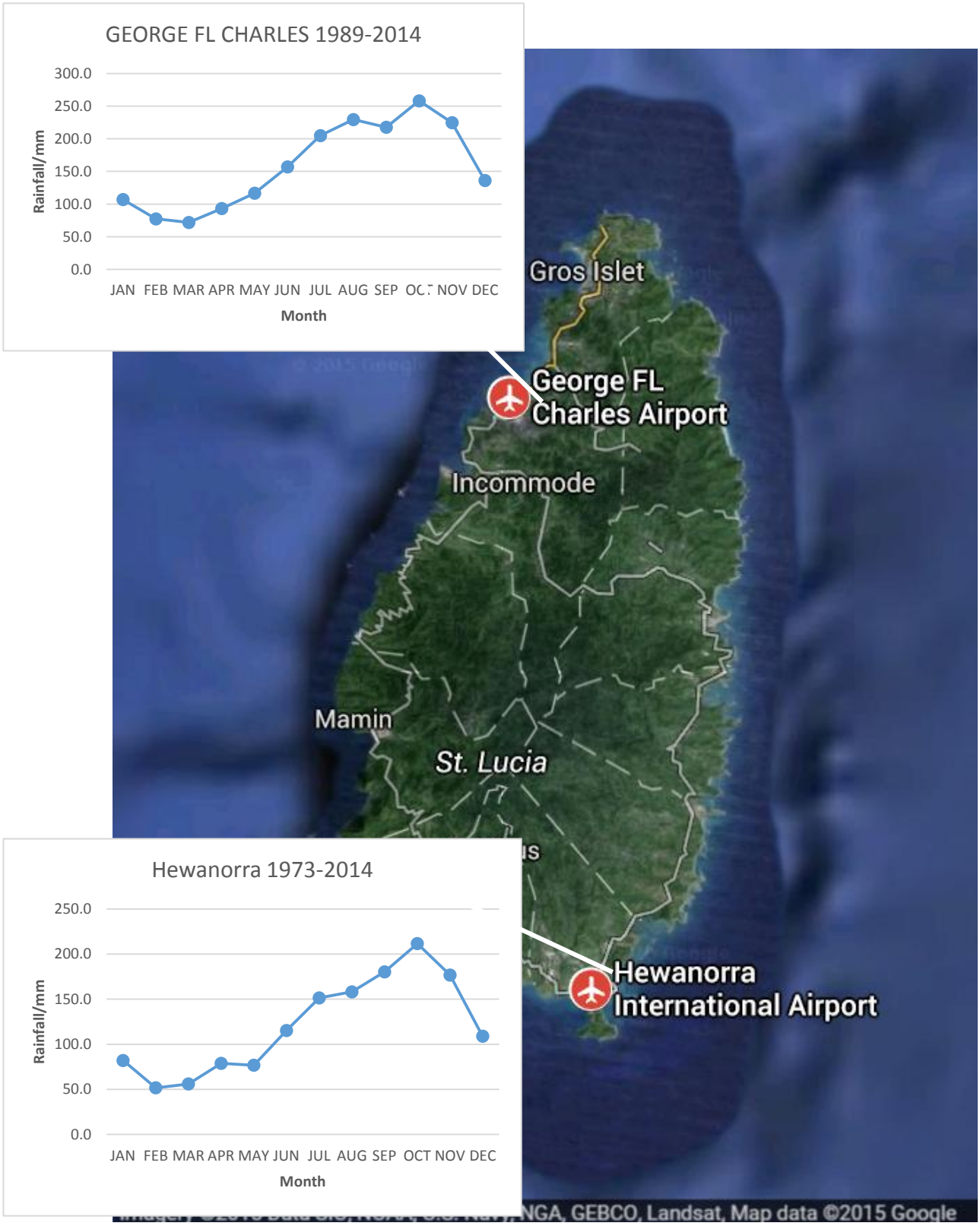


Figure 2.1: Monthly rainfall climatology for two stations in Saint Lucia

Table 2.1: Monthly Rainfall Climatology for two Stations in Saint Lucia. Values are in mm

	George FL Charles Airport	Hewanorra International Airport
	Coordinates: 14°N, 61°W Elevation: 2m	Coordinates: 13.7°N, 60.9°W Elevation: 4m
Jan	107.0	82.0
Feb	77.4	51.8
Mar	71.9	56.1
Apr	93.3	78.9
May	116.8	76.8
Jun	157.0	115.3
Jul	204.9	151.4
Aug	229.5	158.1
Sep	217.7	180.3
Oct	258.1	211.7
Nov	224.7	176.8
Dec	136.2	109.0

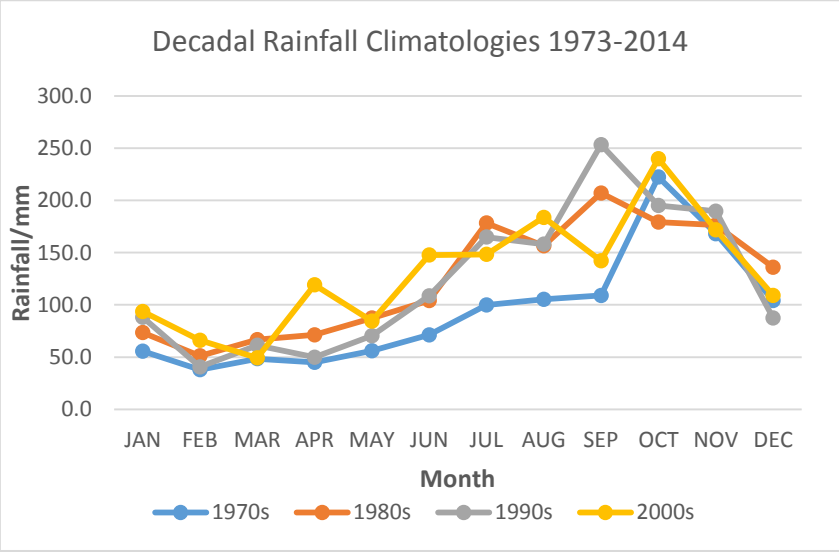


Figure 2.2: Average Monthly Rainfall by Decade for the 1970s, 1980s, 1990s and 2000s at the Hewanorra International Airport.

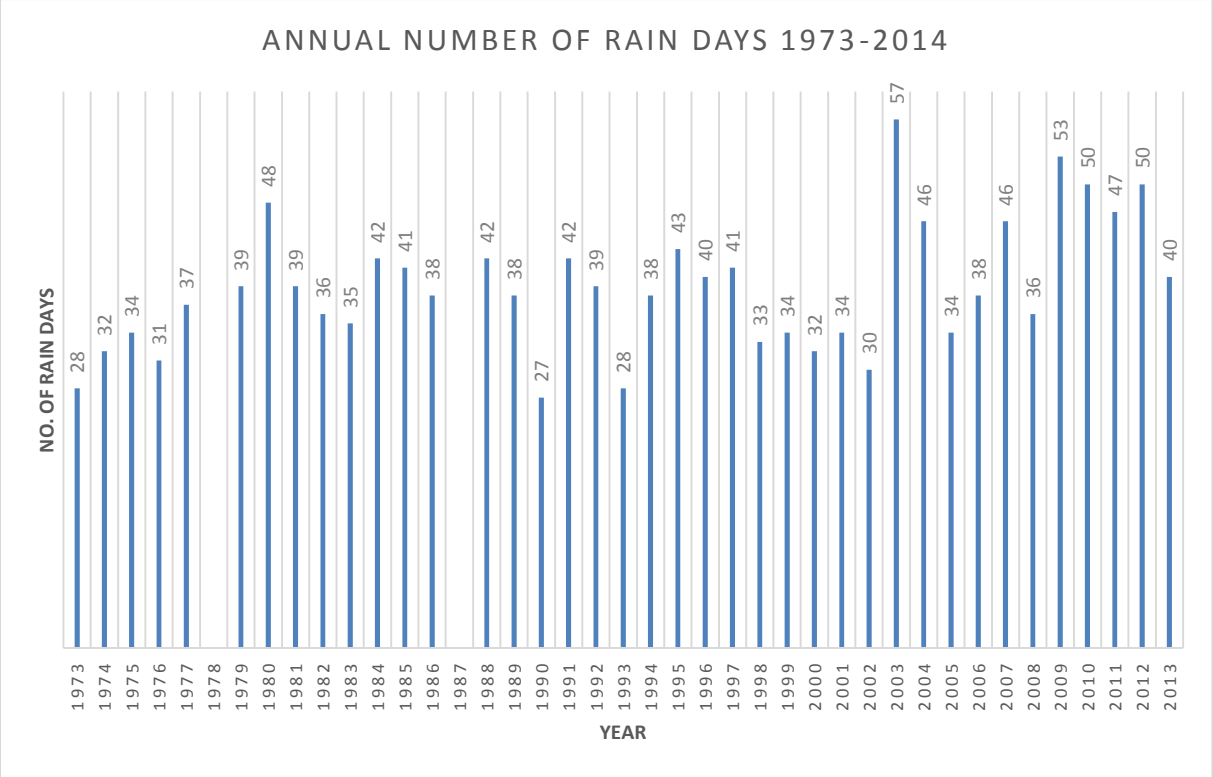


Figure 2.3: Annual number of rain days for 1973-2014 at the Hewanorra International Airport

2.2.3 Extremes

2.2.3.1 Drought

To assess the occurrence of drought or drought-like conditions in Saint Lucia's recent climate, a Standardized Precipitation Index (SPI) was calculated for the Hewanorra International Airport (Figure 2.4). The SPI is a tool developed to identify periods of anomalously low or high precipitation events from a seasonal to an interannual (3 - 8 years) time scale. The SPI-1 and SPI-12 are presented here, to denote rainfall accumulation periods of one and twelve months, respectively. Values of magnitude greater than one are considered to be outside of the normal range and greater than two are extreme. When these values are found to be positive, they are indicative of wet conditions, and negative indicative of dry conditions.

The SPI-1 identified 18 dry periods (below -1) and 46 wet periods (above +1) in the Hewanorra dataset. There was a consistent drop in rainfall after August 2010, which had the highest SPI in the entire time series. Driest conditions occurred three times in the 1980s, consistent with a drier than normal Caribbean in the late 1980s and the next driest period was in January of 2010, consistent with the 2009-2010 Caribbean-wide drought.

For the SPI-12, there were six dry periods and nine wet periods. The wettest period occurred in the year leading up to April 2011, after which there was a descent into the dry period up till the end of the time series. The driest period occurred in the 1980-1981 period.

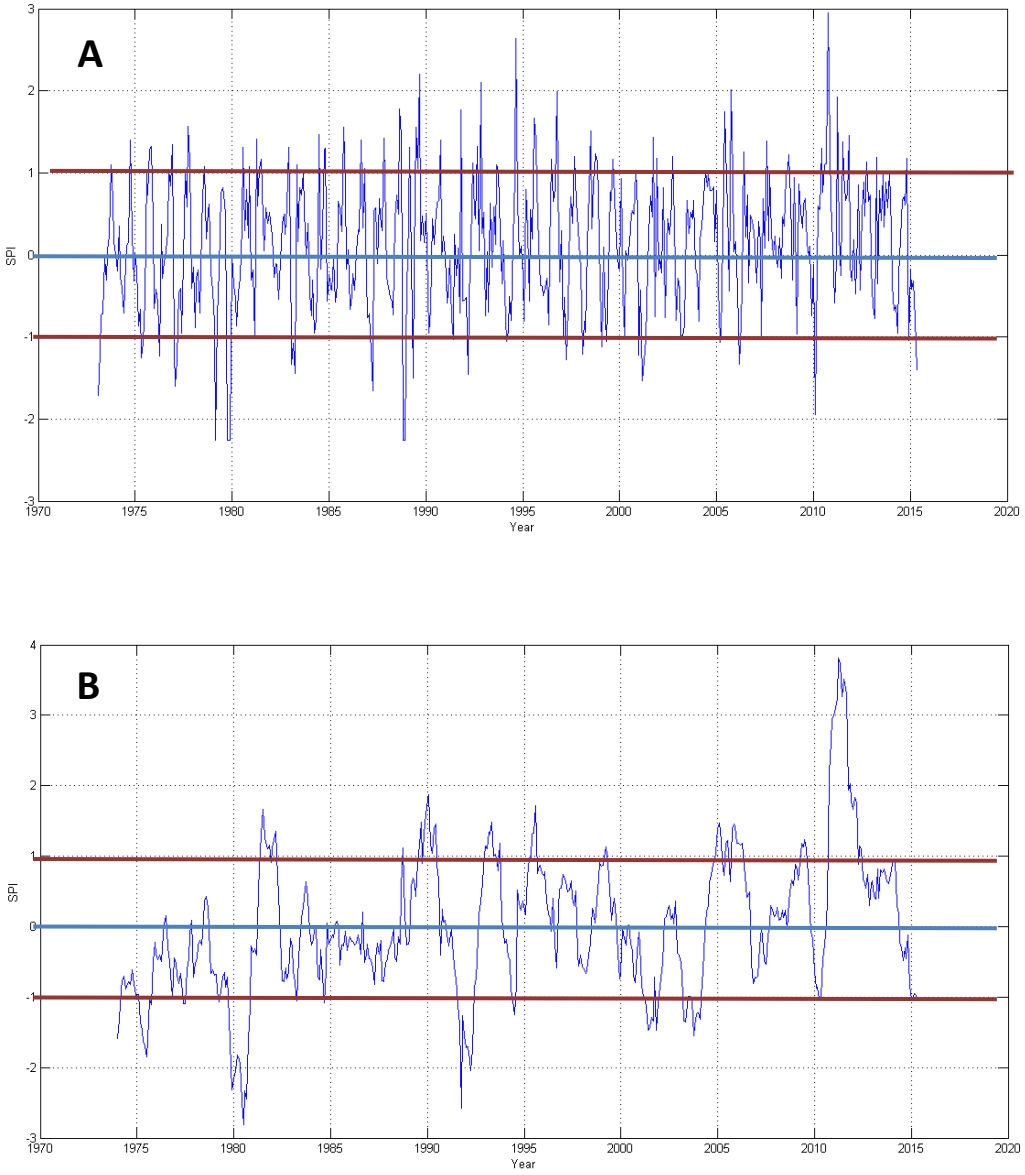


Figure 2.4: A) SPI-1 and B) SPI-12 time series for the Hewanorra International Airport. Zero values are normal (Blue line), positive values are wetter than normal and negative values are drier than normal.

2.2.4 Extreme Indices

An increase in rainfall extremes has been noted at the Hewanorra International Airport, reaffirming the trend of increased rainfall noted in the climatological shift of recent years (Table 2.2). There has been only a fractional increase in the number of days with rainfall above 10 mm, maximum number of consecutive dry days, and maximum number of consecutive wet days. However, marked increases in maximum 5-day rainfall, annual total precipitation when rainfall is above the 95th percentile (very wet days) and cumulative annual rainfall over the 42 year period suggest escalation in both intensity and duration of rainfall events.

Table 2.2: Trends in extreme rainfall indices for the period 1973-2014 at the Hewanorra International Airport

Descriptive Name	Indices	Units	Trend (/year)
Max 5-day precipitation	RX5day	mm	1.43
Days above 10 mm	R10mm	days	0.02
Consecutive dry days	CDD	days	0.09
Consecutive wet days	CWD	days	0.03
Very wet days	R95P	mm	3.07
Extremely wet days	R99P	mm	2.44
Annual precipitation	PRCPTOT	mm	3.64

2.3 Temperature

2.3.1 Climatology

The temperature climatology of Saint Lucia is characterized by summer warming that begins to escalate in April and winter cooling beginning in December (Figure 2.5). The average diurnal temperature range is 5.6°C, with temperatures peaking during summer months. Maximum temperature values may reach as high as 33^{o}C in these months, while minimum temperature values may drop to 18 ^{O}C in January/February. The 2000s was the hottest decade on record (Figure 2.6) with the years 1998 and 2010 being the hottest year on record.

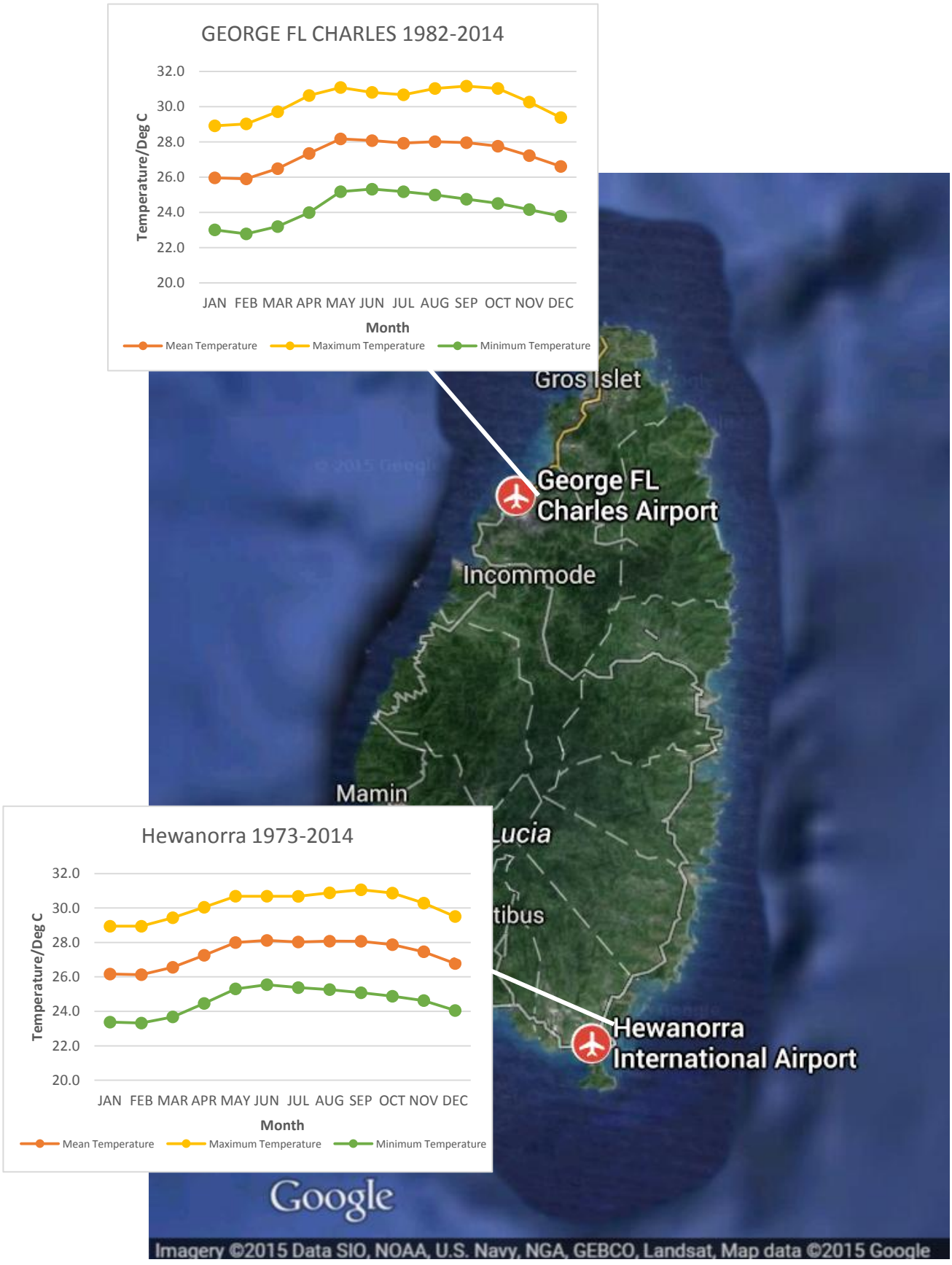


Figure 2.5: Monthly Temperature Climatology for Two Stations in Saint Lucia

2.3.2 Trends

Decadal temperature climatologies show that temperatures have risen steadily over time (Figure 2.6). Summer minima were highest in the 1990s, but the warmest decade on record at the Hewanorra International Airport was found to be the 2000s.

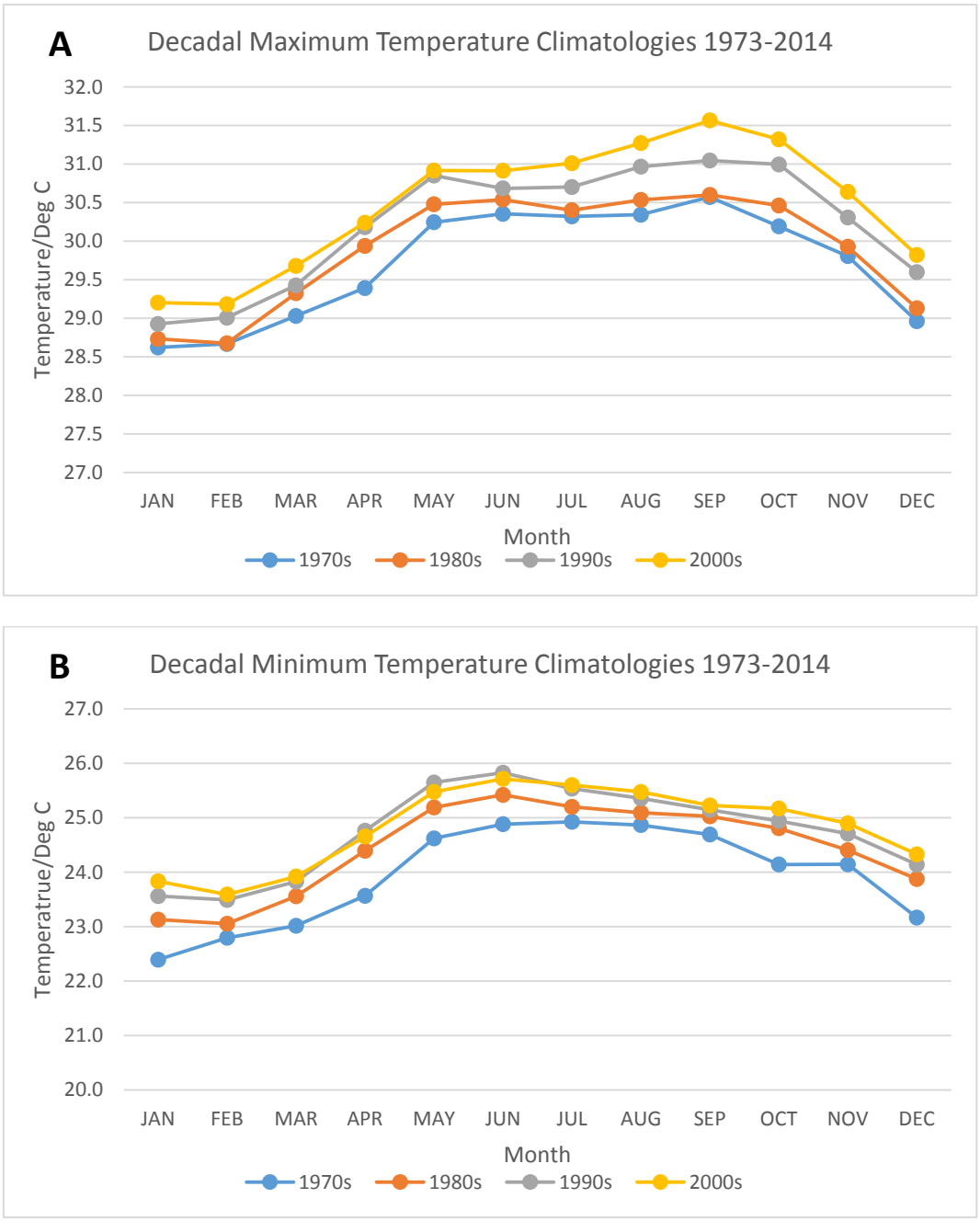


Figure 2.6: Average monthly variations in (A) maximum temperature and (B) minimum temperature

2.3.3 Extreme Indices

There has been an increase in the annual frequency of warm days and nights accompanied by a decrease in cool days and nights, both with statistically significant trends (Table 2.3). Monthly mean maximum and minimum temperatures have been increasing at a rate of 0.025 °C/month and 0.026 °C/year, respectively. All indicators point to overall warming over the period 1973-2014.

Table 2.3: Trends in extreme temperatures indices 1973-2014 at the Hewanorra International Airport

Descriptive Name	Indices	Units	Trend (/decade)
Annual Maximum Temperature	TMAXmean	°C	0.025
Annual Minimum Temperature	TMINmean	°C	0.026
Cool days	TX10P	%	-0.385
Warm days	TX90P	**%**	0.514
Cool nights	TN10P	%	-0.314
Warm nights	TN90P	%	0.402

2.4 Hurricanes

Figure 2.7 illustrates the number of hurricanes that have impacted Saint Lucia, between 1950 and 2013, passing within 50km of its capital city Castries. It can be seen that Saint Lucia, on average, is impacted by a hurricane once every 12 years. An assessment of the extended best track hurricane dataset suggests that Saint Lucia experiences a major hurricane (a hurricane above category 3) once in every hundred years, see Table 2.4. Of the 5 hurricanes listed in Table 2.4, more than 60 percent had a path that directly impacted Saint Lucia. The decades commencing 1970 and 1990 represented a period of absolutely no hurricane within a radius of 50 km of Castries. However, for the decade of 1980, Saint Lucia was impacted by the strongest category hurricane to pass within 50km of Castries.

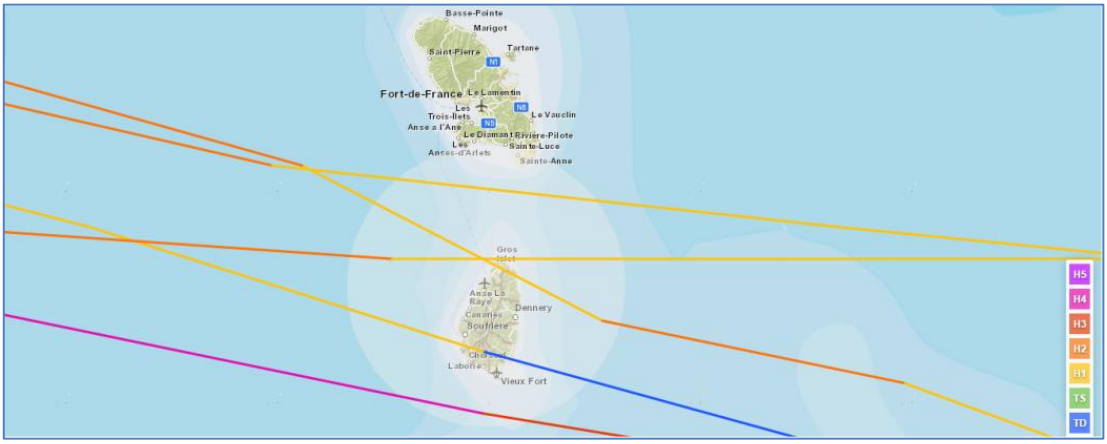


Figure 2.7: Number of Hurricanes as well as their intensity when passing within 50km of the Castries, between 1950 and 2013

Table 2.4: Detailed timeline of Hurricanes that impacted Saint Lucia between 1950 and 2013

Year	Hurricane Name	Maximum Intensity
1951	Dog	H1
1960	Abby	H1
1963	Edith	H2
1980	Allen	H4
2007	Dean	H1

An investigation of the number of tropical storms that have impacted the island suggest that 66% of these storms made landfall over the 50 year period examined (see

Figure 2.8). In fact a closer examination of the dataset indicates that prior to 2012, all tropical storms passing within 50 km of Saint Lucia made landfall.

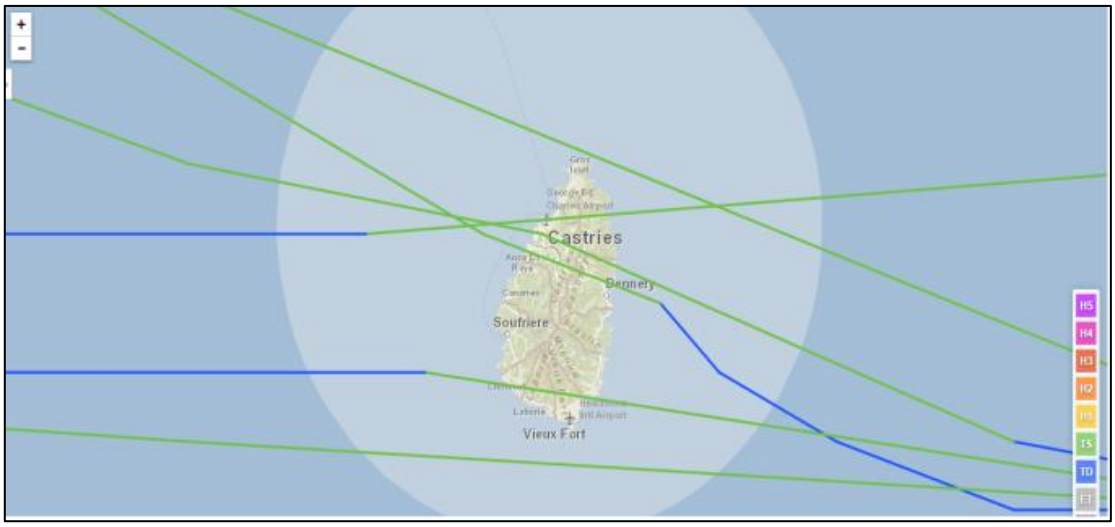


Figure 2.8: Number of Tropical Storms that passed with 50 km of Castries, Saint Lucia, between 1950 and 2013.

Table 2.5: Names and dates of occurrence of tropical storms that passed within 50km of Castries, Saint Lucia, between 1950 and 2013.

Year	Storm Name
1966	Judith
1967	Beulah
1979	Ana
1994	Debby
2012	Ernesto
2013	Chantal

2.5 Sea Level Rise

2.5.1 Global

Using proxy and instrumental data, it is virtually certain (i.e. with 99-100% probability) that the rate of global mean sea level rise has accelerated during the last two centuries, marking the transition from relatively low rates of change during late Holocene (order tenths of mm yr^{-1}) to modern rates (order mm $year^{-1}$). Rates and absolute changes in global mean sea level pressure are shown in Table 2.6.

Table 2.6: Rates and absolute change in mean sea level pressure. Rates are obtained from IPCC (2013)

Period	Rate (mm yr^{-1})	Total sea level rise	IPCC Likelihood
1901 – 2010	1.7 ± 0.2	0.19 ± 0.02	Very likely
1971 – 2010	2.0 ± 0.2	-	Very likely
1993 – 2010	3.2 ± 0.4	-	Very likely

The rate represented in the 1993-2010 period reflects data obtained from tide-gauge and satellite altimeter sources. It is likely that rates similar to this period also occurred between 1930 and 1950. It is also likely that global mean sea level has accelerated since the early 1900s, with estimates ranging from 0.000 to 0.013 [-0.002 to 0.019] mm yr^{-2} (IPCC, 2013). Accelerations in the rate of increase over the 20th Century have been detected in most regions.[12]

2.5.2 Caribbean

Estimates of observed sea level rise from 1950 to 2000 suggest that sea level rise within the Caribbean appears to be near the global mean. Table 2.7 shows the rates of sea level rise for a number of locations in the Caribbean. All values suggest an upward trend. It is important to note that due to shifting surface winds, expansion of warming ocean water and the addition of melting ice, ocean currents can be altered which, in turn leads to changes in sea level that vary from place to place. Additionally, more localized processes such as sediment compaction and tectonics[13] may also contribute to additional variations in sea level.

Table 2.7: Observed rates of sea level rise for some Caribbean stations. Source: The State of the Jamaican Climate (2013)

Tidal gauge Station	Observation Period	Rates (mm yr^{-1})
Bermuda	1932 –2006	2.04 ± 0.47
San Juan, Puerto Rico	1962 –2006	1.65 ± 0.52
Guantanamo Bay, Cuba	1973 –1971	1.64 ± 0.80
Miami Beach, Florida	1931 –1981	2.39 ± 0.43
Vaca Key, Florida	1971 –2006	2.78 ± 0.60

[12] See for example Woodworth et al. (2009), and Church and White (2006).
[13] Tectonics defined as the study of the processes by which the earth's crust has attained its present structure (Source: http://dictionary.reference.com/)

3 Future Projections

3.1 Presenting the Model Data

Global Circulation Models (GCMs) are useful tools for providing future climate information. GCMs are mathematical representations of the physical and dynamical processes in the atmosphere, ocean, cryosphere and land surfaces. Their physical consistency and skill at representing current and past climates make them useful for simulating future climates, under differing scenarios, of increasing greenhouse gas concentrations (scenarios are discussed further below).

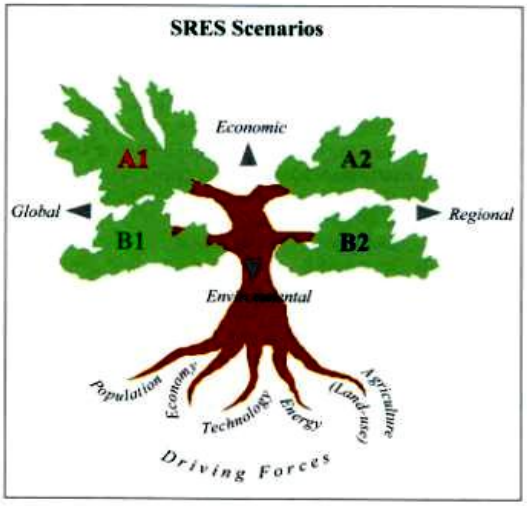
Projections of rainfall and temperature characteristics for Saint Lucia to mid-century are extracted from the CMIP3 project (McSweeney et al. 2010). Data from 15 GCMs were analysed and projected change averaged over Saint Lucia for the 2030s and 2060s, under three emissions scenarios, are presented in summary tables. An inherent drawback of the GCMs, however, is their coarse resolution relative to the scale of required information. The size of Saint Lucia precludes it being physically represented in the GCMs, and there is a need for *downscaling* techniques to provide more detailed information on a country or station level. The additional information that the downscaling techniques provide do not, however, devalue the information provided by the GCMs, especially since (1) Saint Lucia's climate is largely driven by large-scale phenomenon; (2) the downscaling techniques themselves are driven by the GCM outputs; and (3) at present, the GCMs are the best source of future information on some phenomena e.g. hurricanes.

Data from d*ynamical* downscaling methods are also used. This downscaling method employs a regional climate model (RCM) driven at its boundaries by the outputs of the GCMs. Like GCMs, the RCMs rely on mathematical representations of the physical processes, but are restricted to a much smaller geographical domain (the Caribbean in this case). The restriction enables the production of data of much higher resolution (typically < 100 km). Available RCM data for Saint Lucia were obtained from the PRECIS (Providing Regional Climates for Impact Studies) model (Taylor et al., 2007). The PRECIS model resolution is 25 km.

3.2 Emission Scenarios

The GCMs, RCM, and statistical downscaling model are run using the Special Report Emission Scenarios (SRES) (Nakicenovic et al. 2000).[14] Each SRES scenario is a plausible storyline of how a future world will look. The scenarios explore pathways of future greenhouse gas emissions, derived from self-consistent sets of assumptions about energy use, population growth, economic development, and other factors. They, however, explicitly exclude any global policy to reduce emissions to avoid climate change. Scenarios are grouped into families according to the similarities in their storylines as shown in Figure 3.1 below.

[14] In 2000, the Intergovernmental Panel on Climate Change (IPCC) published a Special Report on Emissions Scenarios (SRES), presenting multiple scenarios of greenhouse gas and aerosol precursor emissions for the 21st century.



A1 storyline and scenario family: *a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies.*

A2 storyline and scenario family: *a very heterogeneous world with continuously increasing global population and regionally oriented economic growth that is more fragmented and slower than in other storylines.*

B1 storyline and scenario family: *a convergent world with the same global population as in the A1 storyline but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies.*

B2 storyline and scenario family: *a world in which the emphasis is on local solutions to economic, social, and environmental sustainability, with continuously increasing population (lower than A2) and intermediate economic development.*

Figure 3.1: Special Report on Emission Scenarios (SRES) schematic and storyline summary (Nakicenovic et al, 2000)

Since there is an equal probability of each storyline becoming the future, the results presented in the following section cover a range of scenarios, namely the A2, B1, B2 and A1B (see again Figure 3.1). A2 and B2 are representative of high and low emissions scenarios respectively (Figure 3.2), and A1B is a compromise between the two. The A1B scenario is characterized by an increase in carbon dioxide emissions through mid-century followed by a decrease.

The future climate is presented as absolute or percentage deviations from the present day climate which is in turn represented by averaging over 30 year periods, usually 1961-1990 or 1971-2000. Results are presented for 10 year bands centred on 2030 and 2060 and for the end of the century (2100).

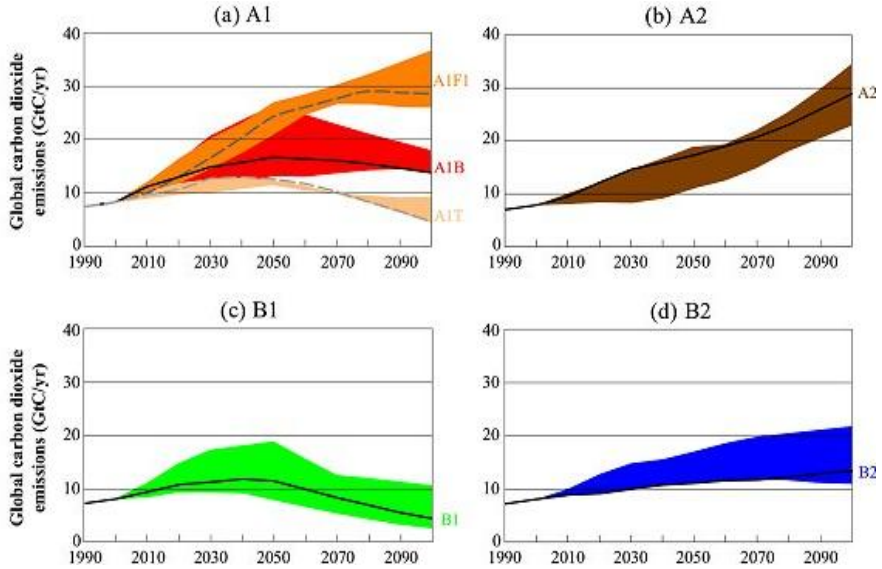


Figure 3.2: Total global annual CO2 emissions from all sources (energy, industry, and land-use change) from 1990 to 2100 (in gigatonnes of carbon (GtC/yr) for the families and six SRES scenario groups (Nakicenovic et al, 2000).

3.3 RCM Perturbed Experiments

RCM results are derived from PRECIS driven perturbed physics experiments (PPE). Created using the A1B SRES scenario, PPE's provide an alternative to using several driving GCM boundary conditions (McSweeney et al 2012). PPE's comprises a 17 member ensemble (HadCM3Q0-Q16); however, for the purposes of this study, a subset of 6 representatives was used. The 6 in question are the ensemble members Q0, Q3, Q4, Q10, Q11 and Q14.

Figure 3.3 shows how the island of Saint Lucia is represented by the PRECIS RCM. The island is covered by two grid boxes. The results presented below will seek to detail temperature (mean, maximum and minimum), precipitation and wind speed changes associated with each grid box for the 2030's. For each of these variables, the average of the 6 perturbations is presented, as well as, the minimum and maximum associated change in the monthly, seasonal and annual time scales.

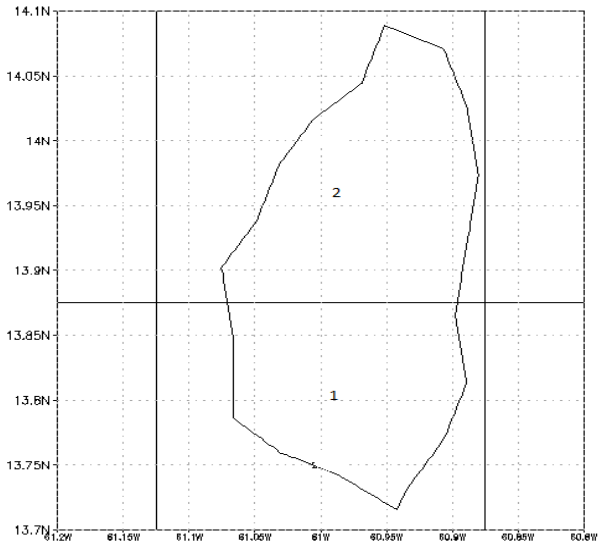


Figure 3.3: Saint Lucia as represented by the PRECIS model

3.4 Temperature Projections

3.4.1 Mean Annual Temperature

The annual mean temperature of Saint Lucia is projected to increase irrespective of scenario, model or methodology used.

3.4.1.1 GCM

The mean annual temperature is projected to increase by 0.3 to 1.2˚C by the 2030s and 0.5 to 2.1˚C by the 2060s (Table 3.1). The projected rate of warming is similar throughout the year, but a little more rapid in December-February (DJF) and September-November (SON). Projections indicate a potential increase of 0.3 to 1.3 ˚C in DJF and 0.4 to 1.3 ˚C in SON by the 2030s. By the 2060s, this escalates to 0.5 to 2.2 °C in DJF and 0.6 to 2.2 ˚C in SON.

Table 3.1: Projected Changes in Annual and Seasonal Temperature for GCM grids over Saint Lucia. Changes are Relative to a 1970 - 1999 baseline

		Projected change by the 2030s			Projected change by the 2060s		
		Min	Median	Max	Min	Median	Max
		Change in °C			Change in °C		
Annual	A2	0.7	0.9	1.0	1.3	1.7	2.1
	A1B	0.5	1.0	1.2	0.8	1.7	2.0
	B1	0.3	0.8	1.0	0.5	1.2	1.6
DJF	A2	0.7	0.9	1.0	1.3	1.7	2.2
	A1B	0.5	0.9	1.3	0.8	1.7	2.1
	B1	0.3	0.8	1.1	0.5	1.2	1.6
MAM	A2	0.6	0.9	1.0	1.2	1.6	2.1
	A1B	0.4	0.8	1.2	0.7	1.6	2.0
	B1	0.2	0.8	1.0	0.4	1.2	1.6
JJA	A2	0.6	0.9	1.1	1.1	1.8	2.0
	A1B	0.4	1.0	1.1	0.8	1.7	2.1
	B1	0.2	0.8	1.1	0.4	1.2	1.5
SON	A2	0.7	1.0	1.2	1.4	1.8	2.2
	A1B	0.6	1.0	1.3	1.0	1.7	2.1
	B1	0.4	0.8	1.1	0.6	1.3	1.5

3.4.1.2 RCM

At higher resolutions relative to the GCMs, the projected changes in mean temperature over the northern and southern extent of the island of Saint Lucia appear to be different (Table 3.2). The northern half of Saint Lucia is projected to be warmer than the southern half, though warming is projected across the entire island. Although there is a lack of uniformity on the warming associated with the northern and southern extent of the island, key points are still held true; August-September-October (ASO) and November-December-January (NDJ) still represent the seasons in which the largest mean warming signal is noted. December is projected to have the largest projected increase in temperature when the monthly timescale is considered, and the average projected increase in annual temperatures is approximately 1.3°C.

Table 3.2: Projected Change in Mean Temperature for RCM Grids over Saint Lucia. Changes are Relative to a 1961 - 1990 Baseline

		GRID BOX 1			GRID BOX 2	
	MIN	MEAN	MAX	MIN	MEAN	MAX
JAN	0.845	1.216	1.430	0.878	1.299	1.544
FEB	0.848	1.219	1.435	0.881	1.302	1.547
MAR	0.853	1.222	1.439	0.885	1.305	1.552
APR	0.857	1.225	1.443	0.888	1.307	1.555
MAY	0.862	1.227	1.445	0.893	1.309	1.558
JUN	0.865	1.229	1.449	0.897	1.312	1.562
JUL	0.867	1.232	1.453	0.900	1.314	1.565
AUG	0.870	1.235	1.457	0.905	1.317	1.570
SEPT	0.872	1.238	1.463	0.908	1.320	1.576
OCT	0.875	1.240	1.469	0.911	1.323	1.582
NOV	0.877	1.243	1.472	0.915	1.325	1.585
DEC	0.880	1.245	1.476	0.919	1.328	1.589
NDJ	0.868	1.235	1.460	0.904	1.317	1.573
FMA	0.853	1.222	1.439	0.885	1.304	1.551
MJJ	0.865	1.229	1.449	0.897	1.312	1.562
ASO	0.872	1.237	1.463	0.908	1.320	1.576
ANNUAL	0.864	1.231	1.453	0.898	1.313	1.565

3.4.2 Maximum Temperature

3.4.2.1 RCM

The near term projections of maximum temperature for the grids associated with Saint Lucia suggest an increase of approximately 1.0°C to 1.4°C annually in maximum temperature (Table 3.3). Though the north of the island is projected to have a faster rate of warming in the mean than the south, its rate of warming in terms of maximum temperature is slower than that of the south. However, these differences in rate of warming are relatively small.

Table 3.3: Projected Change in Maximum Temperature for Grids over Saint Lucia for the 2030s. Changes are Relative to a 1961 - 1990 Baseline

		GRID BOX 1			GRID BOX2	
	MIN	MEAN	MAX	MIN	MEAN	MAX
JAN	0.945	1.228	1.405	0.870	1.184	1.360
FEB	0.948	1.232	1.409	0.871	1.186	1.362
MAR	0.954	1.235	1.413	0.875	1.188	1.365
APR	0.956	1.237	1.416	0.878	1.190	1.366
MAY	0.961	1.239	1.414	0.880	1.191	1.368
JUN	0.962	1.240	1.412	0.882	1.193	1.371
JUL	0.962	1.242	1.413	0.882	1.195	1.374
AUG	0.962	1.244	1.417	0.883	1.197	1.378
SEPT	0.959	1.246	1.423	0.881	1.200	1.384
OCT	0.960	1.249	1.429	0.882	1.203	1.390
NOV	0.962	1.250	1.431	0.885	1.204	1.392
DEC	0.963	1.252	1.435	0.888	1.206	1.396
NDJ	0.957	1.244	1.421	0.881	1.198	1.383
FMA	0.953	1.234	1.413	0.875	1.188	1.365
MJJ	0.961	1.240	1.413	0.881	1.193	1.371
ASO	0.960	1.246	1.423	0.882	1.200	1.384
ANNUAL	0.958	1.241	1.414	0.880	1.195	1.376

As is the case for mean temperature, the seasons with the highest projected increases are the summer (August-September-October (ASO)) and boreal winter (November-December-January (NDJ)).

3.4.3 Minimum Temperature

3.4.3.1 RCM

Unlike the changes in maximum temperature, minimum temperatures are expected to increase by 0.9° to 1.7°C by the 2030s on average across Saint Lucia (Table 3.4). However, similar to the projected changes in maximum temperature, the projected changes in minimum temperature indicate a difference in warming rates in the north and south. Again, the north is projected to be warmer than the south by an average of 0.3°C for all seasons. Once again, NDJ and ASO are projected to have the greatest increases. Additionally, the month of December shows the highest change in mean minimum temperature.

Table 3.4: Projected Changes in Minimum Temperature for RCM Grids over Saint Lucia for the 2030s. Changes are Relative to 1961-1990 Baseline

		GRID BOX 1			GRID BOX2	
	MIN	MEAN	MAX	MIN	MEAN	MAX
JAN	0.794	1.255	1.528	0.982	1.520	1.844
FEB	0.797	1.257	1.533	0.985	1.523	1.849
MAR	0.802	1.261	1.538	0.990	1.527	1.856
APR	0.806	1.263	1.543	0.994	1.530	1.862
MAY	0.812	1.267	1.548	1.002	1.534	1.867
JUN	0.817	1.270	1.553	1.008	1.537	1.871
JUL	0.822	1.272	1.557	1.014	1.539	1.875
AUG	0.828	1.276	1.562	1.022	1.543	1.880
SEPT	0.834	1.279	1.567	1.029	1.547	1.885
OCT	0.838	1.282	1.573	1.034	1.550	1.892
NOV	0.843	1.286	1.578	1.041	1.553	1.898
DEC	0.848	1.289	1.582	1.048	1.557	1.902
NDJ	0.828	1.276	1.563	1.024	1.543	1.881
FMA	0.801	1.261	1.538	0.990	1.527	1.856
MJJ	0.817	1.270	1.552	1.008	1.537	1.871
ASO	0.833	1.279	1.567	1.028	1.547	1.886
ANNUAL	0.820	1.271	1.555	1.012	1.538	1.873

3.4.4 Extreme Temperature

3.4.4.1 GCM

The GCM projections all indicate substantial increases in the frequency of days and nights that are considered 'hot' in the current climate (Table 3.5). The annual frequency of warm days and nights is expected to increase to 28-67% by the 2060s, relative to current climate. In contrast, the percentage frequency of occurrence of cool days and nights falls to near zero by the 2060s. A very hot day, or night, is defined as one with temperatures greater than the hottest 10% of days, or nights, in the current climate. Similarly, very cool days, or nights, are those with temperatures less than the coolest 10% of days, or nights respectively, in the current climate (McSweeney et al., 2010). Days that are hot are projected to increase most rapidly in September to November.

Table 3.5: Projected Changes in Seasonal and Annual Temperature Extremes for GCM Grids over Saint Lucia for 2071-2099. Changes are Relative to 1961-1989 Baseline

		Frequency of hot days			**Frequency of hot nights**		
		Min	**Median**	**Max**	**Min**	**Median**	**Max**
		Future % frequency			**Future % frequency**		
Annual	A2	38	52	67	39	52	68
	A1B	40	61	67	40	60	65
	B1	28	44	51	28	49	53
DJF	A2	65	74	96	59	69	95
	A1B	54	79	94	53	77	93
	B1	29	53	76	28	57	74
MAM	A2	67	78	98	64	77	97

		Frequency of hot days			Frequency of hot nights		
		Min	Median	Max	Min	Median	Max
		Future % frequency			Future % frequency		
	A1B	57	78	96	58	79	96
	B1	29	49	89	30	54	87
JJA	A2	57	83	97	53	83	98
	A1B	61	87	94	62	88	96
	B1	36	70	78	32	71	85
SON	A2	80	91	99	80	93	99
	A1B	81	93	99	82	93	99
	B1	55	79	95	58	79	97

3.4.4.2 RCM

Projected temperature extremes confirm the likelihood of warming over the island of Saint Lucia (Table 3.6). Trends in maximum and minimum temperatures are projected to increase under both A2 and B2 scenarios, with the greatest rate of change occurring mid to late century. The percentage of cool days and nights will also decrease under either SRES scenario, in contrast to an increase in warm days and nights.

Table 3.6: Projected changes in trends in temperature extremes for RCM grids over Saint Lucia (14oN, 61oW) for the time slices 2020-2040, 2040-2060, 2060-2080, 2080-2010 and 2071-2099. Changes are relative to 1961-1989 baseline. Values in bold are statistically significant at the 95% level

			2020-2040		2040-2060		2060-2080		2080-2100		2071-2100	
Indices	**Name**	**Units**	**A2**	**B2**	**A2**	**B2**	**A2**	**B2**	**A2**	**B2**	**A2**	**B2**
TMAX mean	**Mean Monthly Maximum Temperature**	°C	*0.01*	*0.02*	*0.03*	*0.03*	*0.04*	*0.01*	*0.03*	*0.02*	*0.03*	*0.01*
TMIN mean	**Mean Monthly Minimum Temperature**	°C	*0.01*	*0.01*	*0.03*	*0.03*	*0.04*	*0.00*	*0.03*	*0.01*	*0.03*	*0.00*
TN10P	**Cool Nights**	% days	-0.02	*0.10*	*-0.92*	*-0.91*	*-1.16*	*-0.25*	*-1.37*	*-0.47*	*-0.90*	*0.05*
TN90P	**Warm Nights**	% days	*0.94*	*1.19*	*1.81*	*1.21*	*1.71*	0.06	*1.16*	*0.71*	*0.77*	*0.42*
TX10P	**Cool Days**	% days	*-0.32*	0.01	*-0.96*	*-1.25*	*-1.19*	*-0.49*	*-1.25*	*-0.65*	*-0.95*	*-0.11*
TX90P	**Warm Days**	% days	*0.69*	*1.02*	*1.75*	*1.08*	*1.73*	0.04	*0.84*	*0.83*	*0.60*	*0.42*

3.5 Rainfall

3.5.1 Mean Rainfall

There is much less consensus in the projected rainfall patterns for Saint Lucia.

3.5.1.1 GCM

Through the 2030s, the projected change in mean annual rainfall ranges from +18% to -25%, dependent on model and scenario and projected changes of +10 to -40% by the 2060s (Table 3.7). Very little can be confidently said about changes in the rainy seasons due to the wide variations in the projected change, dependent on model and scenario. However, median changes are largely negative for all seasons suggesting drier conditions.

Table 3.7: Projected percentage changes in annual and seasonal precipitation for GCM grids over Saint Lucia. Changes are relative to 1970 - 1999

		Projected change by the 2030s			Projected change by the 2060s		
		Min	Median	Max	Min	Median	Max
		% Change			% Change		
Annual	A2	-24	-11	10	-39	-12	10
	A1B	-22	-3	8	-40	-13	7
	B1	-25	-6	18	-36	-7	2
DJF	A2	-19	-3	9	-29	-6	8
	A1B	-25	-3	48	-19	-7	8
	B1	-29	-4	25	-25	-5	13
MAM	A2	-30	-3	12	-39	-8	35
	A1B	-39	-1	13	-67	-6	11
	B1	-14	-2	30	-64	-2	10
JJA	A2	-37	-14	2	-55	-16	23
	A1B	-38	-9	15	-56	-17	2
	B1	-36	-5	24	-55	-13	11
SON	A2	-39	-3	21	-45	-6	12
	A1B	-32	4	17	-46	-5	12
	B1	-28	-3	28	-41	-4	5

3.5.1.2 RCM

In agreement with the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4), Table 3.8 shows a projected mean percentage decrease in precipitation. The maximum decrease in monthly average percentage values is projected to occur in dry months of January to March (20%). However, on the seasonal scale, the largest decreases are seen in February-March-April (FMA) (21%) and May-June-July (MJJ) (20%). All mean monthly percentage decreases are no less than 4% for Saint Lucia, with slightly greater drying occurring in the south than in the north.

Table 3.8: Projected percentage change in monthly, seasonal and annual precipitation for RCM grids over Saint Lucia relative to a 1961-1990 baseline

		GRID BOX 1			GRID BOX 2	
	MIN	MEAN	MAX	MIN	MEAN	MAX
JAN	-21.201	-9.558	-3.282	-20.806	-5.981	1.220
FEB	-21.191	-9.539	-3.095	-20.756	-5.957	1.273
MAR	-21.204	-9.466	-2.846	-20.765	-5.889	1.419
APR	-21.030	-9.396	-2.537	-20.524	-5.804	1.471
MAY	-20.985	-9.364	-2.339	-20.460	-5.746	1.923
JUN	-20.452	-9.184	-2.285	-19.842	-5.527	2.452
JUL	-19.746	-9.011	-1.998	-18.860	-5.330	2.833
AUG	-19.044	-8.794	-1.734	-18.066	-5.064	3.062
SEPT	-18.061	-8.696	-1.546	-17.146	-4.945	3.378
OCT	-17.502	-8.728	-1.468	-16.599	-4.943	3.192
NOV	-17.390	-8.366	-0.865	-16.484	-4.523	3.947
DEC	-17.192	-8.189	-0.694	-16.159	-4.309	4.214
NDJ	-18.612	-8.713	-1.620	-17.838	-4.947	3.115
FMA	-21.142	-9.467	-2.826	-20.682	-5.884	1.388
MJJ	-20.395	-9.186	-2.207	-19.722	-5.535	2.402
ASO	-18.204	-8.740	-1.582	-17.272	-4.985	3.211
ANNUAL	-19.594	-9.029	-2.059	-18.885	-5.341	2.526

3.5.2 Extreme Rainfall

3.5.2.1 GCM

The proportion of annual total rainfall that falls in heavy events decreases in most model projections, changing by -22% to +5% by the 2060s (Table 3.9). Annual Maximum 1- day rainfall totals show a tendency towards remaining constant, as suggested from the equal bands and zero and near-zero median values, under the range of scenarios. The maximum 5-day rainfall is projected to decrease by up to 5 mm across the annual and seasonal timescales, as suggested by the median change values.

Table 3.9: Projected changes in Rainfall Extremes for GCM grids over Saint Lucia for the 2060s. Changes are Relative to a 1970-1999 Baseline

		% total rainfall in Heavy Events (R95P)			**Maximum 1-day rainfall (RX1day)**			**Maximum 5-day Rainfall (RX5day)**		
		Min	**Median**	**Max**	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**
		% Change			**Change in mm**			**Change in mm**		
Annual	A2	-20	-1	4	-8	0	2	-17	-1	7
	A1B	-19	-1	5	-7	-1	8	-20	-5	7
	B1	-22	-2	5	-7	0	9	-21	-2	13
DJF	A2	-13	0	5	-3	0	0	-7	-1	5
	A1B	-7	0	4	-1	0	0	-7	0	5
	B1	-13	0	5	-2	0	1	-7	0	6
MAM	A2	-9	-3	4	-1	0	3	-4	0	9
	A1B	-10	-2	5	-2	0	4	-5	0	9

		% total rainfall in Heavy Events (R95P)			Maximum 1-day rainfall (RX1day)			Maximum 5-day Rainfall (RX5day)		
		Min	Median	Max	Min	Median	Max	Min	Median	Max
		% Change			Change in mm			Change in mm		
	B1	-17	-3	2	-6	0	0	-13	-1	0
JJA	A2	-25	-3	7	-12	0	2	-28	-4	10
	A1B	-23	-4	3	-10	-1	1	-24	-5	4
	B1	-27	-1	7	-13	0	5	-28	-4	9
SON	A2	-11	-1	7	-6	-1	2	-13	-1	7
	A1B	-22	-3	8	-5	-1	8	-18	-5	19
	B1	-17	-1	6	-4	0	5	-16	-1	7

3.5.2.2 RCM

RCM projections of extreme rainfall indicate a brief mid-century increase in the amount of rainfall, followed by overall drying towards late Century, though most of these trends are not significant at the 95% level (Table 3.10). Despite the likely drying trend, the number of consecutive dry days will also decrease in this time, indicating the possibility of less intense rainfall events accompanied by shorter dry spells.

Table 3.10: Projected changes in trends in rainfall extremes for RCM grids over Saint Lucia (14oN, 61oW) for the time slices 2020-2040, 2040-2060, 2060-2080, 2080-2010 and 2071-2099. Changes are relative to 1961-1989 baseline. Values in bold are statistically significant at the 95% level

			2020-2040		2040-2060		2060-2080		2080-2100		2071-2100	
Indices	Name	Units	A2	B2	A2	B2	A2	B2	A2	B2	A2	B2
CDD	Consecutive Dry Days	days	-0.01	-0.12	-0.44	-0.28	-0.01	-0.17	-0.06	-0.21	-0.12	-0.24
CWD	Consecutive Wet Days	days	0.01	-0.12	0.06	-0.01	0.08	-0.04	-0.01	0.01	0.00	0.03
PRCPTOT	Annual Total Wet-Day Precipitation	mm	0.30	-3.09	1.23	2.55	0.62	0.14	-0.07	-0.38	-0.17	-0.44
R10	Number of Heavy Precipitation Days	days	-0.01	-0.05	0.02	0.01	0.00	-0.01	-0.02	-0.01	-0.01	-0.01
R95P	Very Wet Days	days	0.84	-2.81	0.05	2.38	0.11	-0.14	-0.38	-0.52	-0.39	-0.73

			2020-2040		2040-2060		2060-2080		2080-2100		2071-2100	
Indices	**Name**	**Units**	**A2**	**B2**	**A2**	**B2**	**A2**	**B2**	**A2**	**B2**	**A2**	**B2**
R99P	**Extremely Wet Days**	**days**	0.93	-2.81	-0.02	2.77	***0.31***	-0.06	-0.25	-0.41	-0.24	-0.30
RX5day	**Max 5-Day Precipitation Amount**	**mm**	0.74	-2.78	0.07	2.42	0.25	-0.13	-0.32	-0.26	-0.28	-0.43

3.6 Wind Speed

There is a high degree of agreement on the projected changes in wind resources across the island, with mean increase of 0.06 m/s (Table 3.11). The northern extent of the island is projected to have smaller increases in mean wind resources than the southern extent in all time scales.

Table 3.11: Projected Changes in Wind Speeds for Grids over Saint Lucia for the 2030s. Changes are Relative to a 1961-1990 Baseline

		GRID BOX 1			GRID BOX 2	
	MIN	MEAN	MAX	MIN	MEAN	MAX
JAN	-0.036	0.071	0.149	-0.046	0.061	0.139
FEB	-0.033	0.069	0.152	-0.043	0.059	0.142
MAR	-0.035	0.069	0.152	-0.046	0.059	0.141
APR	-0.038	0.068	0.154	-0.049	0.058	0.143
MAY	-0.036	0.068	0.152	-0.047	0.058	0.141
JUN	-0.041	0.067	0.155	-0.052	0.057	0.144
JUL	-0.043	0.065	0.155	-0.055	0.055	0.144
AUG	-0.044	0.063	0.157	-0.056	0.053	0.145
SEPT	-0.043	0.062	0.157	-0.055	0.052	0.145
OCT	-0.045	0.060	0.160	-0.057	0.050	0.148
NOV	-0.047	0.061	0.166	-0.059	0.051	0.154
DEC	-0.047	0.062	0.164	-0.059	0.052	0.151
NDJ	-0.043	0.064	0.160	-0.055	0.055	0.148
FMA	-0.035	0.069	0.152	-0.046	0.059	0.142
MJJ	-0.040	0.067	0.154	-0.051	0.057	0.143
ASO	-0.044	0.061	0.158	-0.056	0.052	0.146
ANNUAL	-0.041	0.065	0.156	-0.052	0.055	0.145

3.7 Tropical storms

Since the models examined do not explicitly model hurricanes, it is the IPCC's projections that are relied on. Based on a range of models, the IPCC suggests that future hurricanes of the north tropical Atlantic will *likely*[15] become more intense, with larger peak wind speeds and heavier near storm precipitation. The stronger hurricanes result from ongoing and projected increases in tropical ocean temperatures (from surface through 450 m) and atmospheric water vapour content (Barnett et al.

[15] In the IPCC Summary for Policymakers, the following terms have been used to indicate the assessed likelihood, using expert judgement, of an outcome or a result: *Virtually certain* > 99% probability of occurrence, *Extremely likely* > 95%, *Very likely* > 90%, *Likely* > 66%, *More likely than not* > 50%, *Unlikely* < 33%, *Very unlikely* < 10%, *Extremely unlikely* < 5%.

2005; Levitus et al., 2005; Anthes et al., 2006). Increases in both variables can be linked to warmer air temperatures. The warmer ocean temperatures would satisfy the warm sea surface temperature criterion for hurricane intensification, but would also likely limit a natural 'braking' process of hurricanes. Colder deeper waters typically serve to weaken a storm as they are churned up by the strong wind field. If deeper waters become too warm, the natural braking mechanism will be diminished.

There is, however, less confidence in regional projections of a *decrease* in the number of relatively *weak* tropical cyclones, *increased* numbers of *intense* tropical cyclones and a global *decrease* in the *numbers* of tropical cyclones (Bender et al., 2010; Emanuel et al., 2007; Knutson et al., 2010). Projections of North Atlantic hurricane activity indicate that the frequency of the most intense storms is more likely than not to increase by more than +10% (IPCC 2013, AR5), while the annual frequency of tropical cyclones are projected to decrease or remain relatively unchanged (see Figure 2.4) .Some modelling studies attribute the possible global decrease in the number of cyclones to increased stability of the tropical troposphere (due to differential warming in the vertical in a warmer climate), which compensates for the impact of the warmer ocean temperatures (IPCC 2013, AR5).

Under CMIP3's A1B scenario, Bender et al., 2010 evaluated projections of tropical storm and hurricane frequencies modelled across a suite of global climate models (GCMs). The frequency of North Atlantic tropical storms and hurricanes is projected to decline by an average of 28% per year, while hurricanes of category 4 and 5 (wind speeds greater than 59 m/s) show an increase of 81% per year under a warmed climate. The projected increases just about triple for the most intense storms of wind speeds greater than 65 m/s, with an annual increase of 250%. Similar results are obtained through other studies with high resolution dynamical models (Oouchi et al., 2006; Bengtsson et al., 2007; Knutson et al., 2008; Gualdi et al., 2008; Sugi et al., 2009), statistical models (Villarini et al., 2011; Camargo, 2013), and statistical-dynamical methods (Emanuel et al., 2007).

Alternatively, more recent studies acknowledge the growing influence of spatial variations in sea surface temperatures on tropical cyclone activity in the North Atlantic as SSTs increase throughout the region (Sugi et al., 2009, Murakami et al., 2012, Camargo, 2013). Under CMIP5's RCP4.5, projections based on relative SSTs indicate a steady increase of 50% in Atlantic potential dissipation index (PDI) values by the end of the Century (Villarini and Vecchi, 2013).

Studies also suggest that rainfall rates associated with hurricanes are likely to intensify (Knutson et al., 2013; Villarini et al., 2014). Knutson et al., 2013 concluded that radius-averaged rainfall rates may increase by approximately 20% for radii within 100-km of the hurricane core. This conclusion follows from a projected increase in atmospheric water-vapour content, which in turn increases moisture convergence and the subsequent development of convective systems, such as hurricanes. However, due to complex dynamics, projections of rainfall rates near to the centre of the hurricane prove to be more difficult (Knutson et al., 2010).

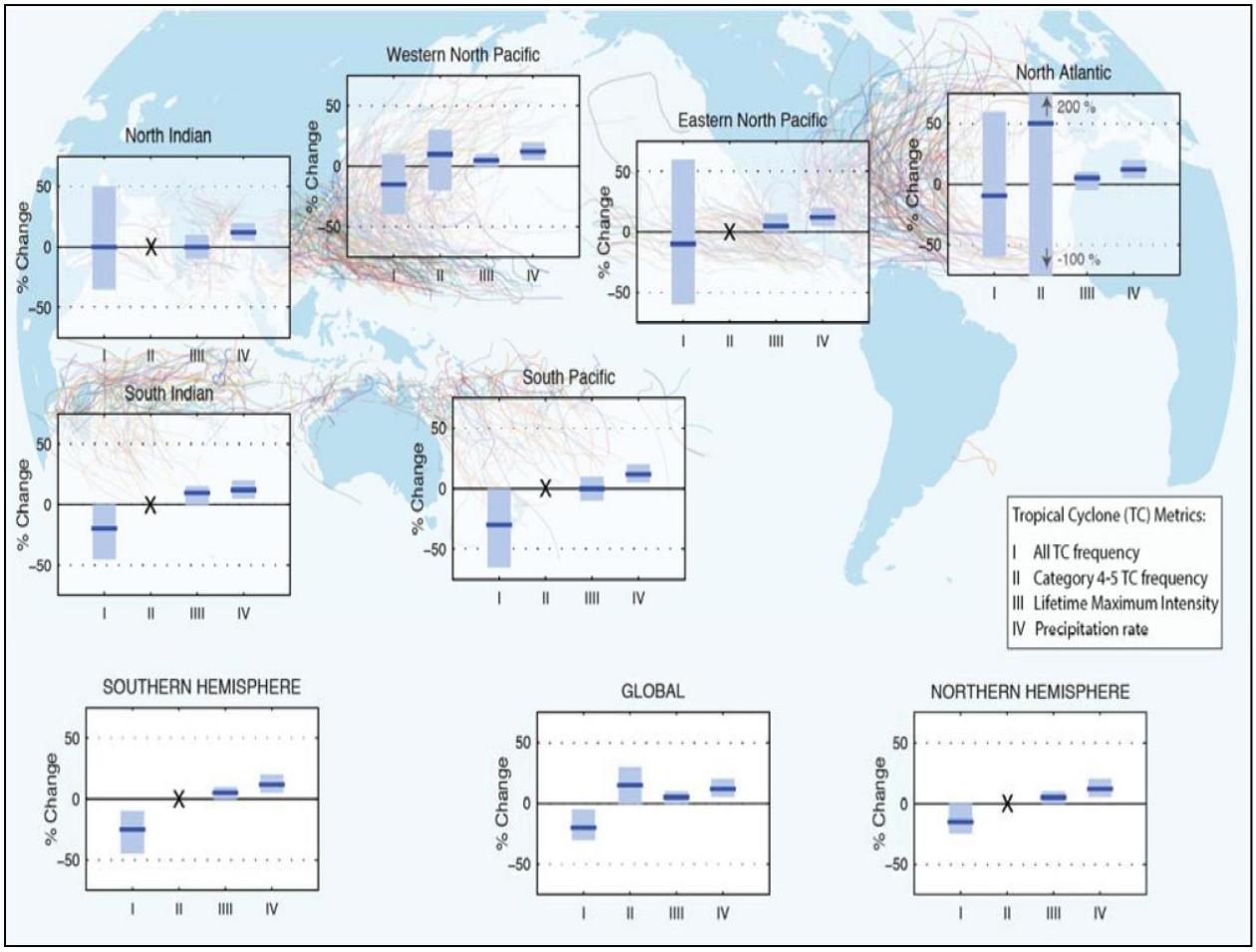


Figure 3.4: Projected changes in tropical cyclone statistics. All values represent expected change in the average over period 2081-2100 relative to 2000-2019, under an A1B-like scenario, based on expert judgement after subjective normalisation of the model projections. Four metrics were considered: the percent change in I) the total annual frequency of tropical storms, II) the annual frequency of Category 4 and 5 storms, III) the mean Lifetime Maximum Intensity (LMI; the maximum intensity achieved during a storm's lifetime), and IV) the precipitation rate within 200km of storm center at the time of LMI. For each metric plotted, the solid blue line is the best guess of the expected percent change, and the coloured bar provides the 67% (likely) confidence interval for this value (note that this interval ranges across -100% to +200% for the annual frequency of Category 4 and 5 storms in the North Atlantic). Where a metric is not plotted, there is insufficient data (denoted "X") available to complete an assessment. A randomly drawn (and coloured) selection of historical storm tracks underlaid to identify regions of tropical cyclone activity. Source: IPCC AR5

3.8 Sea Level Rise

Ocean expansion (due to warming) and the inflow of water from melting land ice have raised the global sea level over the last decade. Large deviations among the limited set of models addressing the issue, however, make future estimates of sea level change uncertain, including for the Caribbean. Though little data exists to project future sea level rise for Saint Lucia, changes in the Caribbean region are expected to be near the global mean. Under the A1B scenario, sea level rise within the Caribbean is expected to be between 0.17 m and 0.24 m by 2050 (IPCC 2007). For comparison, global sea level rise is expected to average 0.35 m (0.21 to 0.48 m) under the same scenario by the end of the Century (relative to the period 1980-1999) (Table 3.12).

Higher projections of sea level rise are noted in the IPCC Fifth Assessment Report (AR5) in comparison to the Fourth Assessment Report (AR5). This is considered to be primarily due to the improved modelling of land-ice contributions. There is also higher confidence in the projections of sea level rise in the latter report due to improved understanding of the components of sea level, improved agreement of process-based models with observations, and the inclusion of ice-sheet dynamical changes. Projections and Graph are shown below. In the Representative Concentration Pathway (RCP) projections (see Appendix II), thermal expansion accounts for 30 to 55% of the 21st Century global mean sea level rise, and glaciers for 15 to 35%. AR5 notes that the basis for higher projections of global mean sea level was considered, but it was concluded that there is currently insufficient evidence to evaluate the probability of specific levels above the assessed *likely* rate. Finally, the point is made in AR5 that sea level rise will not be uniform. It is *very likely* that sea level will rise in more than about 95% of the ocean area. Approximately 70% of the coastlines worldwide are projected to experience sea level change within 20% of the global mean sea level change (Table 3.13).

It is useful to note that for the SRES A1B, which was assessed in AR4, the likely range bases on the science assessed in the AR5 are 0.60 [0.41-0.79] m by 2100 relative to 1986-2005 and 0.57 [0.40-0.75] m by 2090-2099 relative to 1990. Compared with the AR4 projection of 0.21-0.48 m for the same scenario and period, the largest increase is from the inclusion of rapid changes in Greenland and Antarctic ice-sheet outflow.

Table 3.12: Projected increases in global mean surface temperature and global and Caribbean mean sea level from the IPCC (2007) contrasted with those of Rahmstorf (2007). Projections are by 2100 relative to 1980-1999. Source: CARIBSAVE Climate Change Risk Atlas

Scenario	Global mean surface temperature (°C)	Global mean sea level rise (m)	Caribbean mean sea level rise (±0.05 m) relative to global mean
IPCC B1	1.1 – 2.9	0.18 – 0.38	0.14 – 0.43
IPCC A1B	1.7 – 4.4	0.21 – 0.48	0.16 – 0.53
IPCC A2	2.0 – 5.4	0.23 – 0.51	0.18 – 0.56
Rahmstorf, 2007	-	Up to 1.4 m	Up to 1.4 m

Table 3.13: Projected increases in global mean surface temperature and global mean sea level. Projections are taken from IPCC (2013) and are relative to 1986-2005

		2046 – 2065		2081 – 2100	
Variable	Scenario	Mean	Likely range	Mean	Likely range
Global Mean Surface Temperature Change(°C)	RCP2.6	1.0	0.4 – 1.6	1.0	0.3 – 1.7
	RCP4.5	1.4	0.9 – 2.0	1.8	1.1 – 2.6
	RCP6.0	1.3	0.8 – 1.8	2.2	1.4 – 3.1
	RCP8.5	2.0	1.4 – 2.6	3.7	2.6 – 4.8
Variable	Scenario	Mean	Likely range	Mean	Likely range
Global Mean Sea Level Rise (m)	RCP2.6	0.24	0.17 – 0.32	0.40	0.26 – 0.55
	RCP4.5	0.26	0.19 – 0.33	0.47	0.32 – 0.63
	RCP6.0	0.25	0.18 – 0.32	0.48	0.33 – 0.63
	RCP8.5	0.30	0.22 – 0.38	0.63	0.45 – 0.82

4 Tourism Sector Vulnerability Issues and Threats

4.1 Sector Profile

Whatever the reason for the shift in development objectives, Saint Lucia has actively marketed the island as an ideal tourist destination based on its diversity of heritage: "rich in history, a perfect blend of French, British and African cultures". The island has and continues to receive positive reviews from visitors. Most Saint Lucians see tourism as particularly important, having significant positive effects on their own lives[16]. However, the industry was once seen as being owned and managed by foreigners and had not been fully accepted as a replacement for agriculture, (Crick 2003). This island was therefore ranked as "not hostile to tourism but not particularly warm to it either". It was noted that this was potentially due to the island being in transition then, from an agrarian to a service-driven economy.

To develop more favourable attitudes to the industry since then, marketing campaigns have been employed as well as the organization of festivals where the communities within the island can directly benefit from tourism. The National Vision Plan, approved by the Cabinet of Ministers in 2009, also provides policy direction to transform the appeal of the island by zoning the island in quadrants and taking advantage of cultural and heritage aspects in various areas.

Saint Lucia is known as a leading international tourist destination for luxury, romance and nature with great potential to further leverage natural and cultural resources and is already a leading international tourist destination for romance and luxury. The island boasts some unique natural attractions, such as, the Twin Peaks of the Pitons Mountains ,a UNESCO World Heritage Site and also the world´s only drive in volcano and its Sulphur Springs in Soufriere. Saint Lucia has been recognized eight times as the world's leading Honeymoon destination by World Travel Awards and boasts the destination with the most luxurious boutique hotels in the world.

Tourism plays an important role in the economy of Saint Lucia. In 2012, Saint Lucia contributed US$169 million directly to GDP (13% contribution); created 13,300 direct jobs (18.6% contribution) and 17,500 indirect jobs. Tourism expenditure in 2012, was US$516 million with contribution to taxes representing approximately 60% of that cost[17]. Saint Lucia enjoys direct connectivity to most major US gateways and the UK. There are two airports; most visitors flying into Saint Lucia from international destinations go through the Hewanorra International Airport in the south. LIAT, Air Caraibes and Caribbean Airways service regional travel from the George F L Charles Airport in the capital, Castries.

In 2014, Saint Lucia received a 6% increase (from 2013) in the number of visitors, driven primarily by an 11% increase in stay-over arrivals from the USA, which accounts for 42% of all visitors. Additionally, the island recorded growth from its entire major source markets in 2014, namely the UK (4%), Canada (15.3%), Germany (9%), France (10%) and the rest of Europe (13%). This evidenced the growing demand and allure of Saint Lucia as a destination of choice as major airlines increased airlift capacity to the island in 2014. This included cruise liners, such as: Celebrity, Carnival,

[16] Crick, A. P. (2003). Internal Marketing of Attitudes in Caribbean Tourism, International Journal of Contemporary Hospitality Management, 15 (3), 161-166.

[17] Source: WTTC Country Report, Saint Lucia, 2012; Source: Saint Lucia Tourism Board, Annual Report, 2012; Source: Saint Lucia House of Assembly, 12 July 2012.

Norwegian, Royal Caribbean International, Oceana Cruises and AIDA Cruises visit Saint Lucia. Cruise arrivals have also remained strong, a testament to the draw of the location and the strong demand for the variety of tours and amenities available on the island.

During the period 2010-2014, increases in demand for international travel, specific weather related events and an increase in airlift augured well for Saint Lucia. The island recorded 1.034 million visitors in 2014, the highest in the history of tourist arrivals for the destination as record numbers were realized for both stay-over and yacht arrivals. This contributed to positive developments in the average daily rates (ADRs), visitor length of stay, occupancy and total visitor expenditure, which increased by 14.3 percent in 2014 to $2.0 billion. Value added in the tourism sector, proxied by hotels and restaurants, is estimated to have increased by 2.9 percent in 2014. The expansion in the sector was also evidenced by a net increase of 451 persons employed in the sector in 2014 relative to 2013.

Saint Lucia is quickly positioning itself as a high end, boutique destination with accommodations and amenities that provide the perfect platform for similarly focused investors and their businesses to take advantage of the high-end clientele who are considering Saint Lucia as their destination of choice.

It is for these reasons that the issue of Climate Change must now be given serious attention, as its impacts will have very devastating results on the sector, if the relevant agencies and stakeholders do not pay immediate attention and take corrective action.

Saint Lucia had once been accustomed to a fairly stable and predictable climate. However, over the past few decades, like all Caribbean destinations, it is now experiencing rapidly changing patterns in the climate that are causing major concerns. It is widely accepted that small islands, will be among the first and worst affected by the impacts of climate change.

The projected changes in climate have the potential to impact almost every facet of life in Saint Lucia and as a result, major impacts on the tourism sector. The following have been identified as immediate areas of concern, as these areas heavily impact the tourism sector and overall economic development:

- Planning and Development – beach and shoreline stability as beaches erode and shorelines retreat; serious impacts on infrastructure and human settlement as they are now at greater risk of damage from hurricanes, storm surges, floods, and sea level rise
- Public Utilities (Water and Energy) - increasing energy costs and demand, electricity distribution system at great risk of damage from stronger hurricanes and floods, extreme drought conditions and lack of adequate water supply to all communities.
- Natural Resource Management – destruction of coastal and marine ecosystems coral reefs degrading, mangroves in retreat, seagrass health declining and deforestation.
- Solid Waste Management – During high rainfall events, poor solid waste disposal practices by locals can be washed down to block drainage ways and pollute coastal waters. This can exacerbate flood conditions that can arise from short duration, high intensity rainfall patterns that are predicted under the climate analysis. Additional pollution can also negatively impact the reef system and fish stock, which are already

threatened by rising sea surface temperatures. There are also implications for public health issues with improper disposal.

- Public Health – inadequate water quality monitoring of recreational bathing areas may pose a public health issue in the long run especially with projections of longer drought periods which can impact water quality negatively. In addition, vector control is also key to control communicable diseases such as those spread via mosquitoes especially during and post periods of heavy rainfall and flooding, as well as where solid waste is improperly disposed.
- Food Security/Agriculture – significant drought has been experienced in recent years which have led to limited water available to support crop requirements and such low yield is experienced and supply to the tourism sector is limited. During extreme rainfall events losses occur due to high winds and flooding and this is particularly a challenges when a tropical system passes. With the projection of increased intensity of such, consideration for this should be made.

4.2 Planning and Development

Critical infrastructure such as human settlements, tourism services, facilities for electricity generation and distribution, telecommunication, water supply, public health, transportation, security and emergency services can be defined as those assets that are essential for the functioning of a society and economy. These critical infrastructures are vital components in the planning and development strategies necessary for sustainable nation building. Adequate, secure, sustainable and healthy human settlements are a key indicator of quality of life of any community, town or state.

Climate change poses threats to these critical infrastructure and most importantly human settlements. Firstly there is the threat of temporary and permanent coastal flooding of homes, infrastructure and lands identified for future development. As stronger storm surges from more intense hurricanes occur which results in sea level rise, it brings about extensive damage to the natural environment, basic infrastructure and more importantly, human lives. The degree of vulnerability to these threats is primarily controlled by elevation and setback from the coastline as well as the existence of natural or man-made protective coastal barriers. The, housing, medical facilities, tourism, coastal road network, the primary mode of transport, airports and sea ports, stands out as a class of critical infrastructure that is highly vulnerable as large segments are in some instances in low-lying terrain and directly adjacent to or very near to coastal areas.

Saint Lucia has numerous sandy beaches around its coastline. Beaches are perhaps one of most important tourist attraction on the island and are an important source of recreation for local residents. The beaches are also a critical habitat for some species, especially marine turtles. More generally, shorelines are significant areas throughout Saint Lucia's society and economy as most of the country's critical infrastructure, commercial activity and traditional villages have evolved on the coastline.

In the near-term, the primary climate change challenge for beaches and the shoreline is more intense hurricanes and associated storm surges. Chapter 3 above outlines that rainfall rates associated with hurricanes are likely to intensify as warming continues.

A single major hurricane can have a significant impact on beaches and the shoreline, as was evident with Hurricane Tomas in 2010, which devastated Saint Lucia. This was a classic example of shoreline vulnerability to hurricanes and associated storm surges and probably could be recognized as the "wake-up" call to climate change by the people of Saint Lucia.

Over the long-term, sea level rise will become a climate change impact of significant concern. Chapter 3 above outlined that under the A1B scenario, sea level rise within the Caribbean is expected to be between 0.17 m and 0.24 m by 2050 (IPCC, 2007). As a regional reference for example, scientific research indicates that sea level rise of 0.5 meters (1.5 feet) could consume on average up to 32% of beach area in Bonaire with lower, narrower beaches being the most vulnerable. The implications of this are serious; it would mean that areas of beach and some low-lying areas of shoreline would be at risk of permanent flooding.

In addition to the impacts on beaches and the coastlines, attention must also be paid to the impacts on inland areas as it relates to human lives, critical infrastructure and services that are essential to everyday existence. It is therefore of utmost importance to pay very close attention to overall development plans particularly and in this instance, as it relates to the tourism sector.

The national tourism policy and plan for the sector has to be adequately conceptualized. There must be an inclusive approach by both the relevant public and private sector interests and stakeholders utilizing their skills and insights to develop a sustainable vision of the entire tourism sector (hotel, attractions and services) that will bring optimum social and economic benefits to St Lucia. In the absence of such a plan taking into consideration the impacts of climate change, the Saint Lucia tourism sector will be short lived.

Introduction of principles for ensuring adequate land allocation and land use for tourism development is an important concern. Also the location of critical economic and social infrastructure in relation to tourism amenities must be adequately considered so that spatial development is in keeping with the long-term expectations for national development.

Coupled with this concern is the need for balancing environmental concerns and protection with tourism development expansion. In Saint Lucia a National Land Policy and Coastal Zone Management Policy has been drafted with input from the tourism sector. A Systems of Protected areas has also been developed. The formulation of a national Physical Development Plan, which includes tourism development, and incorporates other existing environmental protection policies, is a matter to be urgently addressed.

4.3 Public Utilities

The island of Saint Lucia depends heavily on fossil fuels to drive its heavily dependent service-based economy, at the same time, providing critical services needed for the society overall. The burning of fossil fuels to produce energy has been recognized by the international scientific community as the primary cause of climate change; carbon dioxide emitted during the process is building up and trapping excess heat in our atmosphere, thereby warming the Earth (Henson, 2006; Pachauri, et al., 2007). Although the Caribbean's total carbon emissions are insignificant in global terms (accounting for far less than 1% of the global total), per capita emissions, while relatively low, leave room for improvement (Dr. Trotz, 2009).

It is without question that one major implication of warmer temperatures, especially in the summer months, is an increase in demand for cooling of offices, public buildings, homes and transportation, which naturally results in an increased demand for both electricity and gasoline. These result in greater pressure on the electrical generating capacity on island and therefore increase business and household costs.

The advent of climate changes ought to force each country to rethink its energy consumption patterns regardless of its overall contribution to the problem. From a purely economic perspective, Saint Lucia, like most other Caribbean countries, already spends a significant percentage of its limited foreign exchange earnings importing fossil fuels. Climate change is likely to increase energy demand and fossil fuel bills (Dr. Trotz, 2009). The Government of Saint Lucia is however looking very seriously at geothermal energy sources in the Soufriere area. The Geothermal Development bill that is being crafted will facilitate this process. The Government is also exploring and furthering solar, wind and biofuel energy options. Although this will provide a less expensive and more sustainable energy supply, this will not lessen the impacts of climate change in the short term.

Reliable and safe water supply is vital to the people of Saint Lucia as well as the tourism economy and it has many implications for other commercial activity and socio-economic development. Climate change, however, stands to make the challenges of meeting growing freshwater demands even greater. The results of the climate analysis in Chapter 3, suggests that the mean annual temperature over Saint Lucia will increase by 0.3 to 1.2˚C by the 2030s and 0.5 to 2.1˚C by the 2060s, relative to 1970-99, as indicated by the GCM Models. The report also suggests a decrease in rainfall intensity towards the end of the Century. Additionally, hurricane intensity over the north tropical Atlantic is likely to increase. These changes could easily result in the increased drought events that are having far reaching implications now across Saint Lucia.

Resulting from these impacts, the Public Service Utilities Company is looking to see what the best structure is for the future development of Water and Sewerage facilities. A Wastewater Management Plan is being developed under the PPCR DVRP project[18]. Additionally, there are projects now going on to improve the water supply in Vieux Fort and rehabilitation at some intakes. This is in addition to the de-silting of the Roseau Dam, which has reduced capacity of water available in the dam since Hurricane Tomas in 2010 which resulted in large deposits of silt. This is a critical and major project being undertaken by the Water and Sewerage Company Inc. (WASCO). This dam serves the water supply for the country.

There are few well water sources in Saint Lucia. A few shallow wells existed in the past for tourism use but these have all been abandoned. Currently, Saint Lucia does not use groundwater and this has not been explored. The Water and Sewerage Act was most recently revised in 2008, however, it does not address extraction or the use of groundwater in Saint Lucia. The OECS has drafted an Integrated Water Resources Management Act as a template for OECS islands to adopt. To supplement the water issues experienced, it is the desire of the WRMA and WASCO to modify Saint Lucia's Water and Sewerage Act (2008) with the guidance that the OECS document provides on ground water extraction.

[18] PPCR DVRP project

4.4 Food Security

4.4.1 Agriculture

In discussions with Ministry of Agriculture (MoA) personnel, they were of the opinion that the agricultural sector is the most affected by climatic change. The intense drought being experienced now has significantly affected food production. As a result, farmers are being encouraged to implement drip irrigation on their farms to minimize wastage as there are serious problems with rainwater shortage. The flow from rivers also falls during drought periods leading to water shortage. Farmers are required to purchase their own equipment to pump water from the river and set up their irrigation system. The cost of infrastructure is a deterrent to farmers and so, many farmers have significant water issues. Farmers are allowed to use river water for their farming activities throughout the year as long as they have an abstraction license. If there are drought conditions and water shortages as a result, restrictions may be imposed on the farmers' use of water. During droughts, farmers are not allowed to use WASCO's water for irrigation. Outside of a drought, farmers can use WASCO and pay for their own water.

Coupled with these issues, greenhouse farming is not doing well in Saint Lucia, as temperatures are now getting too high and as a result, crop production is being negatively affected. Temperatures can get as high as 40 degrees Celsius. The Ministry of Agriculture received assistance from the Government of Mexico, to train farmers and technical officers to rectify the heat problem in greenhouses.

A Farmers Certification Programme is being introduced by the Ministry of Agriculture. The aim of this programme is to certify farmers who adopt good agricultural practices to encourage the consistency of wholesome produce for hotels and supermarkets. There are a number of farmers who are currently certified. This strategy was introduced to help in the sale of produce to meet the market demand for consistently good products.

This programme involves six weeks of training and upon completion, farmers are provided with an identification card. The idea was also for farmers to get a premium price for their goods. The programme is intended to make the farmer auditable and for them to have priority sale at supermarkets and other locations.

Hotels and supermarkets import much because the required volume and quality of many products cannot be met locally. Farmers need to improve quality.

4.4.2 Fisheries

The debate still continues on the full impacts of climate change on commercial and sport fisheries, as considerable uncertainty remains in this area. Like with agriculture, some positive impacts may occur. For example, increased temperatures may result in increased fish larval growth rate and swimming ability while reducing the age of metamorphosis (transition from larvae) which could increase larval survival (Johnson & Marshall, 2007).

Reef ecosystems are significantly threatened by climate change. Coral bleaching, increased incidence of disease and reduced complexity of coral reefs will be felt right up the food chain and reflected in reduced abundance of reef-associated fish and changes in fish species composition, favouring smaller generalist species and those lower on the food chain. Already scientists are observing a

sudden and rapid decline in Caribbean reef fish densities since 1995 in the order of 2.7 – 6% loss per year, as a result of coral reef degradation.

Rising sea temperatures will also be significant as several species are very sensitive to slight changes in ocean temperature and changes may cause migration to new areas or depths with more suitable temperatures (Mimura et.al, 2007). The habitat for Dolphin fish, for example, would become significantly less favorable with a 1 °C (1.8 °F) increase in the average temperature of the Caribbean Sea (Dr. Trotz, 2009).

Fish distribution could also be impacted if climate change causes shifts in ocean currents and other oceanographic conditions that help to determine where fish settle out in their larval stages and influence their migration patterns and other dynamics in their adult stages (Johnson & Marshall, 2007). While these changes may result in the loss of established fisheries, they may also give rise to new fisheries.

The rise in ocean temperatures and change in species composition could lead to significant decreases in spawning opportunities, increased mortality, and increased incidence of disease in favoured commercial species such as Snapper and Grouper (Ministry of Physical Development, Environment, and Housing, 2005). Temperature changes in the ocean could also create more favourable conditions for invasive species as climate change could disrupt natural ecosystem processes (IUCN, n.d.). Invasive species tend to out-compete or prey on local species to their detriment. Although this is believed not to be attributable to climate change, the recent invasion of the Lionfish in the Caribbean Sea and the effects this has already had on fisheries in many islands demonstrates the damage that just one marine invasive species can do. One of the innovative solutions to the invasion of the Lion Fish in Saint Lucia is the introduction of Lion Fish Derby, a "sport" created to capture the Lion fish for commercial and recreational purposes therefore helping to eliminate the now increasing population. The use of the lionfish, particularly within the tourism community, can be introduced as an alternative seafood delicacy, in the face of decreasing fisheries partly attributable to climate change. Another reason could be the diversification of the tourism product, through the introduction of a new activity for tourists, in light of decreasing viability of reefs for snorkelling and diving which resulted from coral bleaching.

Climate change may also trigger other changes in water quality such as salinity and nutrient content from melting ice caps and increased river activity that may impact on the fisheries. For example, it was recorded that the Virgin Islands waters experienced a strong influx of high nutrient freshwater runoff from the Orinoco River in Venezuela which temporarily reduced water quality and thus impaired fishing conditions and catch.

More severe hurricane events and sea level rise could easily result in both short and long-term damages to fisheries facilities with implications for productivity, and insurance and future development costs.

4.5 Natural Resources

Saint Lucia is exceptionally rich in animals and plants. More than 200 species occur nowhere else, including 7 per cent of the resident birds and an incredible 53 per cent of the reptiles[19].

The nation's best known species is the gorgeous but endangered Saint Lucia National Bird, the *Amazona versicolor*[20]. Other species of conservation concern include the pencil cedar, staghorn coral and Saint Lucia racer. The racer, confined to the 12-hectare Maria Major Island is arguably the world's most threatened snake following the recent increases in its distant relatives in Antigua.

Though Saint Lucia's rugged, volcanic interior remains thickly forested and healthy coral still abounds offshore, its flatter areas inland have long been cleared for agriculture. The island's coastal dry forests are increasingly destroyed for tourism development. St Lucia's biodiversity is also threatened by over 300 alien invasive species (including rapacious mongooses and opossums) and over-exploitation[21]. At least 69 native species have already disappeared.

More than one fifth of Saint Lucia's 167,000 residents are rated as living in poverty. The Forestry Department is therefore pursuing a policy of integrating livelihoods into the management of the island's extensive forest resources.

The intrinsic and socioeconomic value of biodiversity represents an untapped tourist attraction that could support a new brand of eco-tourism for Saint Lucia. The brand could also be expanded to include medicinal and spa benefits. The terrestrial environment provides rich habitats for a range of flora and fauna. Forests in particular are essential for water and soil conservation.

Climate change is projected to have a profound effect on biodiversity globally (Hanson, 2007). The Climate analysis result presented in Chapter 3 of this report, indicate that annual maximum temperature is projected to increase by an average of 1.0°C to 1.4°C across the island in the near term and annual minimum temperature is expected to increase by 0.9° to 1.7°C. The results also suggest a decrease in rainfall intensity towards the end of the Century and an increase in the number of warm days. The Fourth IPCC report[22] suggests that warming has negative impacts on known species putting them at risk for extinction.

Lower rainfall and increased temperatures poses a problem for moist forests already at the mountain peaks with essentially nowhere to migrate, therefore threatening forests. More severe hurricanes would also exacerbate forest habitat loss.

Coral reefs, mangroves, and seagrass meadows along the coastline in Saint Lucia form a highly interdependent and valuable coastal and marine ecosystem network. This network represents significant potential revenue through fisheries and tourism - from diving and snorkeling especially, sizable savings in coastal defense, and potential undiscovered medical treasures. All three components of the network are, however, threatened by climate change.

[19] Fauna and Flora International
[20] Fauna and Flora International
[21] Petit J. & Prudent G.(2008, July). Climate change and biodiversity in the European Union Overseas Entities: Pre-conference version. Brussels: IUCN.
[22] IPCC. (2007). Summary for Policymakers. In Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. & Hanson, C.E. (Eds.), Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

Seagrass distribution, growth, and community composition are influenced by several factors that will be altered by climate change including salinity, temperature, sea level, carbon dioxide levels, storm intensity, and ultraviolet irradiance.[23]

Seagrass Forest - The primary impacts to seagrass meadows are expected through increased sea surface temperatures which could slow photosynthesis, increase respiration, and dry and burn seagrass near the upper tidal limit, thereby negatively affecting seagrass health and growth rates (Johnson & Marshall, 2007)[24]. On the other hand, increased levels of carbon dioxide could stimulate faster growth of seagrass meadows

Mangrove Forest - A mix of positive and negative impacts to mangroves is possible, with the net effect being determined by several country specific factors. On the positive side, warmer temperatures and high levels of carbon dioxide would increase mangroves growth rates. On the flip side, however, mangroves will likely suffer from salt water intrusion, coastal erosion, and sea level rise. [25]

As they inhabit the inter-tidal zone, the mangrove habitat niche is defined by sea level on one hand and hydrology on the other. Mangroves are naturally sensitive to predicted chances in long-term sea level and rainfall patterns, especially in regions like the Caribbean where the tidal range is low (Nicholls et. al, 2007). Although mangroves build up sediments that can counter the impact of sea level rise, global assessments have shown that many mangrove shorelines are already subsiding and retreating inland (Nicholls et. al, 2007).

In addition, while mangroves are typically regarded as a source of protection in the face of hurricanes, these systems are not immune to high winds and raging seas. Guadeloupe, for example, lost 75% of its Red Mangrove coverage to Hurricane Hugo (Imbert, 2002). As severe hurricanes become more likely in the region, mangroves may not have sufficient time (typically ten years) to recover from a serious hit before being subjected to another (Petit & Prudent, 2008).

Coral Reefs - Coral reefs are extremely delicate and sensitive ecosystems. They require clear, nutrient poor and relatively shallow waters, and can only tolerate slight deviations from average maximum ocean temperatures (as little 1-2 °C/ 1.8-3.6 °F) (Spalding et al, 2001). With the advent of climate change, an increased frequency of coral bleaching events can be expected as sea surface temperatures increase; increased physical damage to reefs from more intense hurricanes; and decreased coral skeleton growth rates and weakening of existing skeletons as the ocean becomes more acidic (ocean acidification) due to increased concentrations of carbon dioxide (Mimura et.al, 2007; Wilkinson & Souter, 2008). Ocean acidification not only affects the coral itself, but the "calcareous algae" that is important to cement the reef together (Johnson & Marshall, 2007).

Coral bleaching leaves coral vulnerable to algae overgrowth and diseases such as white plague and black band that have been detrimental to Caribbean reefs (Nicholls et. al, 2007). In turn, these impacts can seriously affect the abundance and diversity of reef fish that depend directly on the

[23] Nicholls et.al, 2007

[24] Angela Burnett Penn, Administrative Cadet Lynda Varlack, Environmental Education Officer; Draft Virgin island issue Paper, October 2009,

[25] Nicholls et al, 2007

coral for food, protection, and a breeding ground (Petit& Prudent, 2008). Coral bleaching, therefore, affects the reefs much longer than temperatures remain elevated.

In the Fall of 2005, which was recorded as the hottest year on record in the Northern Hemisphere, water temperatures in the Caribbean exceeded 29.5 °C (85.1 °F) for 12 weeks, triggering a region wide mass-bleaching event (Wilkinson & Souter, 2008).

Similarly, climate change also negatively impacts critical infrastructure in Saint Lucia such as facilities for their electricity generation, telecommunication, water supply, public health, transportation, and very importantly, tourism services. Equally important are the impacts on human settlements. There is the threat of temporary and permanent coastal flooding of homes, infrastructure and lands identified for potential development as sea level rises and stronger storm surges from more intense hurricanes occur. Adequate, secure, and healthy human settlements are key indicators of quality of life for the people of Saint Lucia and if these are affected, then the quality of life and the improvement in the livelihoods of the people will decline. The degree of vulnerability to these threats is primarily controlled by elevation and setback from the coastline as well as the existence of natural or man-made protective coastal barriers. It is therefore extremely important that these factors are taken into consideration when planning and implementing zoning and development guidelines for all the regions in Saint Lucia.

4.6 Solid Waste Management

The Saint Lucia Solid Waste Management Authority (SLSWMA) was established in 1996 under Act No. 20 of 1996 (repealed and replaced by the Waste Management Act No 8 of 2004). The Authority was established with the goal of improving existing standards of public health and environmental quality through more efficient waste management.

The SLSWMA is administered by an eleven member Board of Directors. SLSWMA's mission is to enhance Saint Lucia's environmental integrity and the health of her people through the provision and management of an integrated system of public education and awareness and for the collection, treatment, recycling and disposal of solid and hazardous waste. In addition, it is to improve existing standards of public health and environmental quality through more efficient waste management.

The mandate given to the SLSWMA is as follows:

- Manage, regulate and treat waste either alone or in conjunction with private companies or organizations;
- Establish, maintain, improve and regulate the use of sanitary landfills and facilities, in accordance with established scientific principles and practices;
- Establish and manage facilities for the collection and treatment of hazardous waste;
- Establish and maintain transfer stations;
- Establish and promote a resource recovery system;
- Oversee scheduling, safety and maintenance issues associated with solid waste management;
- Promote and oversee public education related to solid waste management in collaboration with the relevant Ministries; and
- Develop a network to receive, monitor and respond to public complaints.

The Authority is responsible for the collection of solid waste from households and Government establishments, e.g. schools, hospitals, health centres, prisons, government offices. In this regard, a minimum of a twice weekly waste collection service is provided throughout the island. In addition, a monthly bulky waste collection service is provided to every community. All waste collection services are privatized.

The Authority does not offer collection service to businesses. All business owners (which would include all tourism businesses) are required to contract the services of a licensed waste hauler or transport waste to the disposal facilities themselves.

Disposal Services:

The Authority operates two solid waste management facilities namely Deglos Sanitary Landfill which serves the north of the island and the Vieux-Fort Solid Waste Management Facility which serves the south of the island.

Categories of waste accepted include industrial waste, green waste, commercial waste, hazardous health care waste and derelict vehicles. Others categories of waste accepted, also referred to as special wastes, include asbestos, fiberglass, ship waste, condemned food, confidential documents, pharmaceuticals, construction and demolition. For the disposal of special waste, a disposal fee, as well as, special arrangements are required prior to the disposal of the above items.

The island is divided into eleven collection zones with private collection contractors operating in each zone as follows:

- Gros-Islet .....Shuga Waste Management
- Dauphin/Castries Outer .....Trashbusters Limited
- Castries Inner .....Saint Lucia Environmental Company Limited
- Castries South .....Shuga Waste Management
- Anse La Raye/Canaries .....Serieux's Solid Waste Disposal
- Soufriere .....Sadoo & Sons Trucking Company
- Choiseul .....South Shore Auto Services & Waste Disposal
- Laborie .....South Shore Auto Services & Waste Disposal
- Vieux-Fort .....Sadoo & Sons Trucking Company
- Micoud .....Sadoo & Sons Trucking Company
- Dennery/Praslin .....South Shore Auto Services & Waste Disposal

According to the report "Municipal Solid Waste Management in the Caribbean - A benefit-cost analysis"[26], "Waste management is one of the least recognized public policy issues in the Caribbean. Quite apart from the obvious physical unattractiveness of the business, waste management often competes with more pressing economic and social issues such as fiscal and trade matters, unemployment and poverty, education and health, and crime and security".

Although environmental sustainability, specifically as it relates to the tourism sector, has been heralded throughout the region, the management of the region's waste has and continues to play

[26] Willard Phillips and Elizabeth Thorne; ECLAC – Studies and Perspectives series – The Caribbean – No. 22 Municipal solid waste management in the Caribbean

second fiddle to more apparently manifest challenges, such as land and coastal degradation, biodiversity loss, and climate change.

The report further stated that waste management still remains a major challenge for many Caribbean societies, since all natural processes generate waste. The particular economic, social and environmental circumstances of the Caribbean make this issue especially critical for medium- to long-term sustainable development.

It was reported that Saint Lucia generated an estimated 80,470 metric tons of waste in 2008 (Simmons, 2011), with an approximate growth rate of 0.62% per annum since 2004. This translates to a daily per capita waste generation rate of 1.44 kg. The Table below, summarizes growth trends for waste disposal at the country's two landfills since 2004. Based on a 2008 waste characterization study, the major components of municipal waste generated were organics (45%), plastics (22%) and paper and paperboard (10%) (SLSWMA, 2008).

The Saint Lucia Solid Waste Management Authority also promotes waste reduction initiatives by supporting the recycling of lead batteries, scrap metal, PET bottles, corrugated cardboard and paper. This programme is supported by a vigorous public education campaign, as well as through strong links with community-based organizations, the commercial sector, and other stakeholders (CEHI, 2011). There is a strong relationship between solid waste management and public health.

Table 4.1: Tonnage of Waste Disposal - Saint Lucia

Year	Deglos Sanitary Landfill	Vieux Fort Waste Disposal Facility	Total
2004/2005	49,885	23,130	73,015
2005/2006	59,426	22,191	81,617
2006/2007	58,663	20,173	78,836
2007/2008	64,691	19,836	84,527

Source: Saint Lucia Solid Waste Management Authority

The main public health issues associated with solid waste in Saint Lucia include gastroenteritis and dengue fever. Since 2010, leptospirosis has also emerged as a public health concern along with both Chik-V and Zik-V. The maintenance of a clean and pleasing environment is a key strategy for avoiding many of the public health costs that are likely to arise from a deficient solid waste management regime. Moreover, given the high level of dependence on tourism in Saint Lucia, a clean environment is important for attracting visitors, which in turn contributes to tourism sector earnings.

The current solid waste management system in Saint Lucia reflects the results of a medium-term development initiative implemented in the Eastern Caribbean States. Known as the OECS Solid and Ship-Generated Waste Management Project (OECS SWMP), this World Bank-funded initiative was implemented over a period of eight years from 1995-2003. Its main objective was to "reduce public health risks and protect the environmental integrity of the islands and their coastal and marine systems" (World Bank, 2003). The project focused on controlling terrestrial pollution in an effort to preserve the marine environment. It also undertook improvements in domestic waste facilities in order to ensure compliance to the Special Area designation of the Caribbean Sea for MARPOL 73/78 (World Bank, 2003). The project was implemented in six OECS countries: Antigua and Barbuda,

Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines. The following general outcomes were achieved to varying degrees in each of the project countries:

- The establishment of semi-autonomous solid waste management entities (SWMEs);
- Increased coverage and improved quality of land-based solid waste management services (collection, transport and disposal);
- Enhanced public awareness of solid waste management issues, resulting in behavioral changes;
- Improved institutional arrangements with functioning systems to help each country manage and dispose effectively of waste generated by ships and leisure craft;
- The OECS SWMP was also instrumental in the establishment of 7 new sanitary landfills,24 the upgrading of 6 existing ones, and targeting 22 others for closure (CSD, 1998).

4.7 Public Health

Good health is critical to the quality of life of any nation and it is one of the foundations of sustained economic growth and improved livelihoods. Health factors and health safety have always been major concerns that significantly influence ones decisions to visit a specific country or region. A study by the University of East Anglia, conducted in Bonaire, revealed that low health risk ranks with warm temperatures and clear waters as the top three environmental factors influencing choice of vacation destination[27].

Climate change will likely have a number of human health implications including increased likelihood of insect and rodent-borne diseases, respiratory infections, water- borne diseases, and food-borne illnesses as well as increased incidences of heat stress.

Over the last number of years Central America, South America, and the Caribbean have seen a marked increase in the incidence of Dengue Fever, with 2008 being a record- breaking year in which close to 909,000 cases were recorded, of which 12,398 were from the Caribbean (PAHO, 2008). With warmer temperatures, changes in humidity, and more episodes of heavier rainfall, the frequency and severity of dengue fever is set to increase (Mimura et.al, 2007). Already, the number of dengue and Chik-V cases in the Caribbean is again on the rapid increase.

The increased threat of respiratory diseases, such as asthma, is due to an increased prevalence of allergenic plant pollens, soil fungi, and toxic mold as temperature warms, the level of carbon dioxide increases, and areas become more flood prone. Another significant contributing factor is increased Sahara Desert dust clouds reaching the Caribbean since the 1960s and still very prevalent today. This is as a result of desertification and changes in the Atlantic Trade Winds. Already, the Caribbean and South and Central America receive an annual dose of several hundred million tons of African dust.[28]

[27] Uyarra, M.C., Cote, I.M., Gill, J.A., Tinch, R.R.T., Viner, D., Watkinson, A.R. (2005). Island-specific preferences of tourists for environmental features: implications of climate change for tourism-dependent states. Environmental Conservation 32 (1): 11–19.

[28] Gyan, K., Henry, W., Lacaille, S., Laloo, A., Lamsee-Ebanks, C., McKay, S., et al. (2005). African dust clouds are associated with increased paediatric asthma accident and emergency admissions on the Caribbean island of Trinidad. International Journal of Biometeorology 49 (6): 371 -376.

In summary, given the diversity of impacts, it cannot be overemphasized that climate change is not just an environmental issue; it is equally an economic issue, a disaster management issue, a food security and human health issue, and a quality of life issue. This makes climate change everyone's business and a cause for concern and action at the individual, community, organizational, and country level.

5 Economic Analysis

5.1 Existing and Trending Economic Setting

Several studies and reports have established the transition of the Saint Lucian economy from its structure around banana exports to the EU to its growing dependence on tourism, based primarily on visitors from the USA and UK. The consensus attributes the transition to the loss of the preferential access to the EU market, specifically as a result of the push for competitive access to the EU market by the US-backed companies producing cheaper bananas in Central America, and more generally, as a consequence of the liberalization of global markets that accelerated in the 1990s. A BBC report in 2005, summarized the impact of the loss of preferences as, "St Lucia's banana exports have declined from 132,000 tons in 1992 to just 42,000 tonnes last year. The number of banana farmers has also fallen from 10,000 to 1,800 today."[29]

Figure 5.1 and Figure 5.2 show the decline in banana exports, the rise in visitor arrivals and tourism expenditure over the period 2004 to 2014.

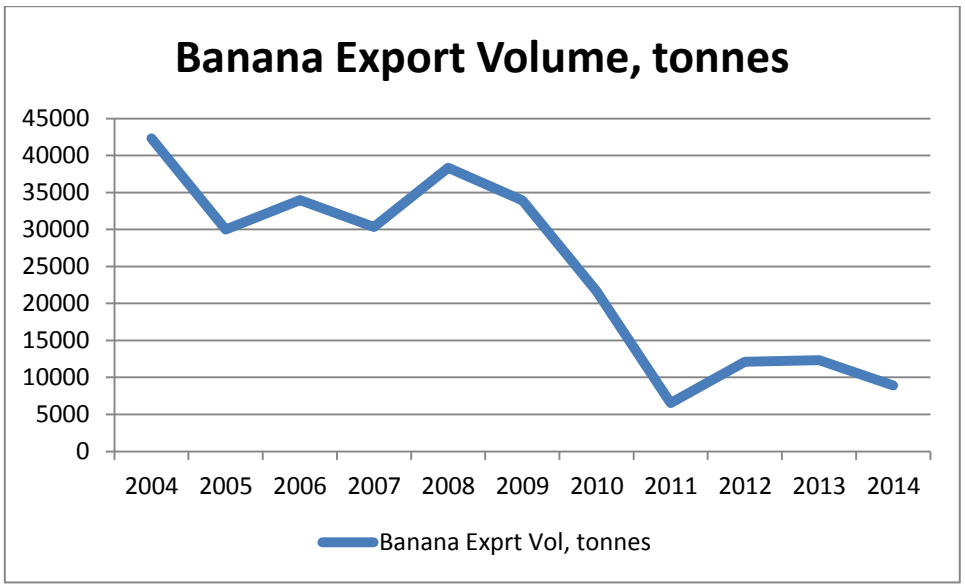


Figure 5.1: Banana Export Volume, tonnes

[29] Guy Ellis, St. Lucia's Declining Banana Trade, BBC, August 2, 2005http://news.bbc.co.uk/2/hi/americas/4737473.stm

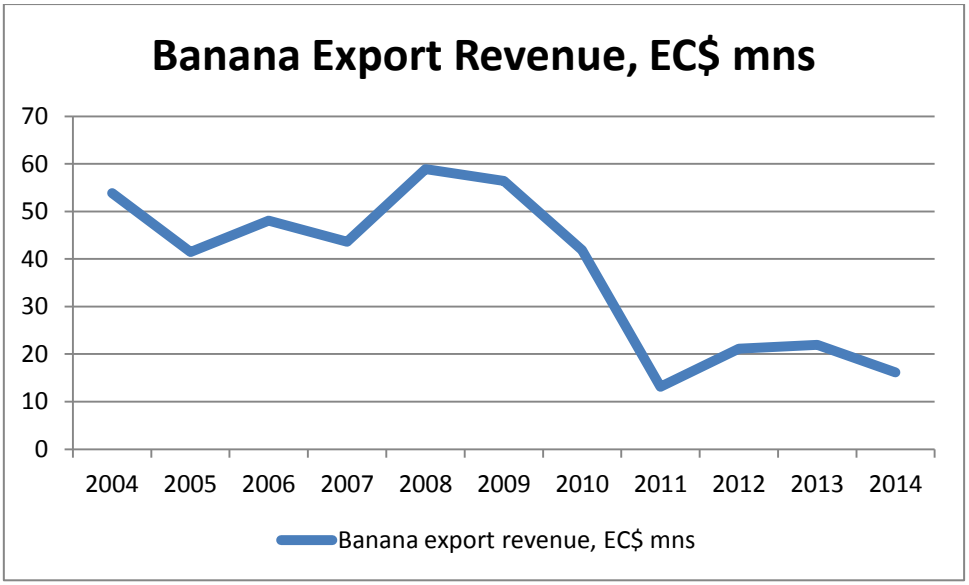


Figure 5.2: Banana Export Revenue, EC$ mns

The decline in the contribution of bananas to export revenues has been precipitous, and has been further pressured in recent years by storms and disease. Figure 5.3, shows the steady rise in visitor arrivals and tourist expenditure over the last decade and a half. Together, they show the shift in the dynamic of the economy from banana exports to tourism. While tourism expenditure of almost EC$2 billion in 2014 is a gross figure that has to cover a high level of imports for the tourism sector, the flows of foreign currency dwarf the peak annual performance of bananas at EC$60 Million in the same period.

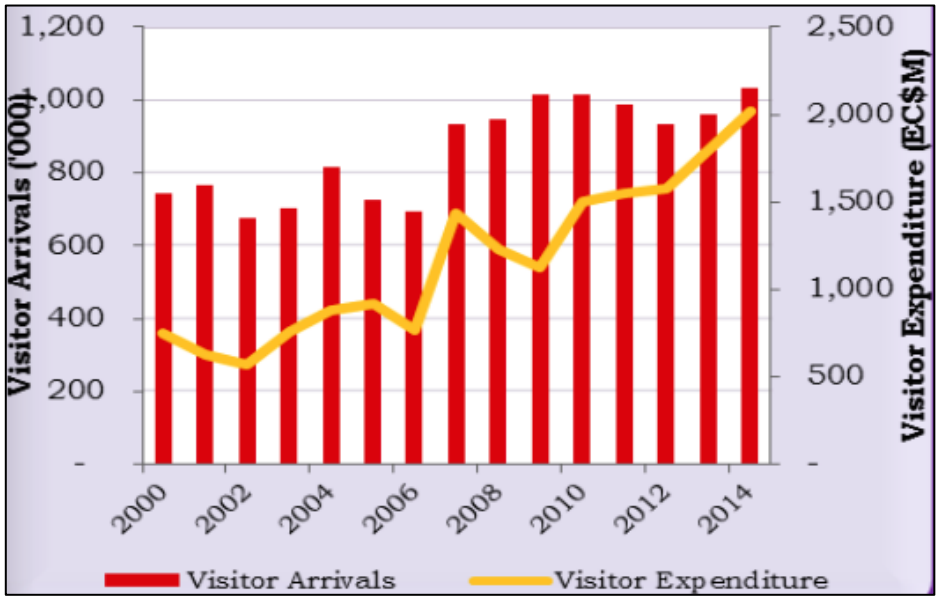


Figure 5.3: Total Visitor Arrivals and Expenditure (Source: GOSL, Review of the Economy, 2014, Figure 1, p. 17

GDP – Structure

Figure 5.4 shows the structure of GDP by the main sectors for the decade, 2004-2014.

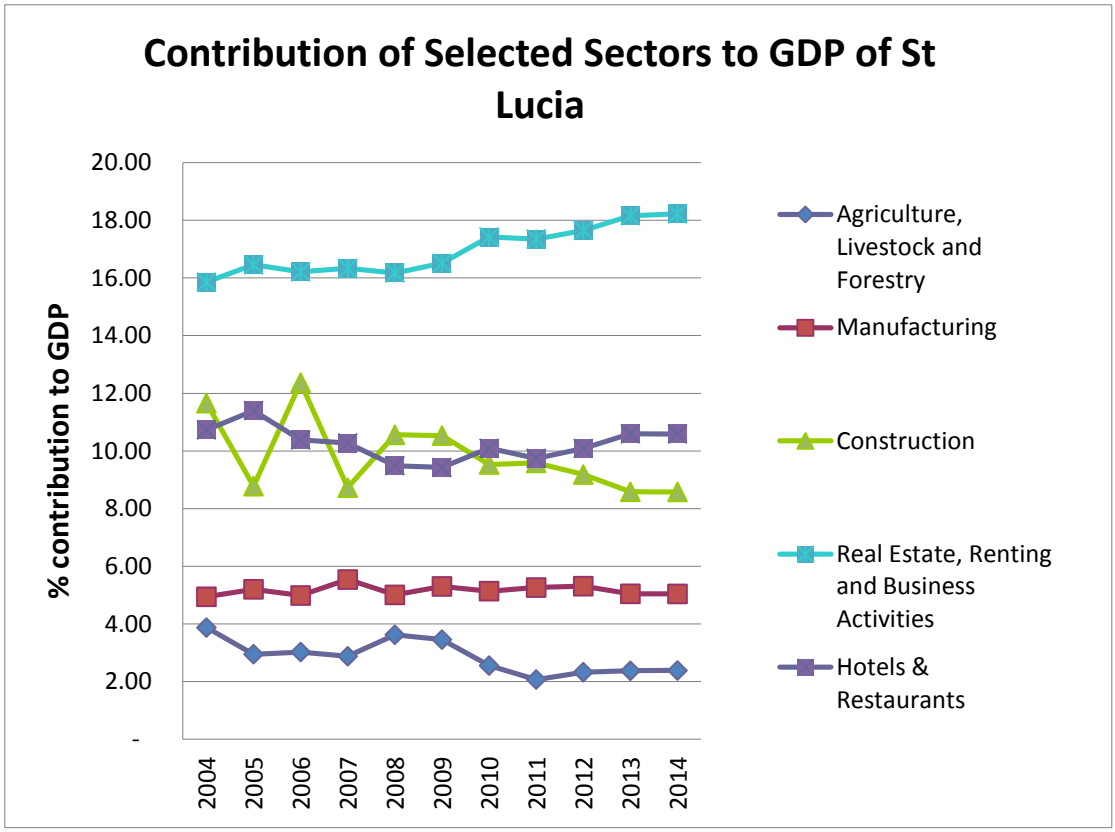


Figure 5.4: Contribution of Selected Sectors to GDP of Saint Lucia

Despite their importance in Saint Lucia's international trade, the agricultural and tourism sectors contributed only 18% to the GDP of the formal economy in 2014, where "hotels and restaurants are used as the proxy for Tourism."[30] It should be noted, that the World Travel and Tourism Council estimated the size of the Tourism sector in 2012 to be as high as 40%.[31]

While banana production for export has been the most important agricultural subsector, the GOSL has made many efforts to diversify the sector, especially after banana production began its rapid decline, following the loss of preferential access to the EU market in 1995. The gap left by the contraction of banana production has not been filled, and the sector's contribution to GDP as a whole continued to decline from 20% in 1986 to 3% in 2014. Even so, the sector continued to play an important role in household subsistence for the small farmer population that constituted the bulk of the producers. In 2013, the sector was still accounting for 8.7% of employment.

Manufacturing

The contribution of the manufacturing sector to output and employment has also declined. Its share of GDP fell from a high for the period 2000-2014 of 5.4% in 2007 to 4.7% in 2014, and it

[30] ECLAC, 2010 (Measurem
[31] L. Giminez cited Country Reports, World Travel and Tourism Council, 2012, in footnote 4, p.10

provided 5% of employment in 2013. Figure 5.5, shows the contribution of manufacturing to GDP for the period 2000-2014.

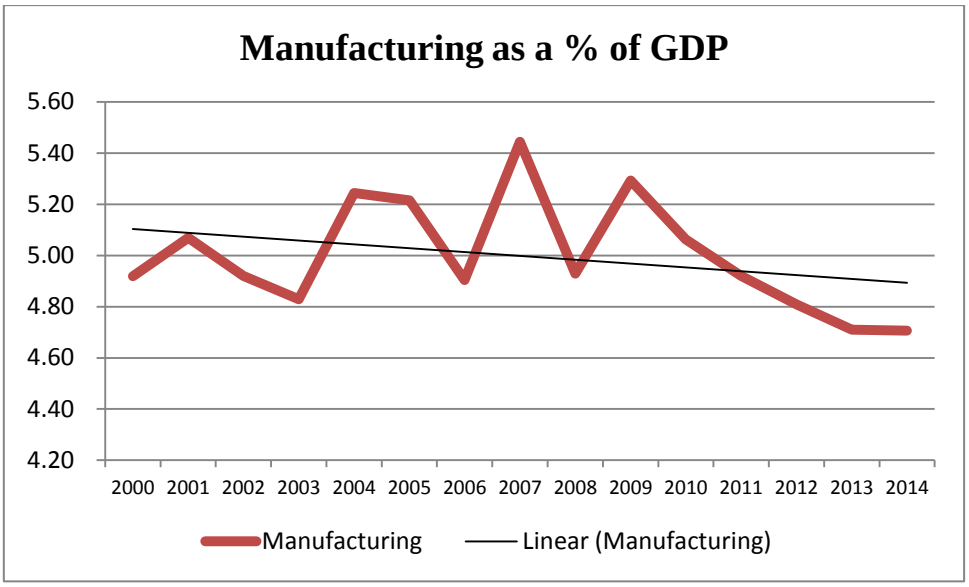


Figure 5.5: Manufacturing as a Percentage of GDP (Source: ECCB, http://eccb-centralbank.org/Statistics/#tradedata)

Services

As with most of the CARICOM Caribbean economies, Saint Lucia is predominantly a service economy with services accounting for 80% of GDP. The contributions of the main service industries to the GDP in 2014 are shown in Table 5.1 below.

Table 5.1: Percentage Contribution of Main Service Sectors to GDP in 2014

Main Service Sectors	**%**
Transport, storage and communication	19
Real estate, renting and business activities	18
Tourism, as proxied by hotels and restaurants	17
Wholesale, retail trade, repair of motor vehicles, motorcycles and personal and household goods	8
Financial Intermediation	8

Source: CARICOM Regional Statistics, http://www.caricomstats.org/natacct.html

These services are heavily dependent on imports of commodities, equipment, and energy, and by extension, they are dependent on the earnings of bananas and tourism.

Tourism

Estimates of the contribution of Tourism to the GDP vary from 17% to 40%, according to how it is measured[32]. Similarly, estimates of Tourism's share of employment range from 13.3% to 18.6%.

Government

The economic challenges arising from the collapse of banana exports and the impact of the global crisis have expressed themselves in the large deficit on current account for the GOSL and the rising level of debt. "Saint Lucia's public debt to GDP ratio rose to around 80 percent of GDP in 2013 from the pre-crisis level of 57 percent of GDP (International Monetary Fund, 2014)"

Economic Growth

Figure 5.6, shows the annual rate of growth of the economy as measured by the rate of growth of the real GDP from 2000-2013. It shows the trend of the rate of the growth of the economy increasing from 2001 to 2006, and then declining thereafter. The economy stopped growing in 2008 in the context of the global financial crisis, and contracted sharply in the following year. Since then, the economy grew marginally in 2011 and 2012, and then contracted again in 2013.

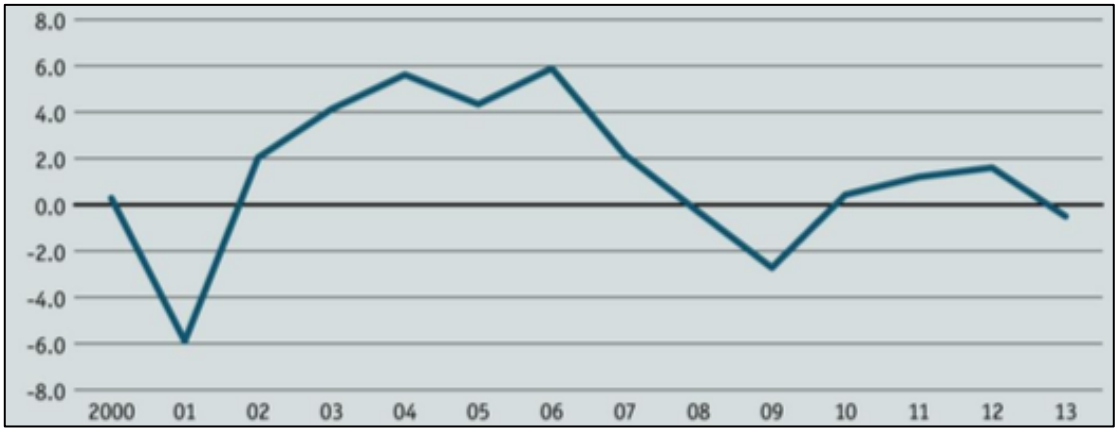


Figure 5.6: Real GDP Growth, 2000-2013, % (Source: The Economist Intelligence Unit, cited by PSAR, 2013, in Figure 2, p.6)

Informal Economic Activity

The IMF's definition of the informal economy was used to estimate the size of the informal economy in Saint Lucia "in the early 2000s" as 41.5%[33] "The *informal economy* comprises those economic activities that circumvent the costs and are excluded from the benefits and rights incorporated in the laws and administrative rules covering property relationships, commercial licensing, labour contracts, torts, financial credit and social systems."[34]

[32] The lower estimate is derived from using "hotels and restaurants" as the proxy for Tourism, while the higher estimate includes those services that contribute directly to the Tourism product. Often, these estimates have to be imputed.
[33] G.Vuletin, 2008, Table 3, p.27
[34] Guillermo Vuletin, "Measuring the Informal Economy in Latin America and the Caribbean", IMF Working Paper, 2008, p. 3

ECLAC estimated that "informal enterprises" contributed 8% of Saint Lucia's GDP, and provided 27.3% of employment in 2008[35]. Agricultural activities dominated the informal economy accounting for 43.3% of total (formal plus informal) agriculture GDP.[36] In the case of Tourism, informal activities generated 6.1% of that sector's GDP.

"The Private Sector Baseline Survey (2009), funded by the European Union, estimated that there were 7,430 enterprises in Saint Lucia, of which 2,867 (39%) were considered informal."[37] ECLAC estimated that 58% of informal enterprise operators[38] were male and 42% were female.[39]

All studies indicated the importance of informal economic activity as forms of employment, income and livelihoods for small-scale operators.

Employment

The crisis of 2008 drove up the unemployment rate from approximately 15% in 2008 to 24.4% in 2014,[40] with the youth unemployment rate as high as 41.4%.[41] The male unemployment rate was 20.9%, and the female unemployment rate was 28.4%.[42] These are familiar patterns in the CARICOM Caribbean.

Poverty rate - social vulnerability

Table 5.2 shows the main results of the last two poverty assessments conducted for Saint Lucia. With the exception of the rate of indigence, the rate of poverty was increasing up to the eve of the global crisis of 2008. In light of the severe negative impact of the crisis on the economy, as indicated by the increase in the unemployment rate, the increase in the inequality of the distribution of wealth, and the increase in the national debt, it is likely that the poverty rates have also increased.

[35] ECLAC, "Measurement of Informal Sector and Informal Employment in St. Lucia", CSO, St. Lucia, 2010, p.49
[36] ibid, p.44
[37] Private Sector Assessment, 2013, p.11
[38] ibid, p.6 for definition of Household Unincorporated Enterprise with some market activity
[39] ibid, p. 45
[40] Lea Giminez et al, 2015, p. 14; Review of the Economy 2014, Appendix 28, p.80
[41] Review of the Economy 2014, Appendix 28, p.80
[42] ibid, Appendix 28, p.80

Table 5.2: Indicators of Poverty

Indicators of Poverty	1995	2005/6
Households,%	18.7	21.4
Population,%	25.1	28.8
Indigent Households	5.3	1.2
Indigent population	7.1	1.6
	Per capita Household Expenditure	Adult Equivalent Per Capita Household Expenditure
Vulnerable pop,%	57.7	40.3

Source: Kairi Consultants, 2005/2006, Table 1, p.xvi; Table 2, p.xvii

Two different approaches, as indicated in the relevant headings, were used to estimate the vulnerable population as a percentage of the total population of households. Even with the different approaches, it appears that the vulnerable population declined between the two assessments, but remained high. Again, it is likely that the impact of the global crisis increased the share of the population that was classifiable as vulnerable.

Climate Change and the sectors

In both its banana and tourism dependency phases, the Saint Lucian economy has been heavily dependent on the labour of its people and the services of its natural resources and its climate. Banana cultivation required careful husbandry, fertile land, lots of fresh water, and tropical temperatures. Similarly, the Saint Lucian tourist product has largely been based on the "sun, sea, and sand" beach tourism product, which depends on the beach and more generally, coastal resources, fresh water, and tropical climatic conditions.

Saint Lucia's geology and location make it vulnerable to volcanic eruptions and to tropical storms. The last volcanic eruption was in the 18th Century, and today its warm sulphur-rich waters have become a tourist attraction. While the risk of a major eruption may be low, the destructive power of its namesake, Soufriere, in Montserrat indicates the potential for a major disaster, which could severely disrupt tourism.

On the other hand, the impact of frequent storms in recent years has been very costly to the economy. The banana industry has suffered also from drought, and the spread of disease. "Apart from the physical constraints of the islands, the Windward Islands banana industry is vulnerable to natural hazards, such as hurricanes and extensive bouts of dry weather. In 1979 and 1980, for example, Hurricanes *David* and *Allen* hit the industry consecutively. Since then, there was Hurricane *Hugo* in 1989, prolonged dry weather in 1991, and the triple hits of Hurricanes *Iris, Louis* and *Marilyn* in 1995. Then there was Hurricane *Lili* in 2002 as the industry was recovering from drought conditions in 2001, immediately followed by Hurricane *Ivan* in 2003. More recently, there was

Tomas[43] in 2010, which all but decimated the banana industry and, in the middle of the recovery in 2011, came the outbreak of Black Sigatoka disease. These natural disasters inflicted a heavy cost on the industry but, fortunately, the farmers have always mustered the resilience and courage to recover from them. However, this is becoming increasingly difficult with falling incomes and rising production costs."[44]

The last major storm, Tomas, disrupted the tourism sector for several days, even though there was no major damage to the hotels and other facilities. Vacations were shortened and postponed, and cruise ships avoided Saint Lucia for several days. Bad weather disrupts travel plans everywhere as travellers become wary of being injured or stranded, and tend to be cautious with news of inclement weather and especially storms.

Projections of Saint Lucia's climate done for this study indicate that the climate will be warmer and drier, the sea level will continue rising, and the risk of more intense storms is high. Climate change is aggravating the environmental vulnerabilities of the country, and particularly in the case of the main earners of foreign exchange, as seen in Error! Not a valid bookmark self-reference. below.

[43] Hurricane Tomas, estimated by the IMF to have caused damage equivalent to 34% of GDP,

[44] History of Windward Bananas: From Sugarcane to Bananas, http://www.winfresh.net/home/history-of-windward-bananas

Table 5.3: Estimated Impacts on Banana and Tourism Earnings by 2050

	Warming	**Change in precipitation**	**Sea level rise**	**More intense storms**
Bananas	Estimated negative impact on productivity Estimated losses by 2050 range from US$ 127 million (6 times Banana exports in 2009) under the B2 scenario at a 4% discount rate to US$ 389 million (21 times Banana exports in 2009) under the A2 scenario with a 1% discount rate[45] "Out of all the crops considered, bananas and plantains were expected to have the largest decline in potential yield,by approximately 33 per cent under the A2 scenario, which was considered the Business as Usual case. When compared to B2, the fall in yield was still large, at almost 20 per cent"[46] Hutchinson et al also expected no impact of sea level rise of 1 meter on agricultural land, and therefore no impact on crops.[47]	Negative impact on water resources, and hence productivity	Possible pollution of fresh water aquifers	Bananas are vulnerable to heavy winds
Tourism	Possible negative impact on demand for tourism services from North American visitors enjoying warmer winters US$12.1 billion (12 times 2009 GDP) under the A2 scenario and US$7.9 billion for the B2 scenario (3.6 times 2009 GDP)[48] by 2050	Negative impact on water resources	Possible pollution of fresh water aquifers Damage to hotels and other tourism facilities sited on the coast Greater risks of extreme wave actions	Negative impact on demand for vacations

[45] Sandra Sookram, ECLAC, 2011, Table 2, p.9
[46] Hutchinson et al, p.39
[47] ibid, Table 20, p.46
[48] W.Moore, ECLAC, 2011, p.25

Economic vulnerability

Like the rest of the CARICOM Caribbean, Saint Lucia is also vulnerable to shocks emanating from the major markets of the global economy, in which it participates, as well as the uncertain flows of investment capital and development assistance. In 1999, it was "given a globalization index of 0.66 (1999) that is higher than the CARICOM average of 0.53", which means it was more integrated into the global economy than the average for CARICOM. The loss of preferential access to the EU markets for bananas is the clearest example of this vulnerability. The fragility of tourism demand is well known. Apart from the income of visitors, and the prices of competitors, perceptions of the risk to life from violence, disease, and bad weather are major determinants of the demand for Saint Lucia's tourism services. Also important is the negative impact of sharp increases in the prices of oil and food, which accounted for averages of 18% and 19% respectively of annual imports from 2006 to 2014. The food share of imports ranged from 16% in 2006 to 24% in 2013, and the oil share of imports ranged from 13% in 2006 to 26% in 2008.

Seven (7) years after the global financial crisis, the Saint Lucian economy is yet to recover from the "significant and long-lasting harm to Saint Lucians' well-being."[49] FDI averaged 12.4% of GDP between 2000 and 2007, with a high of 24% in 2007, but averaged 9.2% between the crisis in 2008 and 2013.[50] The decline in FDI was particularly severe for tourism-related construction. One of the consequences was a sharp increase in non-performing loans.[51] Figure 5.5 above showed the marginal recovery of GDP in 2011 and 2012, and the subsequent contraction.

Social Vulnerability

Along with the rest of the OECS, Saint Lucia was hit harder than the rest of Latin America by the crisis, but not as hard as others in the OECS. Recovery has been slow, with high unemployment, particularly among youth.

The combination of economic and environmental shocks has driven up the unemployment rate, against the background of an already high poverty rate - 28.8% of the population in 2005/6- , and increasing inequality between the household wealth of the bottom 40% of households and the top 60%.[52] This implies that social vulnerability, the third dimension of vulnerability of SIDS, has increased in Saint Lucia.

5.2 The Tourism Sector

Accommodations for visitors are concentrated in the North West in Gros Islet and Castries, the South West at Soufriere, and the Southern tip of the main island of Saint Lucia at Vieux Fort. Only Gros Islet and Castries have the full range of accommodations - small and large properties, apartments, luxury and boutique hotels, all-Inclusives and villas. Table 5.4 shows the distribution of accommodations by type for the main locations. It is clear that small properties dominate, but without further information on room availability for each type of accommodation, no conclusion can be drawn on the scale of accommodation that characterizes the industry.

[49] Lea Giminez et al, "The Aftermath of the 2008 Global Financial Crisis on the Eastern Caribbean: the Impact on the St. Lucian Labour Market, 2015, p.8
[50] ibid, p.11
[51] ibid, p. 11
[52] ibid, p.27

Table 5.4: Number of Accommodation Facilities by Type by Principal Location

Location	Small Properties	Large Properties	Guest Houses and Apartments	Apartments	Luxury and Boutique Hotels	All-Inclusives	Villas and Cottages
Gros Islet	25	5	7	8	4	3	20
Castries	8	6	3	6	5	5	3
Soufriere	15	0	4	0	7	0	0
Vieux Fort	7	1	4	0	0	1	1

Source: Ministry of Tourism, Heritage and Creative Industries, "List of Tourism Products"

The main extra-regional sources of visitors are the USA and the UK. Apart from beach tourism, Saint Lucia is reputed to be the leading honeymoon market/destination for visitors from the USA,[53] and a country with a lot to offer for Nature lovers.

Table 5.5 presents data for the decade, 2004 to 2014, on visitor arrivals, expenditure, length of stay, and occupancy.

Table 5.5: Indicators of Tourism

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Visitor Arrivals	818963	725571	695299	931803	946743	1014761	1015645	986370	931939	960617	1034332
Stay-Over	298431	296678	302510	287518	295761	278491	305937	312404	306801	318626	338158
Cruise	481279	394364	359593	610345	619680	699306	670043	630304	571894	594118	641452
Avg length of stay, days	9.3	10.1	10.5	9	8.9	8.9	8.6	8.9	8.5	8.7	8.8
Tourist expenditure, EC$ mns	879	919	768	1439	1233	1122	1500	1554	1602.4	1763.7	2015.3
Stay-Over	817	864	724	1364	1175	1059	1442	1500	1553.4	1712.7	1960.2
Cruise	62	55	44	75	58	63	58	54	49	51	55.1
Stay-over per capita	977.7	1040.1	854.8	1694.3	1418.9	1358.1	1683.4	1714.8	1808.3	1919.7	2070.2
Cruise per capita	46.0	49.8	43.7	43.9	33.4	32.2	30.9	30.6	30.6	30.7	30.7

[53] Visitor Expenditure and Motivation survey, January – March 2014, Table 2, p.5

Stay-over per capita per day	105.1	103.0	81.4	188.3	159.4	152.6	195.7	192.7	212.7	220.7	235.3
Avg Hotel Occupancy, %	61.9	68.7	64.9	64.9	61.6	53.3	58.7	58.3	62.3	64.6	68.4

Source: GOSL, Review of the Economy – 2014, Appendix 5, p. 64

Figures 5.7 and 5.8 compare the daily per capita expenditure of Stay-Over visitors with cruise ship visitors, and the average occupancy rate of accommodations facilities, based on data in Table 5.5.

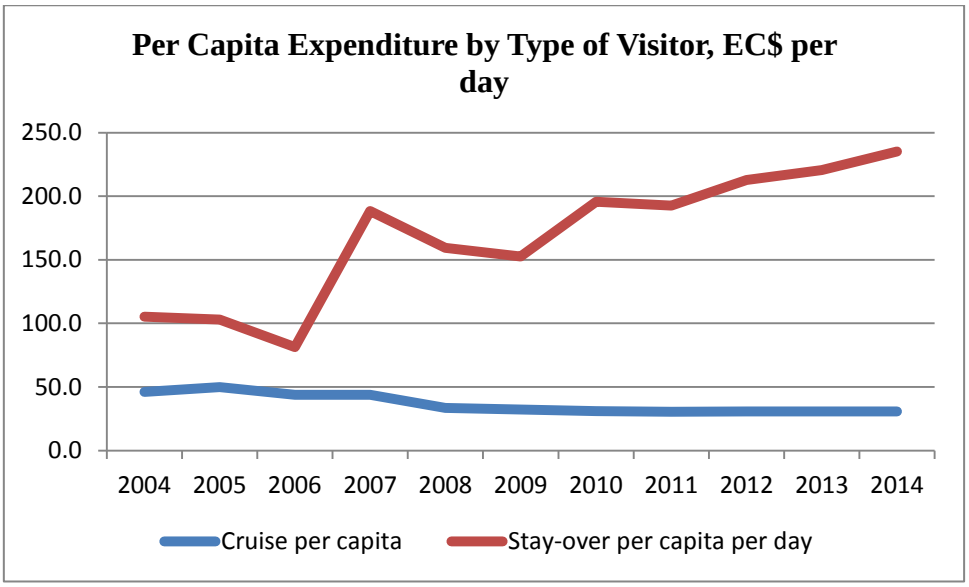


Figure 5.7: Per Capita Expenditure by Type of Visitor, EC$ per day

The gap between per capita expenditure of the two types of visitors has grown continuously from 2006, with Stay-Over visitors spending more than six (6) times cruise ship visitors on a typical day. Whereas the daily per capita expenditure of Stay-Over visitors has grown rapidly, the rate for cruise ship visitors has been declining gradually but steadily.

On the other hand, cruise ship visitors out-numbered Stay-Over visitors 2 to 1 for the past 5 years and in one year, it was as high as 2.5 to 1. As in other Caribbean territories, Saint Lucia has been receiving more and more cruise ship passengers who are spending less and less. Fortunately, both the numbers of Stay-Over visitors and the average daily expenditure have been rising to off-set the relative losses on cruise ship visitors. Further, it appears from Figure 5.8 that the growth of accommodations has kept pace with the growth of the number of Stay-Over visitors and the average length of stay, with the result that occupancy rates have been fairly constant.

It will be important to estimate the relative environmental impact of each type of visitor to guide planning for expansion of the industry in the future. A comparison of the cost of terrestrial resources used by the typical Stay-over visitor, with the cost of the coastal resources attributed to the typical cruise visitor, will be a challenge that has to be met to be able to determine the net returns from each type of service.

Similarly, the relative impacts of climate change on the feasibility, viability and the net returns of each type of tourism service have to be estimated.

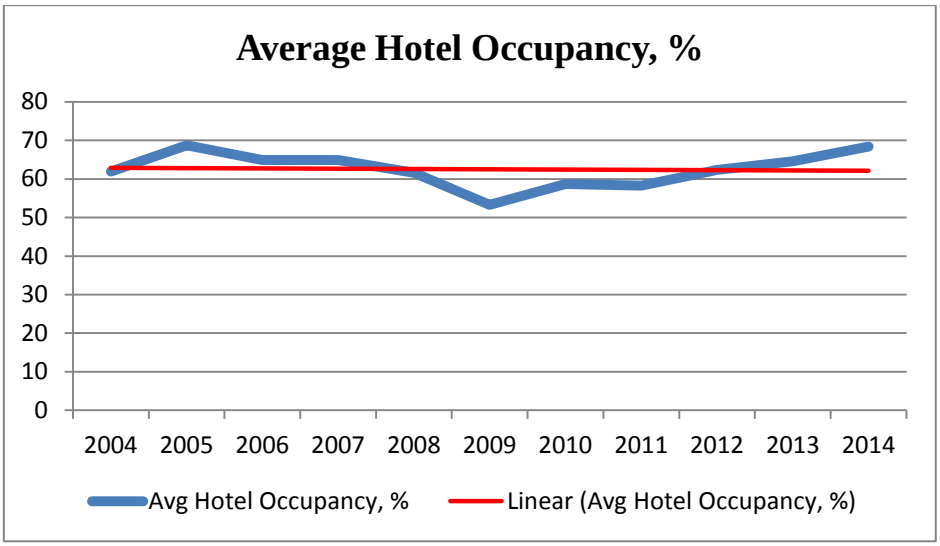


Figure 5.8: Average Hotel Occupancy %

The Saint Lucia Tourism Strategy and Action Plan Report estimated that the sector provided 13,500 direct jobs, or 18.6% of employment, as well as 17,500 indirect jobs. Indirect employment arises from ancillary activities serving the tourism sector, as is the case with job creation by this sector in other economies in which tourism is important. In the case of Saint Lucia, it allows for persons having multiple occupations, usually farming and some service activity, as well as informal employment.

The Tourism industry is a major source of tax revenue for the government. The report cited above speaks of "60% ***to*** tax revenue"[54]

Visitor expenditure in 2014 was EC$ 2015.3 million, which was equivalent to 1.25 times the import bill and 9.7 times domestic exports in that year. With the high import content of consumption and the accrual of income to foreign property owners, the net retention was probably much less, which is the pattern throughout the region.

Visitor expenditure surveys have documented the pattern of expenditure by large categories. The findings for the first quarter of 2014 are shown in Table 5.6 below.

Table 5.6: Profile of Visitor Expenditure

Type of Expenditure	%
Accommodation	59.4
Food and Drink	16.8
Transport	6.4
Shopping	3.9
Recreation	12.6
All other	0.9

[54] St. Lucia Tourism Strategy and Action Plan Report, p.9

Source: Visitor Expenditure and Motivation Survey, January-March, 2014

Perhaps, food and drink, and recreation are the areas where the greatest potential for retaining more of the visitors' expenditure exists. The expansion of agriculture and fishing to tap more of the food and drink market is really consistent with the thrust for a more productive sector to compete internationally. Selling to tourists is really selling to that segment of the international market that comes to Saint Lucia. Similarly, the cultural industries are high priority for the expansion and development of the Saint Lucian economy. The annual Saint Lucia Jazz festival has a strong international name. Like the farmers, providers of cultural services will be supplying the international market when they tap more of the tourist dollar for recreation and related services.

The Saint Lucian economy has traditionally been based on small-scale producers, and for that reason the banana export economy was inclusive. The challenge is to ensure that small-scale operators participate integrally in the tourist economy so that the earnings from the industry will be spread throughout the economy. Of course, as with the banana producers, small-scale operators are challenged to become sufficiently productive to be competitive in a very demanding industry with high international standards for quality of service.

5.3 Climate Change and the Tourism Sector

The tourism sector is vulnerable to all the major expressions of climate change. The rising sea level threatens beaches and the hotels and other facilities located on them, and underground sources of fresh water. Reduced precipitation[55] will lead to shortages of fresh water. Warmer temperatures will facilitate more and rapid breeding of disease bearing vectors, principally the mosquito, thereby increasing the health risks to visitors. Warmer sea temperatures will damage the coastal marine resources by bleaching coral reefs, and encouraging the migration of fish stocks to cooler waters. Warmer winters may also reduce the demand for tropical vacations everywhere, including Saint Lucia. The attraction of diving to visitors will be diminished. On higher sea levels, extreme wave actions from storms will threaten facilities further inland behind beaches. Wind damage from more intense storms threaten facilities for visitors, and will be perceived as high risks to life. In short, the beach activities that feature in the Saint Lucian tourism product is highly vulnerable to all the expressions of the projected changes that the climate of Saint Lucia is undergoing.

The tourism sector cannot adapt to climate change by itself. Any sector strategy, has to be a part of an economy-wide strategy, since tourism is so central to the dynamic of the economy. Greening the economy is an appropriate context for tourism, and any other sector, to adapt to climate change.

A recent scoping study[56] for the greening of the Saint Lucian economy sketched the policy context[57] for a green economy, and focused on the efficiency of natural resource use. Specifically, it argued

[55] The projections for precipitation done for this report are ambiguous with respect to the increase or decrease of annual precipitation rates, but the authors are inclined to believe that there will be drier conditions. "Very little can be confidently said about changes in the rainy seasons due to the wide variations in the projected change, dependent on model and scenario. However median changes are largely negative for all seasons ***suggesting drier conditions***." Climate Studies Group, "Characterization of Climate Variability, Trends and Projections for Saint Lucia.", p. 25

[56] Keron Niles et al, "Green Economy Assessment for Saint Lucia:Scoping Study", UNEP, 2014

for the reduction of the carbon footprint by more efficient use of energy, the development of indigenous energy resources, the more efficient use of land and water, and the improvement of waste management. It also argued for the use of "technology and skill transfer to minimize the adverse impacts of economic activities on the environment."[58] Further, "There is considerable scope for both private and public sectors to introduce environmentally benign, socially inclusive, economic activities and to engage in the reform and/or re-design of ecologically harmful practices that currently exist.[59]

Much of the study was directed at the transformation of agriculture, even though it recognized the leading role of tourism. In the case of tourism, it suggested that, "The benefits of 'greening' tourism include enhancing visitor experience, adding value to local businesses, supporting biodiversity and reducing the impact on the environment. "[60] It argued, for the encouragement of "sustainable local small to medium sized tourism enterprises and initiatives"[61] because they were less resource-intensive, and such a strategy would promote inclusive growth of the industry.

The study did recommend diversification of the tourism products, which would include reducing the dependence on beach tourism. A gradual move of the centre of gravity of the industry inland, would reduce the risk of property damage from beach erosion and extreme wave actions, on the basis of increasing sea level. This does not obviate the need for scientific management of coastal resources.

It also drew attention to the potential to access climate funds for investment, especially with public-private partnerships that employed green technologies.

Climate proofing Saint Lucia's tourism sector will benefit from the more intensive use of indigenous energy resources and more efficient management of fresh water resources that are integral to the proposed greening strategy.

It will also entail revised building standards that anticipate warmer temperatures with structures that facilitate natural cooling and lighting.

The GOSL must develop the policy and institutional framework to promote the climate proofing of the sector. In the first instance, this requires mainstreaming climate change policy in sector policy, as well as the policy for the economy as a whole. In the second instance, climate proofing will require investments that will depend critically on forging partnerships with local and foreign private investors.

Moore's study of the impact of climate change on tourism in Saint Lucia, conducted cost-benefit analyses of nine (9) "potential mitigation options."[62] These were:

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[57] Ibid, p.20: "---the 'greening' of the Saint Lucian economy also directly complements the country's National Vision Plan and relevant national policies such as the National Environment Policy (NEP), Climate Change Adaptation Policy, Land Policy and Energy Policy."
[58] Ibid, p.6
[59] ibid, p.7
[60] ibid, p.48
[61] ibid, p.49
[62] Winston Moore, 2011, p.34. These seem more like adaptation options than mitigation options to this author. Table 14 on p.34, 35 displays the results of the cost-benefit analysis of each option under the assumptions of discount rates of 1%, 2% and 4%.

(a) Increasing recommended design wind speeds for new tourism related structures;

(b) Construction of water storage tanks;

(c) Irrigation network that allows for the recycling of waste water;

(d) Enhanced reef monitoring systems to provide early warning alerts of bleaching events;

(e) Deployment of artificial reefs or fish aggregating devices;

(f) Developing national evacuation and rescue plans;

(g) Introduction of alternative attractions;

(h) Providing retraining for displaced tourism workers; and

(i) Revising policies related to financing national tourism offices to accommodate the new climatic realities.

Of these, three (3) of them promised greater benefits than costs at all discount rates. These were:

(a) Increasing recommended design wind speeds for new tourism related structures;

(b) Enhanced reef monitoring systems to provide early warning alerts of bleaching events; and

(c) Deployment of artificial reefs or fish aggregating devices;

Moore went on to note that the other options recommended themselves because of "non-tangible benefits."

Saint Lucia's adaptations to climate change have to concentrate on the supply side since the demand for its tourism services is beyond its control and influence. Warmer northern winters, lower incomes, and negative perceptions of air travel have to be taken as given, and appropriate adjustments made to the attractiveness of vacations in Saint Lucia to offset falling demand. The approach that is being proposed here relates to the medium and long run efforts to cushion the impact of the projected fall-out cited above. It means also that Saint Lucia will be advised to take a holistic approach to adapting to climate change in the rest of the economy, especially in agriculture as a relevant related strategy to the adaptation of the tourism sector.

5.4 Climate-Proofing the Tourism Sector

The Tourism sector cannot adapt to climate change by itself. Any sector strategy has to part of an economy-wide strategy since Tourism is so central to the dynamic of the economy. Greening the economy is an appropriate context for Tourism, and any other sector, to adapt to climate change.

A recent scoping study[63] for the greening of the Saint Lucian economy sketched the policy context[64] for a green economy, and focused on the efficiency of natural resource use. Specifically, it argued

[63] Keron Niles et al, "Green Economy Assessment for Saint Lucia:

for the reduction of the carbon footprint by more efficient use of energy, the development of indigenous energy resources, the more efficient use of land and water, and the improvement of waste management. It also argued for the use of "technology and skill transfer to minimize the adverse impacts of economic activities on the environment."[65] Further, "There is considerable scope for both private and public sectors to introduce environmentally benign, socially inclusive, economic activities and to engage in the reform and/or re-design of ecologically harmful practices that currently exist."[66]

Much of the study was directed at the transformation of agriculture, even though it recognized the leading role of Tourism. In the case of Tourism, it suggested that, "The benefits of 'greening' tourism include enhancing visitor experience, adding value to local businesses, supporting biodiversity and reducing the impact on the environment."[67] Further, it argued for the encouragement of "sustainable local small to medium sized tourism enterprises and initiatives"[68] because they were less resource-intensive, and such a strategy would promote inclusive growth of the industry.

The study did recommend diversification of the tourism products, which would include reducing the dependence on beach tourism. A gradual move of the centre of gravity of the industry inland would reduce the risk of property damage from beach erosion and extreme wave actions on the basis of increasing sea level. This does not obviate the need for scientific management of coastal resources.

It also drew attention to the potential to access climate funds for investment, especially with public-private partnerships that employed green technologies.

Climate proofing Saint Lucia's Tourism sector will benefit from the more intensive use of indigenous energy resources and more efficient management of fresh water resources that are integral to the proposed greening strategy.

It will also entail revised building standards that anticipate warmer temperatures with structures that facilitate natural cooling and lighting.

The GOSL must develop the policy and institutional framework to promote the climate-proofing of the sector. In the first instance, this requires mainstreaming climate change policy in sector policy, as well as the economy as a whole. In the second instance, climate proofing will require investments that will depend critically on forging partnerships with local and foreign private investors.

Moore's study of the impact of climate change on Tourism in Saint Lucia conducted cost-benefit analyses of nine (9) "potential mitigation options."[69] These were:

Scoping Study", UNEP, 2014

[64] Ibid, p.20: "---the 'greening' of the Saint Lucian economy also directly complements the country's National Vision Plan and relevant national policies such as the National Environment Policy (NEP), Climate Change Adaptation Policy, Land Policy and Energy Policy."
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Saint Lucia's adaptation to climate change has to concentrate on the supply side since the demand for its tourism services is beyond its control and influence. Warmer northern winters, lower incomes, and negative perceptions of air travel have to be taken as given, and appropriate adjustments made to the attractiveness of vacations in Saint Lucia to offset falling demand. The approach that is being proposed here relates to the medium and long run efforts to cushion the impact of the projected fall-out cited above. It means also that Saint Lucia will be advised to take a holistic approach to adapting to climate change in the rest of the economy, especially in Agriculture as a relevant related strategy to the adaptation of the Tourism sector.

6 Institutional Framework, Policy and Legislative Review

6.1 Institutional Map

Table 6.1 below shows the Government Agency/Ministry/ or NGO/Regional body and their associated tourism and climate related legislation, and policy/plan, if applicable. A detailed review of these Ministries and documents are presented in Appendix III and Section 6.2 outlines the relevant issues and recommendations.

Table 6.1: Government Agency/Ministry and associated Policy and Legislation

Government Agency/Ministry	Division/Sections/Units/ Statutory Bodies	Legislation	Policy/Plan
Ministry of Tourism, Heritage and Creative Industries	• Administrative • Saint Lucia Tourism Development Programme • Saint Lucia Tourist Board	• Tourism Incentives Act • Tourism Stimulus and Investment Act	• National Tourism Policy, 2003 • Saint Lucia Tourism Strategy and Action Plan, 2007 • Strategy and Action Plan: Draft Report Saint Lucia Tourism Benchmarking and Competitiveness Assessment
Ministry of Agriculture, Food Production, Fisheries, Cooperatives and Rural Development	• Agricultural Division • Fisheries Department	• Agricultural Small Tenancy Act • Fisheries Act • Land Conservation and Improvement Act • Wildlife Protection Act	• Agricultural Policy and Strategy, 2006 • National Agricultural Policy 2009 - 2015
Ministry of Sustainable Development, Energy, Science and Technology	• Biodiversity Unit • Coastal Zone Management Unit • Energy Science and Technology Section • Forests and Land Resources Development Department • Land Conservation Board • National Water and Sewerage Commission • Protected Areas Management • Public Utilities Department • Saint Lucia Solid	• Forest, Soil and Water Conservation Ordinance • Montreal Protocol (Substances the Deplete the Ozone Layer) Act • Waste Management Act • Water and Sewerage Act • Draft Biosafety Bill • Draft Biodiversity and Sustainable Use Bill • Draft Environment Impact Assessment Regulation	• Coastal Zone Management Policy • National Biodiversity Strategy and Action Plan of Saint Lucia, 2000 • National Climate Change Policy and Action Plan, 2002 • National Environmental Policy and Management Strategy, 2014 • National Forestry Action Plan • Draft Coastal Zone Management Strategy and Action Plan

Government Agency/Ministry	Division/Sections/Units/ Statutory Bodies	Legislation	Policy/Plan
	• Waste Management Authority • Sustainable Development and Environment Division • Water Resources Management Agency • Water and Sewerage Company		• Saint Lucia Climate Change Adaptation Policy, 2015
Ministry of Infrastructure, Port Services and Transport	• Department of Public Works	• Beach Protection Act	•
Ministry of Physical Development, Housing and Urban Renewal	• Physical Planning Section	• Physical Planning and Development Control Act	• National Land Policy, 2007
Ministry of Finance and Economic Affairs	•	•	• National Vision Plan, 2008
Ministry of Health, Wellness, Human Services and Gender Relations	• Environmental Health	• Public Health Act	•
National Emergency Management Organisation	•	• Disaster Management Act • Disaster Preparedness and Response Act	• National Emergency Management Plan • Water Management Plan for Drought Conditions, 2009 • Hazard Mitigation Plan • Hazard Mitigation Policy
National Environment Commission	---	---	
National Conservation Authority		• National Conservation Authority Act	
Non-governmental Organizations			
Saint Lucia Hotel and Tourism Association	---	---	
Saint Lucia National Trust	•	• Saint Lucia National Trust Act	
Caribbean Natural Resources Institute	---	---	
Saint Lucia Meteorology Service	---		

6.2 Review of Institutional Framework, Policies and Legislation

Legislation concerning land use regulation has evolved over time and concentrates on the control of urban land, the building situation and construction. Various pieces of legislation have been enacted for natural resource protection or management include:

a) The Public Works and Roads Ordinance (1969) with regard to siting and access for any development proposals.

b) The Industrial and Commercial Buildings Act (1973).

c) The Public Health Act (1975) for sanitation, sewage treatment and other public health measures.

Under the Physical Planning Act, land developments require the developer to first obtain the permission of the Development Control Authority (DCA). The DCA is governed by the Physical Planning and Development Act No. 29 of 2001 and its amendments of 2005. The developer must submit the application including requirements such as, cover letter, drawings, land documents, survey plans, and pre-DCA Approvals (e.g. health, Fire, EIA). Payments of the required fees must be made before applications are registered. An application can be made for approval in principle or full approval. Implementation of land use proposals and building regulations prepared by the Authority depends on the process of granting a planning permit for development. Three main problems have been encountered in implementing these proposals. First, not all developers apply for permission. In addition, the Authority's staffing capacity to monitor all developments is limited. Furthermore, the Authority lacks sufficient staff to prosecute all cases of illegal development, and the fines set are inadequate, offering little disincentive to evasion, and second, decisions on major development proposals are made by the Cabinet discouraging the Authority in the fulfilment of its tasks.

The Physical Planning Act significantly redesigned planning legislation but neither Physical Planning Regulation, nor EIA regulations, have ever been promulgated (although drafts were prepared but not approved by Cabinet). Thus the legislative framework in this area is incomplete.

The Public Health Act needs to be revised including the level of fines and other imposing sanctions.

The National Development Corporation has powers under its legislation to act as Development Control Authority within designated development areas. Special areas need to be designated by the Governor General and approved by the House of Assembly. Development areas have been designated in various sections of Saint Lucia. Currently, there are two development control authorities in Saint Lucia with powers to regulate development in various areas.

A key legislation, with a bearing on the control and regulation of rural land use, is the Forest, Soil and Water Conservation Ordinance enacted in 1945. This Ordinance covers only a narrow aspect of natural resource conservation. The Ordinance delegates to the Chief Forest Officer the duties of overseeing the timber industry and timber dealers in the country and preventing the unlawful removal of timber from Crown Lands (Sections 6 and 18). Provisions was made in the Ordinance for the establishment of forest reserves (Sections 19 and 20) and/or the declaration of protected forests on private lands, allowing the Chief Forest Officer to regulate its utilization "in order to protect

covered areas of importance for protection against storms, prevention of soil erosion, the maintenance of water supplies in springs, rivers and reservoirs and the preservation of health. The Ordinance is supported by the Forest, Soil and Water Conservation (Crown Land forest produce) Rules. Both the Ordinance and the Rules need significant revision and they are outdated. A new Draft Forest Act and Forest Rules have been prepared but they have neither been implemented nor approved by the Cabinet.

The declaration of preserved and protected forests and their corresponding rules and provisions are the only aspects of the Forest, Soil and Conservation dealing with the regulation of land use in rural areas. They address only the forestry-related aspects of soil and water conservation, without considering the agricultural land use aspects of environmental management.

The beaches are the only other natural resource partially protected by legislation in Saint Lucia. The Beach Protection Act (2002) is very limited in scope, preventing digging and removal of sand, stones, shingle or gravel from the seashore. The Act permits the Government to undertake such operations and authorises granting licences to private citizens or companies to carry out any activities prohibited by the Ordinance. The definition of seashore given in the Act is fairly broad (including the bed and shore of the sea, every channel, creek, bay or estuary and every river as far as the tide flows), and the Government owns all lands covered by the Act (the Queen's Chain), but no legal provision exists in this legislation for the integrated protection of the delicate coastal ecosystems on which much of the tourism industry is based. These ecosystems are being permanently damaged by pollution and overexploitation.

Two pieces of legislation important for the protection of the environment and the scenic beauty of Saint Lucia are the Wildlife Protection Act (9/1980) and the Saint Lucia National Trust Act (No. 16, 1975).[18] The former was enacted specifically to protect various species of wildlife that are either unique to Saint Lucia or of ecological importance, and the latter to legally sanction an institution capable of preserving buildings and areas of architectural, historical or natural interest. While only the Wildlife Protection Act is regulatory in character, the National Trust is important regarding actions required for protecting natural resources.

Despite the existence of some legislation, misuse of land, water, mangrove, swamps and other natural resources has proceeded loyally unchecked in Saint Lucia for years.

The Water and Sewage Act, 2005, provides a legal framework for the management of water resources to regulate the delivery of water supply services and sewage services throughout Saint Lucia. The Act and its accompanying regulations provide a comprehensive legal framework for the management of water.

With regards to tourism, the main legislation (primarily dealing with incentives) are the Tourism Incentives Act, 1996 and the Tourism Stimulus and Investment Act, 2014. However, tourism is affected by a vast array of legislative instruments. The Physical Planning Act would govern the siting of hotels. However, whilst provision for EIA is contained in this Act, no EIA regulations have been promulgated to effectively deal with this issue (although draft EIA regulations have been proposed but not approved by Cabinet). The Public Health Act and its regulations also affect sanitation, public

health measures, etc. However, they are not adequate or comprehensive regulations to address pollution issues in the county – this gap would also affect the tourist sector. Ecotourism and related activities would also relate to the legal and institutional aspects in other sectors e.g. Forest, Soil and Water Conservation Ordinance and the Rules. The Wildlife Protection Act and Saint Lucia National Trust Act are also relevant. The Beach Protection Act affects the issue of beaches, which is highly relevant to the tourism sector. Any improvement in the legislative structure affecting national resource management will be directly relevant to the tourism sector. So draft legislation such as the draft Forest Act, the draft Environmental Management Act and the draft EIA regulations will enhance the regulatory framework for the tourism sector, if they are approved by Cabinet and enacted, or fall under the purview of legislation promulgated by the appropriate Minster.

What is needed is greater interagency coordination, common understanding of key policies and the operationalization of Cabinet approved National Policies, into the operational framework of these institutions dealing with natural resources management.

During the early seventies there were significant institution building efforts in the creation of the National Development Corporations, the Housing and Urban Corporation, the Town and Country Planning Departments, the Saint Lucia National Trust etc. Later, the institution building efforts continued with the Physical Planning Unit, the Solid Waste Management Authority, the National Conservation Authority, the National Waste and Sewage Commission, the Water Resource Management Agency, the Sustainable Development and Environment Division (SDED) etc. Coordination among agencies is of critical importance and the need for all relevant national policies to fully integrate in the work of all key agencies remains an ongoing issue. In the area of sustainable development, environment, coastal zone management and climate change and other key areas, the SDED plays a critical role which can only be enhanced over time.

Awareness of the need for change has encouraged proposals for institutional development, which may nevertheless reproduce the problems of the existing institutional structure, unless there is a coherent and coordinated approach to all institutional and legislative initiatives, relating to the natural resources management sector.

There is the persistent tendency within the public sector to view problems in isolation and of the institutions' attempt to separately find legal, administrative and financial solutions. Modification of this negative trend is imperative to bring about a unified view of the natural resources conservation development efforts. Certainly, such a change will imply unification of decision-making capacity and rationalization in the use of available manpower at the technical level to parallel the required changes in the legal structure. The development of a wide range of national policies in Saint Lucia is a good start in the process. What is needed is the full implementation of these policies and integration into the work and operations of all natural resources agencies.

While there is an extensive range of policies and legislation there are still significant gaps in the policy and legislative framework. In addition, there exists a comprehensive number of institutions. Some of the key agencies include Forestry Department, NEMO, CZMU, Solid Waste Management Authority, Physical Planning Department, the Environment Health Unit etc. Many of these key institutions need to be strengthened both in terms of staffing and technical capacity.

6.2.1 Policy and Legal Instruments

Policy

The National Vision Plan, although it includes sustainability, does not deal with climate change considerations, such as adaptation.

Legislation

Whilst there is a wide range of legislation (see Appendix III), it has been widely recognised that many of the laws are outdated, lack effective sanctions and in certain areas, key legislative frameworks are missing. Hence, the significant number of draft Acts and Regulations that have been prepared. The next step is to enact these Acts and promulgate necessary Regulations.

Enforcement

Inadequate enforcement of existing legislation is a pervasive problem for all the existing Acts that have been reviewed. This is a crucial issue that needs to be addressed.

6.2.2 Institutional

There are a number of key institutions involved. These include the Forestry Department, the Solid Waste Management Authority, the Physical Planning Unit and the Environment Health Unit. Of these, additional strengthening is needed in the Forestry Department, the Physical Planning Unit and the Environmental Health Unit.

The Forestry Department's role in the management of forests is of critical importance for ecotourism. There is a need to strengthen the capacity of the Forestry Department to enforce its existing laws. In addition, a major revision of its existing laws is also required.

The Physical Planning Department has been recognised as a critical support government agency to the tourism sector given its role in development control. Its insufficient staffing and budget has hindered monitoring and forward planning and as such, negative environmental impacts from various developments, including tourism operations are not controlled.

The Environmental Health Unit is not equipped and appropriately funded to sustain environmental monitoring activities. This is a challenge.

Whilst Saint Lucia has a broad range of institutions there is need for institutional strengthening of most of these institutions (technical staff, staff training etc.). In addition, additional funding of these institutions is required to ensure their effectiveness.

6.2.3 Recommendations

6.2.3.1 Institutional Recommendations

The 2012 *Climate Change Adaptation Planning in Latin American and Caribbean Cities Final Report: Castries, Saint Lucia* by ICF GHK[70] found that public sector bodies have narrow sectoral mandates, which affects the planning strategies and, development planning in Saint Lucia is characterized by "a

70 http://www.worldbank.org/content/dam/Worldbank/document/LAC/Climate%20Change%20Adaptation%20Planning%20for%20Castries_FINAL.pdf

short-term perspective as well as fragmentation, with little cooperation and cross-border interaction between agencies and ministries. In effect, this prioritizes short-term objectives and disintegrates development policy."

6.2.3.2 Policy Recommendations

The 2012 *Climate Change Adaptation Planning in Latin American and Caribbean Cities Final Report: Castries, Saint Lucia*, noted that Castries was susceptible to many natural hazards such as storm surges, tropical cyclones, and landslides, however, Castries was particularly prone to flooding from rain, even minor rainfall due to increased impermeable surfaces from urbanization, lack of an adequate storm water drainage system and inappropriate waste disposal. Climate change is projected to result in decreased rainfall but due to the city being largely at sea level, sea level rise, population and tourism growth would likely increase the impact of coastal flooding. Climate change in some cases will result in the increase intensity of rainfall and runoff and this will also have a deleterious effect. Although there is a good system in place for disaster response and management, NEMO is weak in risk management and is reactive rather than being proactive which is required for climate change adaptation. Climate Change vulnerability has to be considered in all government planning and development activities[71].

A number of draft Policies need to be finalized and submitted for Cabinet approval. These include-

- Draft National Forest Policy
- Draft National Forest Management Plan

The above mentioned will help in climate change adaptation, since forest cover reduces erosion, runoff and assists in mitigation by acting as carbon sinks, among other functions.

6.2.3.3 Legislative Recommendations

There are many draft Acts and Regulations which have not been enacted or promulgated. It is recommended that the following draft Acts be finalized and enacted:

- Draft Forest Act
- Draft Forest Regulations
- Draft Environmental Management Act
- Draft Environmental Impact Assessment Regulations
- Draft Wildlife Protection Act
- Draft Biodiversity Conservation and Sustainable Use Act
- Draft Land Development Regulations

The enactment of the Environmental Management Act will strengthen the legal capacity to effectively manage the environment, and establish a strong legal framework for the legal control of pollution. The EIA Regulations will strengthen the mechanisms for carrying out and evaluating EIAs which will be beneficial to all sectors of the economy including tourism. Stronger legal provisions for setbacks in the Draft Land Development Regulations will enhance the protection of coastal areas from new coastal developments (including tourism developments). The Draft Forest Act and the

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http://www.worldbank.org/content/dam/Worldbank/document/LAC/Climate%20Change%20Adaptation%20Planning%20for%20Castries_FINAL.pdf

Draft Forest Regulations, will enhance the legal protection of forest reserves etc. The strengthening of the regulatory framework should greatly enhance tourist related activities associated with forest areas.

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