CHAPTER THREE

FORESTRY AND TERRESTRIAL ECOSYSTEMS CLIMATE CHANGE VULNERABILITY AND ADAPTATION

By
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3.1 INTRODUCTION

St. Lucia is a mountainous island primarily of volcanic origin in the Windward Islands of the Lesser Antilles. St. Lucia (lat. 13°42′ and 14°06′ N, long. 61°05′and 61°52′ W) lies between Martinique, 28.3 km to the north and St. Vincent, 31.2 km to the south. The island is 44.7 km long and 21.5 km at its widest point. The total surface area is 616.4 km^2. The island's mountains are predominantly in the south-central portion of the island. The highest elevation is 950 m above sea level.

There are two (2) climatic seasons based on rainfall: a wet season that extends from June to November and a dry season occurring between December and May. In recent times, this distinction has not been clear-cut. Average annual rainfall ranges from 1,500 mm in the northern and southern extremities to 3,500 mm in the wet mountainous regions (GOSL, 2000).

The island is characterized by a maritime tropical climate and is influenced by the North East Trade Winds. The climate is characterized by a pleasant temperature of 26°C, and a relative humidity of about 75% with little seasonal or diurnal variation. Rainfall tends to be orographic in nature and is distributed into a drier season from January-May and a wetter season from June-December, with a risk of hurricanes and tropical storms from late June to early October and the threat of severe tropical storms with high winds and very heavy rains through November.

3.2 FOREST RESOURCES

Introduction; Island area: 61,500 ha.; forest cover 23,157 ha (16,621 rainforest, 7515 dry scrub forest, 2666 in grass and open woodland, (GOSL 1993). The forest reserve consists of 7500 ha. total, of which 6607 ha. compose the natural forest and 263 ha. under plantation. 1560 ha. of Crown lands are under natural habitats. There is a 4,500 ha. parrot sanctuary (95 % within the Government Forest Reserve). Forested private lands (14170 ha.), represents 10% of total private land (GOSL 1993).

Natural Vegetation types:
St. Lucia's rugged terrain led to a variety of vegetative types. The principal types and the dominant species are described as follows (Beard 1949).The rainforest; dominant vegetation of the mountain slopes. Main tree species, gommier (*Dacryodes excelsa*) and various *Sloanea* species. The forest canopy typically (30-40 m) in height lower

montane rain forest: in higher elevations, plant composition and structure of the forest change, with lower canopy. Dominant species include *Licania ternatensis* and the palmiste *(Euterpe globosa)*. elfin woodland; or cloud forest occurs on highest peaks. Trees are adapted to high rainfall, shallow soil and windy conditions and a lower temperature regime.
Xerophytic forest; natural dry forest, typically in the coastal region, most frequently converted for development. Primarily secondary woodland consisting of regenerating forest interspersed with cultivation. White cedar (*Tabebuia pallida*) is the dominant species.
Dry scrub woodland; driest portions of the island, dominant species (*Haemotoxylon campechianum*), various species of the Acacia, cacti and *Coccoloba pubescens.*
Mangrove area; There are at least 14 key mangrove areas in St. Lucia. They are predominantly on the East coast (Mankote, Savannes Bay, Esperance, Anse Louvet, Praslin and Marigot). Dominant species occurring are *Rhizophora mangle, Avicennia germinans, Laguncularia racemosa* and *Conocarpus erecta*. Several areas have been destroyed over the years (Beard 1949, Portecorp J. and Benito Espinal 1985).

Plantations and Natural Forest

The earliest plantations were established in 1938. The primary species established were blue mahoe (*Hibiscus elatus),* Honduras mahogany *(Swietenia macrophylla),* Caribbean pine *(Pinus caribaea), Leucaeana leucocephala*, and Gmelina (*Gmelina arborea*). The main plantation areas are located at Edmond Forest, Quillesse, Barre de L'Isle and Union. The total standing volume for these species is 45722.7 m^3 (Table 3.1). The mean annual increment for the natural forest (tropical moist to subtropical rainforest) is 1.6 m^3/ha/year (Plitz 1983). The Forest Reserves comprises of 14 units located mainly in the central ridge of the island. There are approximately 4.5 miles of road within the Forest Reserve. Timber production consists of small-scale cutting and extraction by selective tree felling. Conversion is often done by pit-saw technique and more commonly by the Alaskan mill chain saw. Most harvesting occurs on private lands. No commercial harvesting is done from the Forest Reserve.

Table 3.1. St. Lucia Timber Plantation Volumes (m^3)

AGE CLASSES	Blue Mahoe	Honduras Mahogany	Mixed Stands (BM & HM)	Caribbean Pine	Total
Class 1	390.8	170.9	117.0	226.5	905.2
Class 2	5974.3	1478.7	2335.3		9788.3
Class 3	9197.0	8999.2	14176.3	2656.7	35029.2
TOTAL	15562.1	10,648.8	16628.6	2883.2	45722.7

Source: St. Lucia Management & Conservation Project (1989)

Deforestation;
Historically, most of the "Common Property resources" came under an open access regime that led to excessive exploitation. The demand for agricultural land was largely responsible for deforestation. In the 1980's deforestation was estimated at 1.9% per

annum due to banana cultivation. Most likely this rate has declined due to a faltering banana industry (GOSL 1993). More recently, the development of residential construction and the access road network are more prominent in the process of deforestation. Within the past six years the area occupied by squatters in the Forest Reserve has been reduced from 320 ha to 100 ha.

Utilization

The most important material extracted from forest is charcoal which is a primary source of fuel for some households. It is primarily taken from dry forest and mangrove. It is often an incidental product from land clearing for shifting cultivation. Other non-timber products include latanier (*Cocothrinax barbadensis*) used in broom production for local consumption and export, L'encens (*Protium attenuatum*) used in incense production, and bamboo (*Bambusa vulgaris*) in construction industry. Most of the local timber felled for construction occurs on private lands. The Forestry Department obtains some data on the species being converted and the origin of the converted material by means of the timber removal permit system. The system provides an estimated 75 % capture of the actual conversion occurring due to poor enforcement (Table 2).

Table 3.2. Summation of Timber Volumes Extracted From Prioritized Species From The Forestry Department For The Periods 1983-90 &1995-98

Species #	Vernacular Name	Scientific Name	Total Volume (m^3)1983-90	Total Volume (m^3)1995-98	Total Volume (m^3)1983-90 &1995-98
1	Honduras Mahogany	*Swietenia macrophylla*	375.24	164.44	539.67
2	Gommier	*Dacryodes excelsa*	407.09	33.86	440.96
3	Lowyé Mabwé	*Ocotea leucoxylon*	175.40	57.34	232.75
4	White Cedar	*Tabebuia pallida*	545.79	631.80	1177.59
5	Bwa Blan	*Simarouba amara*	467.06	16.19	483.25
6	Bwa Damand	*Hieronyma caribae*	187.62	12.54	200.16
7	Blue Mahoe	*Hibiscus elatus*	131.12	17.66	148.77
8	Red Cedar	*Cedrela odorata*	222.92	19.89	242.81
9	Bwa kwéyòl	*Myrcia deflexa*	0.00	1.12	1.12
10	Bwapen Mawon	*Talauma dodecapetala*	44.66	8.21	52.87
11	Dry Wood	/	0.00	0.48	0.48
12	La Glu	*Sapium caribaeum*	88.01	0.00	88.01
13	Caribbean pine	*Pinus Caribaea*	0.00	26.23	26.23

Source: Forestry Department Timber Removal Permit Data, 1999. (L. John, 2000)

Trees are increasingly used outside forests for a variety of purposes ranging from windbreaks and fencing to riverbank protection and ornamental. The Forestry Department has sought to meet demands by expanding the range of species produced by its nursery under the germplasm program (Table 3). Suitable agroforestry tree crops such as avocado, breadfruit, cocoa, coconut grapefruit, mango, orange are already major economic crops on the island.

Table 3.3 Union Nursery Seedling Production Between 1996-1999

Species	1996/1997	1997/1998	1998/1999	Purpose
Blue Mahoe (BR)	75,880	3,500	0	Reforestation
Blue Mahoe (CS)	1,152	0	0	Reforestation
Honduras Mahogany (BR)	28,000	9,357	25,208	Reforestation
Honduras Mahogany (CS)	11,916	17,596	19,869	Reforestation
C. Pine	10,514	13,620	8,058	Reforestation / Ornamental
Cupressus lucitanica	3,028	9,509	2,154	Christmas tree production
Gmelina	2,562	447	0	Reforestation
Casaurina	900	336	72	Ornamental / Reforestation
Mangoes	35	30	2000	Riverbank protection
Limes	0	0	572	Riverbank protection
Palms	5,117	0	223	Ornamental
Leaucena	940	447	0	Reforestation /Agroforestry
Latanier	0	252	4,105	Research /Reforestation
Ficus	100	610	1,146	Ornamental
Jacaranda	0	0	1432	Ornamental

Source: Forestry Department (CS:containerized stock, BR: Bare root stock) 1999. (L. John, 2000)

Other Forestry Products and Services:Wood-fuels and Wood Energy

Historically, fuelwood has traditionally been used to meet energy demands, particularly in the rural communities. Research done during the 1980's based on the GOSL/CPU's 1981 Household Energy Survey showed estimated tonnage for consumption ranging from 80,0000 metric tonnes (UNDP 1984) to 98,162 short tons per year (Romulus 1987). In the Greenhouse Gas Inventory conducted as part of St. Lucia's National Communication on climate change, charcoal and firewood accounted for 24,994 TOE*(Tonnes of Oil Equivalent)- (Ministry of Planning, Development, & Environment (1999). Approximately 3.9 kg. of fuelwood produces 0.45 kg of charcoal. Charcoal is steadily being replaced by propane gas in rural households and this has offset much of the former demand for charcoal (Forestry Management Plan, 1993). No studies have been conducted during the past decade to assess recent trends in fuelwood use.

Recreation and Tourism

St. Lucia has long distinguished itself as a prime tourism destination. Features such as political stability, its range of natural diversity and a mild climate have maintained a vibrant tourism industry. The island has, over decades, protected its forest and wildlife resources through the enactment of legislation, the establishment of forest reserves, national parks, and conservation areas. St. Lucia has sought to develop policies favourable to the development of ecotourism.

The interest in the island's natural resources was pushed by the growing desire of tourists to visit natural areas. To facilitate this, in 1991, the St. Lucia Forestry Department requested assistance in rehabilitating its Central Rainforest Trail. External funding by CIDA and RARE was effectively used to leverage fiscal contributions from the local government in a ratio about 2:1. In its first full year of operation the trail generated US$40,680 for the Forestry Department. This figure about equals the total capital invested in the trail by the Saint Lucia Government (RARE, 1995). Forest tours have increased with the opening of new trails generating the largest share (56%) of the total revenue generated for the Department (Table 3.4).

Table 3.4 Nature Trail Visitor and Revenue data

Year	Trail	Visitors	Revenue (EC)
1995-1999	Barre d'lisle	9926	235,603.5
1997-1999	Des Bott	1099	10,360.0
1991-1999	Union	23554	19,949.5
1989-1999	Edmond Forest	14871	298,143.3
1997-1999	Embas Saut	2834	55,184.0
1996-1999	Des Cartier	11934	303,965
TOTAL		64118	923,205.3

Source: Forestry Department, 1999 (L. John, 2000).

Watershed Protection and Management

The primary function of forests in St. Lucia is the preservation of water supply. The island's terrain is steep with incised valleys. This coupled with heavy rainfall and relatively short river runs heighten the need for watershed protection. There are 37 main watersheds corresponding to 37 main watercourses each of which are at various states of utilization or degradation. The effects of agriculture have impacted all the major watersheds with some catchments totally deforested. There are seven major river basins (Marquis, Roseau, Vieux Fort, Cannelles, Troumassee, Fond d'Or and Cul de Sac rivers) which supply most of the water used for domestic, agricultural and industrial purposes. Groundwater storage is potentially restricted due to impermeable volcanic substrata.

Non-Wood Forest Products

Traditional use of non-wood forest products has occurred historically in St. Lucia. Rural communities have utilized a greater share of this resource than the urban sector which has traditionally demanded the timber resources. With the exception of the harvest of liannes for which a permit is obtained from the Department, all the other products listed have not been regulated and some are threatened in the wild. The main items in demand are:

Latanier (*Cocothrinax barbadensis*); used in broom production. Sales occur in rural and urban areas. It faces competition from imported plastic brooms. Statistics on the size of the market and the levels of harvest from the wild are currently unavailable.

L'encense (*Protium attenuatum*); used in the production of incense. The latex is tapped from the tree. The intensity of the demand is causing a decline of the species as trees are virtually girdled in the attempt to tap the latex.

Mauby (*Colubrina elliptica*); used in the production of a fermented drink. The bark and twigs are often harvested. The bark is favored for production purposes. This species is highly sought and therefore endangered locally. The local market is reportedly supplemented with stocks from St. Vincent.

Gommier (*Dacryodes excelsa*); The timber has traditionally been used in the production of canoes. The latex is also tapped and used for various indigenous purposes. Tapping for latex in extreme circumstances girdles the tree.

Various flowers are harvested including local orchids (*Oncidium spp*.). There are no statistics available on the rate of collection.

A variety of seeds are harvested for the production of jewelry and crafts. Liannes are also used in the craft industry.

Forestry Policies, legislation, and Institutions

The main legal instruments governing forest use and management are the following:
The Forest, Soil and Water Conservation Ordinance of 1946, amended in 1957 and 1983. This legislation empowers the Minister of Agriculture to establish Forest Reserves on Crown Lands as well as Protected Forests on private lands. It stipulates the conditions for timber harvesting, makes provision for the control of squatting, and defines various other offences;

The Wildlife Protection Act of 1980 places the authority for wildlife legislation in the hands of the Minister of Agriculture, and makes provisions for the conservation and management of wildlife, through the listing of species, the establishment of reserves, and the setting of fines for a variety of offences;

The Crown Lands Ordinance of 1946 establishes the position of Commissioner of Crown Lands and sets the conditions for the management and acquisition of Crown Lands;

The Water and Sewerage Authority Act of 1984 establishes the Authority and gives it some power for the conservation and management of watersheds. It allows it to request the Chief Forest Officer to take specific action required for watershed management, conservation or rehabilitation;

The Land Conservation and Improvement Act of 1992 establishes a Land Conservation Board and gives it a broad mandate with respect to the management of land and water resources. It enables the Board to deal with the issues of deforestation and inappropriate practices on private land;

The main policy document governing the forestry sector in St. Lucia is the Forest Management Plan for 1992-2002 (GOSL 1993). Its goal is to "protect and conserve the natural resources for the protection of the environment and to obtain maximum utilization consistent with sustainable development with regard to the welfare of the rural communities and the country as a whole. It has been approved by the Cabinet of Ministers.

Policy guidance also is or will be provided by three sectoral plans that are all directly related to the forestry sector:
a Biodiversity Action Plan has been developed and approved by Cabinet with funding and technical assistance from the United Nations Environment Program (UNEP), within the framework of the Convention on Biodiversity; a Watershed Management Plan has recently been formulated, with financial assistance from the UK Department for International Development (DFID); a national Environmental Action Plan was developed in 1996-1997, and adopted by the Cabinet of Ministers in April 1997. This plan was developed at the request of the World Bank. The responsibility for its implementation lies within the Ministry responsible for the Environment. (Reynard 1998)

Terrestrial Ecosystems

There are five major vegetative types with two transitional zones in St. Lucia. These have been identified by means of the Holdridge Life Zone classification system. This international system uses altitude, latitude, temperature and precipitation as the standards to determine natural vegetative composition and structure (Table 3. 5).

Table 3.5 Holdridge Life Zone classification for St. Lucia

Name	Area			Climatic Characteristics		
	Hectares	Acres	% of total	Location	Temperature C°	Annual Mean Rainfall (mm)
Tropical dry forest transition to Tropical very dry forest	1233.3	3046.3	2.0	Cap Estate	26	1270
Tropical dry forest	19517.0	48207.0	31.7	Union Roseau Hewanorra La Fargue Corinth	27 26 26.4	 1556 2163
Tropical moist forest	8278.8	20448.6	13.4	Roseau Rabot Ruby Vanard Soucis	26	2199 2441 2354 2786 2680
Subtropical moist forest	4528.8	11186.1	7.3	Patience Giraud	Varies between 18 to 24	2000 2490
Subtropical wet forest	19366.6	47835.5	31.4	Woodlands Barre de L'isle Park Beausejour La Perle	Varies between 18 to 24	2117 2970 2297 2606 2283
Subtropical wet forest transition to Subtropical rain forest	7555.3	18661.6	12.3	Quillesse Bath Nursery	Varies around 19	3743 2623
Subtropical rain forest	1162.2	2870.6	1.9	Mount Gimie	Varies around 19	4000 approx.
Totals	61642	152255.7	100			

(Source: OAS Life Zone Map 1984)

Tropical dry forest to Tropical very dry forest zone

General Conditions: This zone has the lowest annual rainfall in the country
Natural Vegetation: Dry scrub woodlands that merge into thorn scrub and poor grazing approximating to thorn savannah (e.g. Cap Estate, Moule a Chique).

Appropriate Use: Although the rainfall is adequate in the extreme north, the shallowness and stoniness of the soils prevent their use for agriculture. Only certain places with alluvial and colluvial soils are suitable for agriculture with irrigation.

Tropical moist forest

General Conditions: Rainfall all year but with varying intensity. June to December is the most rainy period. June and October are the months with the most precipitation and excess water has to be drained off. Usually February and March are water deficient.
Natural Vegetation: Natural vegetation consisted mainly of trees. At the present time, much of the forest has been felled to allow farming (e.g., Soucis, Union, Chassin).
Appropriate Use: The determining factors of land use in this life zone are soil type, gradient, and proper selection of species. The cost of agricultural production could be higher than in the less moist zones because of a more intensive control of pests and diseases is needed and loss of fertility requires periodic cultural (i.e. fertilization) practices.

Subtropical moist forest

General Conditions: the amount of rainfall here is about the same as that of tropical dry forest zone but due to lower temperatures, the evapotranspiration is also lower and consequently more water is available.
Natural Vegetation: Because of edaphic conditions, vegetation consists of species characteristic of dryer ecosystems (e.g. Desbarras, Savannes Estate).
Appropriate Use: In this lifezone, available land is very limited and isolated. The soils are shallow, stony and of low fertility. Edaphic conditions prevent wider agricultural use except for certain species like cashew, or trees for firewood and charcoal.

Subtropical wet forest

General Conditions: Average potential evapotranspiration may be estimated at 60% lower than total average annual precipitation. Approximately 3/5 of rain water is lost as runoff; therefore rivers carry water throughout the year.
Natural Vegetation: Nearly all the primary forest has been cut down. The remaining natural forest is essentially on the steepest slopes (e.g. Forestierre, Au Leon, Belvedere).
Appropriate Use: It is the largest life zone in the country, with some fertile alluvial soils suitable for intensive agriculture. Lands with moderate gradients are the best suited for perennial crops such as cocoa, and subtropical fruits. On steeply sloping lands erosion can occur, and failure to maintain a forest land use will result in the accelerated damage of the best soils, principally in the lower part of the river basins.

Subtropical wet forest transition to Subtropical rain forest

General Conditions: Higher altitude results in more rainfall than in the case of the Subtropical wet forest.
Natural Vegetation: Natural vegetation has been partially cut down (e.g. Millet, Barre de L'isle)
Appropriate Use: Excessive rain precludes the use of the land for agriculture purposes without risking severe damage to the soil. It is therefore advisable to maintain the forest in areas of steeper slopes in order to protect the catchment basins.

Subtropical rain forest

General Conditions: Higher altitude results in the highest rainfall for the island. More than ¾ of the rain water is lost as run off; therefore rivers carry water throughout the year.
Natural Vegetation: Natural vegetation consists of trees characteristically covered with parasitic and epiphytic plants (e.g.Edmond Forest, Morne Gimie).
Appropriate Use: Relief is broken over the greater part of this zone. The native species to this life zone have much more rapid rates of growth than those of the wet forest and possess a great capacity for natural regeneration, except in areas of high wind activity (e.g. Morne Gimie). Excessive humidity constrains agricultural possibilities. Natural plant cover must be preserved as a means of controlling runoff and soil erosion.
(OAS Life Zone Map information as prepared for Ministry of Agriculture, Lands, Fisheries, Cooperatives and Labour, 1984).

Socio-economic issues

It is recognized that climate change impact will not occur in isolation but rather its effects will be augmented by other existing environmental conditions. Some of the traditional sectors such as agriculture have imposed severe environmental strains on natural ecosystems. Conservation problems are heightened by the difficulty of differentiating climate change impacts from other stress related environmental degradation such as habitat decline, forest fragmentation, alien species introduction, and loss in community diversity.

St. Lucia has suffered from the lack of an appropriate land use policy. Problems such as lack of proof of ownership, lack of an integrated system of planning, inadequate legislation to control land development and an inadequate capacity to monitor development and limited ability to ensure compliance have led to a complex situation creating worsening land use problems (GOSL 1998). St. Lucia's land tenure system falls into three categories: Government Forest Reserve, crown lands and private lands. Approximately 60% of the Government forest reserve borders with private lands under various forms of land use. "The crown lands property has been particularly subjected to abuse through the open access regime. In some cases, public officials have facilitated

access and unregulated use of land resources and the lack of manpower for enforcement of legislation compounds the problem" (GOSL 1998).

Most of the natural vegetation occurring particularly in the moist regimes such as tropical moist forests to the subtropical wet forests areas have been stripped away for agricultural production. The total land devoted to agriculture is 207.73 km^2 (33.7%). A thriving banana industry during the 1980's led to increasing levels of deforestation throughout much of these zones and created an array of associated environmental problems (extensive use of agro-chemicals, severe soil erosion, water pollution).

Human settlement and infrastructure has also impacted on these zones. Most of the settlements in St. Lucia are coastal due to the rugged nature of the inland regions. The current level of domestic and commercial construction with its associated infrastructure is one of the leading causes of deforestation particularly in the tropical dry forest areas along the coast. Watershed protection and management was the leading concern in the establishment of forest reserves, as such, tropical dry forest was perceived to be of relatively minor importance. There are only three small tracts totaling 195 ha. in the Marquis/Dauphin region which are established Government forest reserves. Most of this vegetative type occurs on private lands and is therefore exploited for construction, charcoal production and the harvesting of posts for construction. Between the period 1977 and 1989, scrub forests were reduced by 5,162 hectares.

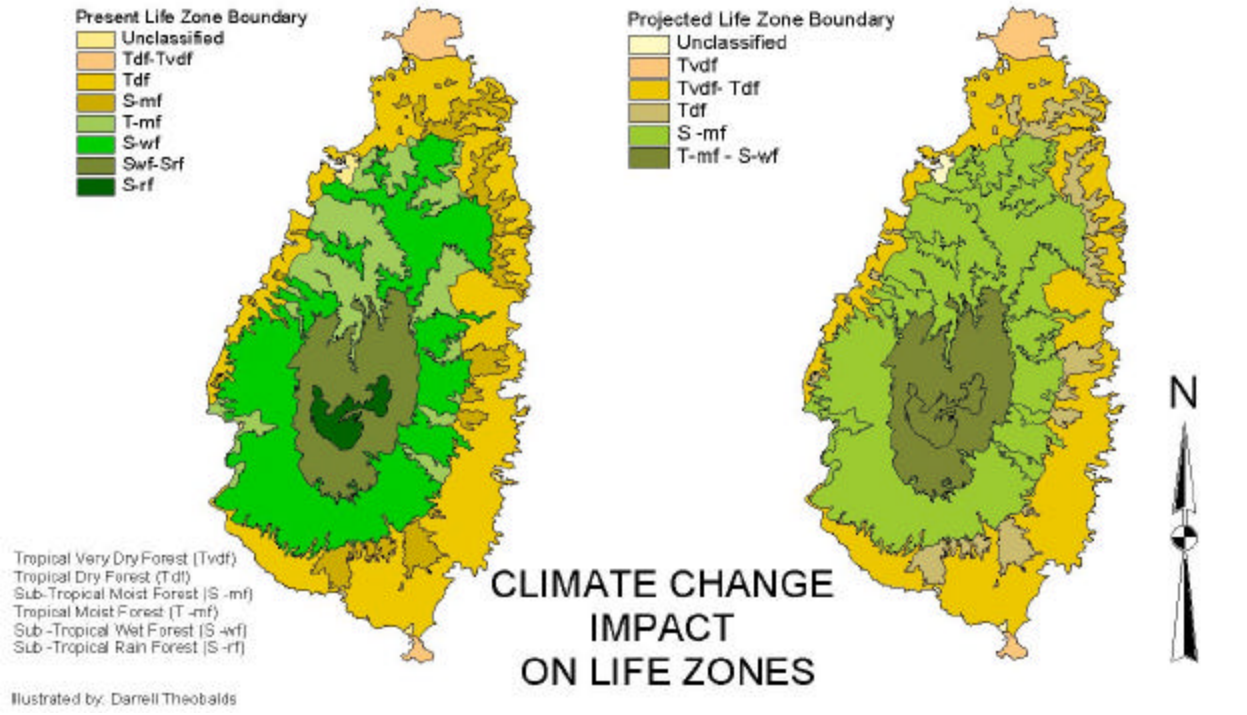
Climate Change Impact

The range of natural life zones occurring in St. Lucia displays heterogeneity and rich diversity typical of the tropics. Under the climate change scenarios, particularly projections of reduced rainfall and increased temperatures, such diversity is expected to be lost as homogeneity in habitats increases. This may be expected as areas of current microclimatic conditions are lost and large scale ecosystem shifts occur. The featured maps (Fig 2.), show a contrast between current conditions (left) and projected conditions by 2050 using a scenario of 20% less rainfall and increased temperatures (right). The projected image shows a substantial increase in the Tropical dry forest (T-df) lifezone replacing much of the current Tropical moist forest (T-mf) areas and the possible loss of subtropical rainforest lifezone, whichis the highest rainfall ecozone in St. Lucia.

Under the current climatic regime, drought has not been a significant factor to the forest ecosystems in St. Lucia. Sporadic fire outbreaks occur during the dry season in the grass areas along the east coast (Dennery and Micoud). However, the area is predominantly scrub forests with isolated patches of grass and the fires do not significantly damage the scrub forests. Many of the fires are deliberately set by individuals who seek to take advantage of dry conditions and use burning in the process of land preparation for planting. Given the projections of reduced rainfall and increasing temperatures, drought could become a more ominous feature in the future, particularly as the very dry forest to dry forest lifezone expands. A forest fire hazard may present

itself in areas such as Cap Estate, Moule-a-Chique (T-vdf lifezone) and along the coastal areas of Micoud and Dennery (T-df lifezone).

Fig. 3.1



Wildlife

St. Lucia is home to a rich array of fauna (Tables 6,7, 8,). There are several endemic species, many of which are habitat specialists. The degree of specialization can create problems for species that cannot adapt to changes provoked by climate change. The St. Lucia Parrot occupies the inland subtropical wet forests to subtropical rain forest habitat. Much of its habitat is secured as Government Forest Reserve. There are five endemic birds and two endemic subspecies which are also endangered (Table 6.): The St. Lucia white-breasted thrasher (*Ramphocinclus brachyurus*) and St. Lucia rufous nightjar (*Caprimulgus rufus*), the house wren (*Troglodytes aedon mesoleucus*) also rare and endangered (Gilardi and John, 1998). These three subspecies all occupy the tropical dry forest scrub habitat along the river valleys. Over 90% of their habitat is found on private land, making it difficult for management purposes (L. John, 1994). The reptiles generally show greater flexibility in habitat association (Table 7.). However, the St. Lucia iguana (*Iguana iguana*) primarily occupies the tropical dry forest habitat of the northeast coast while the St. Lucia whiptail is restricted to the Maria Islands which are composed of the same vegetative type. The mammals are fairly well distributed through out the habitat types (Table 8.). The particularly common species such as the mongoose and the opossum range from the dry forest types to the rain forest. The agouti tends to be associated with the moist vegetative regimes (e.g. subtropical moist forests-subtropical rain forests).

Table 3.6. List of Endemic birds recorded in St. Lucia's Forests

Scientific Name	Common name
Amazona versicolor	St. Lucia Parrot
Melanospiza richardsoni	St. Lucia Black Finch
Leucopeza semper	Semper's warbler
Icterus laudabilis	St. Lucia Oriole
Contopus oberi	St. Lucia Peewee

Table 7. List of Reptile Species Recorded in St. Lucia

Family Name	Scientific name	Common name	Status
Boidae	*Constrictor constrictor orophias*	St. Lucia boa	ES
Colubridae	*Liophis ornatus*	constrictor	E, VR
Gekkonidae	*Sphaerodactylus microlepis*	St. Lucia racer	E, C
Gekkonidae	*microlepis*	St. Lucia pigmy gecko	R, RE
Gekkonidae	*Sphaerodactylus microlepis*	Pigmy gecko	R, RE
Iguanidae	*thomasi*	Pigmy gecko	E
Iguanidae	*Sphaerodactylus vincentin*	Tree lizard	RE
Iguanidae	*diamesus*	Tree lizard	RE
Iguanidae	*Anolis trinitatis luciae*	Tree lizard	R
Leptotyphlopidae	*Anolis rouquet exrtremus*	St. Lucia iguana	R, RE
Teiidae	*Anolis wattsi wattsi*	Worm snake	E
Teiidae	*Iguana iguani iguani*	St. Lucia whiptail	R, RE
Viperidae	*Leptotyphlops bilineata*	Microteiids lizards	E
Gekkonidae	*Cnemidophorus vanzoi*	Fer-de-lance snake	C
Gekkonidae	*Gymnophthalmus pleei luetkeni*	House gecko	R
Gekkonidae	*Bothrops caribbaeus*	Rock gecko	C
Viperidae	*Hemidactylus mabouia*	Tree gecko	EX
	Hemidactylus palaichthus	Cribo	
	Thecadactylus rapicauda		
	Clelia clelia		

Key: VR-very rare; E-endemic, RE-regionally endemic;R-rare;ES-Endemic subspecies;C-common;EX-extinct
Source:Long, 1974; St. Lucia Environmental Profile, 1991

Table 3.8. List of Mammals Recorded in St. Lucia's Forests

Scientific Name	Common name	Status
Ardops nichollsi	NA	RE
Brachyphylla cavernum	Cave bat	RE
Dasyprocta antillensis	Agouti	C
Didelphis marsupialis	Opposum	A
Herpestes auropunctatus	Mongoose	A
Megalomys luciae	St. Lucia muskrat	EX
Monophyllus plethodon	Fruit and nectar-eating bat	RE
Musculus spp.	Mouse	C
Rattus rattus	Rat	A

Key: E-endemic, RE-regionally endemic; C-common; EX-extinct; A-abundant
Source: Long, 1974; St. Lucia Environmental Profile, 1991

3.3 CLIMATE CHANGE IMPACTS ON FORESTS AND TERRESTRIAL ECOSYSTEMS

It is difficult to assess how warmer climatic conditions will affect St. Lucia's landscape, especially for the mountainous tropical conditions. However, climate change impacts on the region by the year 2050 are expected to be significant with increases in the mean annual temperature by approximately 1.71°C leading to a total increase by almost 5°C in the year 2050 (Appendix I). Such an increase in temperature would create drought conditions, particularly if coupled with low precipitation creating instability in forest ecosystems. Current regional impacts are indicating a drying trend. A long-term drying trend in Central Panama appears to a leading cause of major changes in forest composition and diversity on the Barro Colorado island. There is an anticipated trend to early successional forest types and declining populations of *Dacryodes excelsa* and *Sloanea berteriana* in Luquillo Forests, Puerto Rico (O'Brien *et al*, 1992). Two similar species are used to define St. Lucia's Sub-tropical rainforest vegetative association (*Dacryodes excelsa* and *Sloanea caribeae*).

Wildlife research is still very much in its infancy in the Caribbean and St. Lucia is no exception. The possible changes to the environment induced by climate change will most likely upset the current ecological balance in ways that researchers are not able to appreciate due to inadequate knowledge of the systems. Many endangered species currently occur within the tropical dry forest zone of St. Lucia (e.g. White breasted thrasher (*Ramphocinclus brachyurus*), St. Lucia house wren (*Troglodytes aedon mesoluecos*) and the St. Lucia Nightjar (*Caprimulgus rufous*). Some of these species, particularly the white breasted thrasher, display highly specialized behaviour and are particularly affiliated with the riparian zones within the tropical dry forest of the northeast coast. Such riparian zones are created by the relatively constant presence of water as the rivers and streams cut through the dry forest zones to the coast. Under drought conditions, stream flow would be significantly reduced and this specialized habitat would be lost as more drought resistant species would invade former riparian areas.

The St. Lucia Parrot project has been aimed at understanding the behaviour and ecological relationships of this endangered species. In 1999, researchers noted that another bird, the Pearly- eyed Thrasher (*Margarops fuscatus*), was successful in chasing the St. Lucia Parrot from nesting cavities and causing at least seven nest failures in Parrot nesting attempts. Researchers speculate that early and continuous rains from December 1998-March 1999 were the cause of an early start on the 1998-99 Pearly-eyed Thrasher breeding season. In previous years of observation there was little overlap between the two species breeding periods and therefore less conflict (pers. commun. with M. Bobb and A. Dornelly, 2000).

The possible impacts of climate change on forests and terrestrial ecosystems could be summarized as follows:
Alteration in the range of species
Reduced water flow in watersheds
Increase in forest pests and disease

Reduced food availability for wildlife
Increase species competition for scarce resources
Greater vulnerability to extreme events (e.g. hurricanes)

Sea Level Rise

The threat presented by sea level rise to the coastal habitats (e.g. coastal freshwater ponds, brackish water systems, mangroves and arable floodplains) is substantial. Threats by sea level rise may be summarized as:
Increasing pressure on forest reserves due to loss of coastal agricultural lands by salinization (Roseau valley, Cul-de-Sac valley, Fond D'or, Mabouya valley)
Loss of coastal forests due to inundation and increasing storm events (e.g. mangroves and low lying tropical dry forests)
Migration or loss of wildlife species from altered habitats

In coming decades, as pressure on the remaining habitats increase and they decline due to fragmentation, the impact of climate change is expected to exacerbate the situation. The key issues regarding climate change impact on ecosystems are as follows:
The faster the rate of climatic change, the higher the probability of substantial disruption of ecosystem structure and function.

Ecosystems will not react uniformly in response to climate change. Rather, each species will respond differently. Existing species associations will break up and new communities of plants and animals will take their place.

Ecosystem response to climate change will depend largely on competition between species to maintain themselves in new geographic areas or under changing conditions. In many cases, species such as pests, parasites, and opportunists will benefit.

Ecosystems already stressed by human activities will be more vulnerable to climatic threats and will be among the first to show the effects of climate change. However, the multiple factors affecting these ecosystems will complicate the identification of strictly climatic effects.

Species adaptive abilities depend on not only on genetic variability but also on dispersal and migration capacity. Ecosystem resilience and genetic variability within populations are being reduced through habitat fragmentation. They will be further pressured by climate change.

For many ecosystems, increases in the frequency and severity of extreme weather events such as drought, storms, and floods will lead to some of the most serious impacts. Changes in seasonal precipitation patterns and weather variability will also be critical.

Hurricanes and Tropical Storms

With climate change there is also the anticipated increase in the frequency of storms in the Caribbean and therefore an increase in the risk of landfall. The terrestrial ecosystems are severely impacted on during the passage of tropical disasters. The main types of damage are of windblown trees, which represent a major loss of habitat. There is also damage to soils due to landslides and soil erosion.

St. Lucia lies in the path of passing tropical storms and hurricanes. In 1780, the island experienced its first [recorded] hurricane (at that time hurricanes were not yet named), which devastated the agricultural sector. Since then, several types of tropical disturbances have affected St. Lucia causing tremendous damage (Table 9.). The peak period of storm events coincides with the hurricane season in the north Atlantic from August to November. On average, St. Lucia witnesses 25 storms per year, which includes lesser storms not on the tropical storm or gale level. In recent times, tropical disturbances such as Hurricane Allen (1980) and Tropical Storm Debbie (1994) and a series of tropical waves (1996, 1998 and 2000) have caused severe damage. In 1980, Hurricane Allen caused millions of dollars in wind and flood damage and destroyed an estimated 40% of the existing rainforests (Table 10). While in 1994, Tropical; Storm Debbie produced 15 inches of incessant rain in a period of 6-10 hours, resulting in millions of dollars damage to the island's agriculture (53% of banana producing areas were adversely affected), the water resources and natural resource base and affecting revenue generation through ecotourism (M. Andrew 1999). With a projected 20 % increase in cyclonic activity, the resulting devastation to the natural systems and infrastructure could severely jeopardize the islands efforts at sustainable development.

While St. Lucia has been spared significant damage by hurricanes, tropical storms and waves have wrought damage to natural resources and infrastructure. The destruction of nature trails (paths, signs, benches) significantly reduces the revenue generation in the ecotourism sector. Such storms result in habitat destruction by breaking branches, defoliation, debarking and complete uprooting of trees. Significant loss of soils occurs due to land slippage and subsidence which impacts negatively on stream flow and water quality. The reduced habitat impacts negatively on wildlife allowing for disease, predation, lack of cover.

Table 3.9. Tropical storm records for St. Lucia (1780-2000)

HURRICANE HISTORY		
1780	June 12-14	Hurricane
1817	Oct.23	Hurricane
1818	Oct.21	Hurricane
1819	Sept.21/22	Hurricane
1831	Aug.11	Hurricane
1837	Jul.9	Hurricane
1841	Oct.6	Hurricane
1894	Oct.3	Gales &flood
1898	Sept.10/11	Hurricane
1923	Oct.26	Tropical Storm
1951	Sept. 2/5	Hurricane
1955	Sept. 22	Hurricane
1960	Jul.10	Hurricane
1963	Sept. 25	Hurricane
1967	Sept. 5-22	Hurricane
1978	Aug.10	Tropical Storm
1980	Aug. 4	Hurricane
1990	Oct. 4	Tropical Storm
	Oct.11	Hurricane
1994	Sept. 9/10	Tropical Storm
1995	Aug. 26	Tropical Storm
1996	Oct.26	Tropical Wave
1998	Oct.21	Tropical Wave
2000	Feb. 21	Tropical Wave

Wind Hazard

Wind damage on St. Lucia normally becomes a problem when wind speed exceeds hurricane force (64 knots or 120 kilometers per hour). Based on historic data, this phenomenon occurs one or twice every fifty years (DuBois, 1985). Hurricane force winds cause greater damage when approaching from the west or leeward side, due to the island being accustomed to the prevailing easterly winds, which make the east coast more tolerant.

After hurricane Allen (1980) at least 55% of all dominants tree species had broken branches and many had lost large portions of their crowns (Whitman, 1980). The trees with the larger crowns were naturally most affected, and most often were uprooted, creating large openings which exposed small crowned species and stimulating the development of dense undergrowth.

The main types of damage are in two categories; (a) damage caused by wind and (b) damage by water.

Wind Damage; where the forest is broken up into several areas with gaps and this can contribute negatively or positively to the forest, depending on the size of the openings. Numerous openings in the landscape cause the forest to be less resistant to strong winds and therefore less resilient to natural disasters. In plantation forests where thinning has recently occurred, trees tend to be susceptible to wind throw because the newly released stand or plantation does not have the mutual support and wind protection of the tight compact stand.

(b) Water Damage:St. Lucia's rugged terrain and high precipitation makes it prone to landslides (e.g. Ravine Poisson landslides, 1938, Black Mallet 1999). Flooding occurs in all the major valleys, and villages along the coastal areas of St. Lucia. As a result of hurricanes and tropical storms, landslides carry tons of soil and debris, thereby affecting river channels, resulting in major flooding in low lying areas. Floods carry debris which floats on the surface and batters stationary vegetation, and they deposit silt on the surface. Moving flood waters can alter stream and river channels.

Table 3.10. The Impact of Hurricane Allen on the Forestry Sector

Forest Assessment Information	
Area of Government Forest Reserves	16000 acres
Approximate area of commercial natural forest	8000 acres
Number of Forest Ranges sampled	5/5
Number of sample plots (1/4 acre)	22
Total acreage of sample plots	5.5 acres
Total volume sampled	22,630 cubic feet
Average volume/acre of sample plots	4,115 cubic feet
Total number/acre of sample trees	626
Average number/acre of sample trees	114
Type of sampling scheme	selective
Average volume by damage class (islandwide) fatal	42%
Recovering	39%
Unaffected	19%
Affected	81%
Average number of trees by damage class (islandwide)	
Fatal	49%
Recovering	35%
Unaffected	16%
Affected	84%
Average value/acre of fatally affected trees	EC$ 912.00 (US$338.00)
Estimated value of fatally affected trees in government forest reserves (using 8000 acres, based on estimates of natural commercial forest land in government)	EC$7,296,000.00 (US$2,702,000.00)

Source: (M. Andrew, 1999)

Impact on Wildlife

Hurricanes and tropical storms have a recorded history of a severe impact on the ecosystems of the Caribbean. With climate change the frequency of cyclonic activity is expected to increase in the region. Wildlife populations that are already stressed by other environmental pressures may succomb to extinction with the additional pressure of droughts, floods or increased hurricane strikes. Microclimatic changes may result in habitat shifts or the creation of unfavorable habitat conditions for wildlife, some of which may not be able to adjust to increasing temperatures.

With hurricanes and tropical storms, wildlife is exposed to the strong winds, storm surges and geographic displacement of individuals. The indirect effects occur in the aftermath of the storm where the wildlife experience loss of food supplies, foraging substrates; loss of nests, nests and roost sites; increased vulnerability to predation; microclimate changes and increased conflict with humans. The most important effect of a hurricane is the destruction of vegetation. The most vulnerable terrestrial wildlife populations have a diet of nectar, fruit, or seeds; nest, roost, or forage on large old trees; require a closed canopy forest; have special microclimate requirements and or live in a habitat in which vegetation has a slow recovery rate. Small populations with these traits are at greatest risk to hurricane induced extinction, particularly if they exist in small isolated habitat fragments.

Recovery of avian populations from hurricane effects is partially dependent on the extent and degree of vegetation damage as well as its rate of recovery. Also, the reproductive rate of the remnant local population and recruitment from undisturbed habitat patches influence the rate at which wildlife populations recover from damage (Wiley and Wunderle, 1992). In 1980, when Hurricane Allen hit the island, feeding and nesting sites of the St. Lucia parrot were affected. The bird's habitat was severely damaged; some areas were totally stripped; many trees were uprooted with extensive crown damage.

Summary of storm impacts to the islands rainforest and subsequent effects:
Accelerated soil erosion and increase in the number of landslides;
Excessive surface runoff, leading to increased danger of floods;
Changes in wildlife populations;
Increase in the degree of siltation in water supplies
Greater susceptibility of forest trees to wind throw
Increased illegal acts within the forest reserve (i.e.-squatting and illicit felling)
Decline in tourism activities, leading to loss of revenue;
Seed supply diminished

Community Problems

As a result of the forest destruction, mass landslides, blown down trees and tree crops, water and soil related problems; human settlements are affected tremendously. Those

common impacts and effects on the community include: (1) decline in water supplies and in some cases water shortages due to damage caused top water intakes, (2) flooding of rivers and valleys-this restricts access within and into the community (3) transportation and deposition of debris into villages and towns leading to the blocking of drainage systems (4) loss of livestock and crops (5) loss of life and property, (6) loss and damage of infrastructure leading to the food supply dislocation.

3.4 ADAPTATIONS TO CLIMATE CHANGE AND CONCLUSION

The strategies and actions recommended for adaptation to climate change are also suitable to cope with many other environmental pressures that currently exist. These recommendations can only serve to deepen understanding of St. Lucia's natural resources and add resilience to the natural systems in coping with anthropogenic stresses:

Development and implementation of a land use policy

Strengthen legislation and regulations governing forest management on government and private property

Agroforestry; There is the need to prevent land degradation and rapid soil erosion while providing land for agricultural production. Due to the rugged terrain it is absolutely essential to maintain tree cover on slopes 30° and over.

Acquisition of critical private watershed and habitat lands; this is crucial to maintaining an effective water supply to cope with growing agriculture and municipal demands. There is a need to find creative measures to encourage private lands to remain under forest cover. This may be through allowing landowners to benefit from a state fee to cover water extraction from watersheds, encouraging ecotourism activities or through land tax incentives.

Reforestation of critical watersheds; many of the watersheds have been partially deforested largely under the pressure of slash and burn agriculture. It may not be feasible to reforest certain areas with indigenous forest cover due to the level of degradation. In such circumstances, certain fast growing exotic species may be utilized.

Strengthen the existing Wildlife Protection Act and develop, adopt and implement a Wildlife Policy. This should also make provision for ensuring the security of habitat.

Protect wetland ecosystems: Such systems are the most threatened in St. Lucia (e.g. Aupicon Pond). Most of them are coastal and have been targeted as landfill sites and earmarked as future construction sites. These sites are important habitat to migratory and resident wildlife.

Urban Forestry: cities should be developed incorporating meaningful “green spaces”. Aside from aesthetic considerations, this would help alleviate some of the common urbane environmental stresses, particularly heat intensity, and noise pollution.
Public education / awareness on ecosystem threats and applicable conservation strategies

Activate community-based organizations (e.g. Talvan Water Resource Task Force, Dennery Watershed Action Force, Aupicon Charcoal and Agricultural Producers) and create a formal system of acknowledgement which addresses their needs and allows for participation in policy formulation.

A regional approach to critical habitat management and research: there is a need to understand how our tropical ecosystems respond to climatic changes. (e.g. Caribbean Foresters Society, CARICOM, OECS/NRMU)

Climate change is expected to exacerbate serious environmental pressures already placed on terrestrial ecosystems. Pressures such as forest fragmentation, reduction in habitat and the resulting adverse effects on wildlife species are already proving difficult to manage. Inappropriate land use practices have led to increased soil erosion, flooding of low lying areas and the destruction of watersheds. Climate change is expected to burden the natural systems with increasing temperatures, possible drought conditions and an increasing frequency in extreme events.

Effective adaptation calls for an integrated sector response drawing on the foundation of the various environmental legislative articles that currently exist (e.g. Wildlife Protection Act 1980, Water and Sewerage Authority Act (1984), Pesticides Control Act (1975), Land Conservation and Improvement Act (1992)) coupled with a clearly articulated and implemented land use policy. Such steps can only serve to strengthen those areas that are vulnerable to environmental pressure and climate change. The process will also involve the development and implementation of policies that hold natural resource conservation as a national priority.